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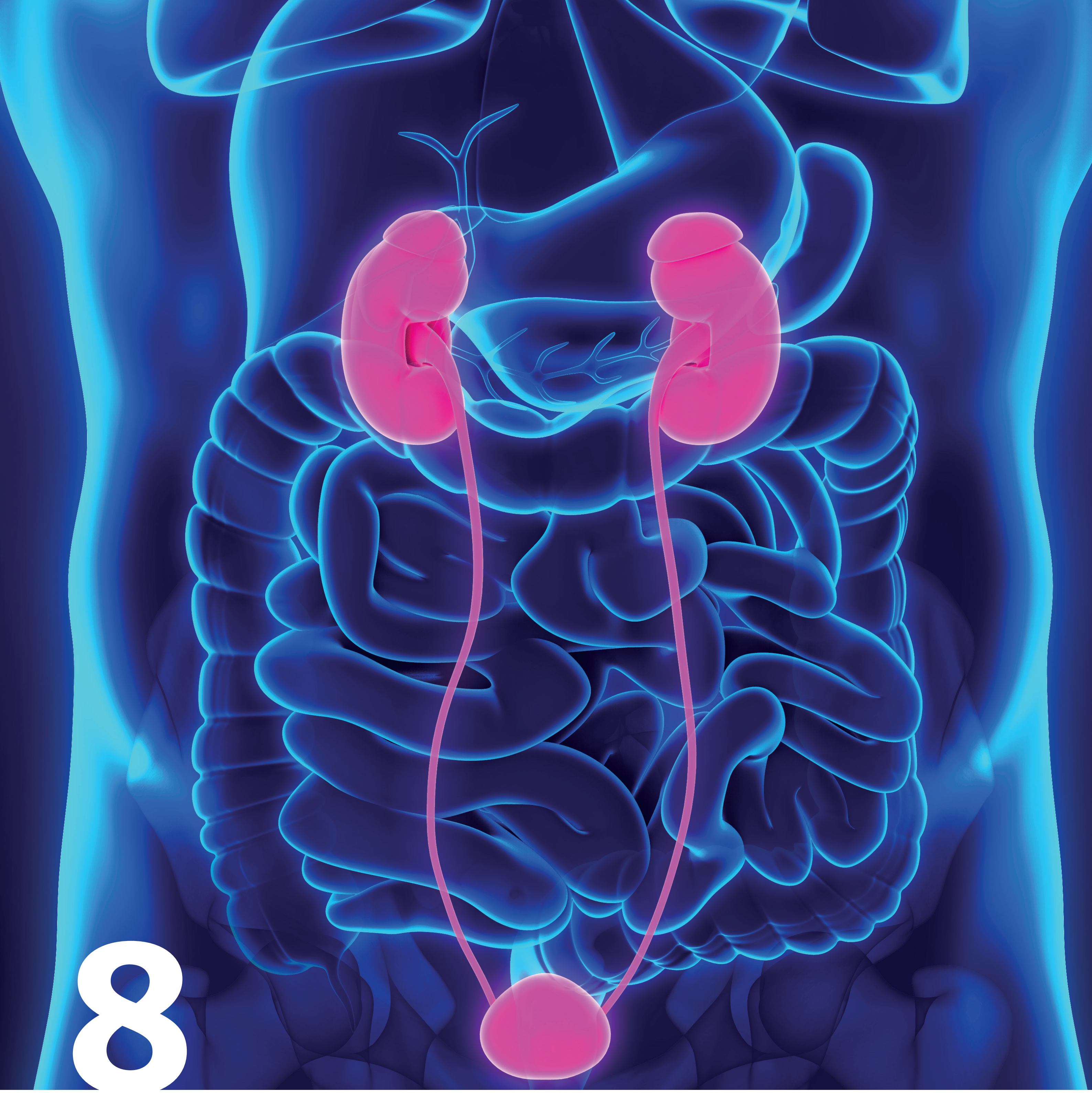
Vicarious Thrill



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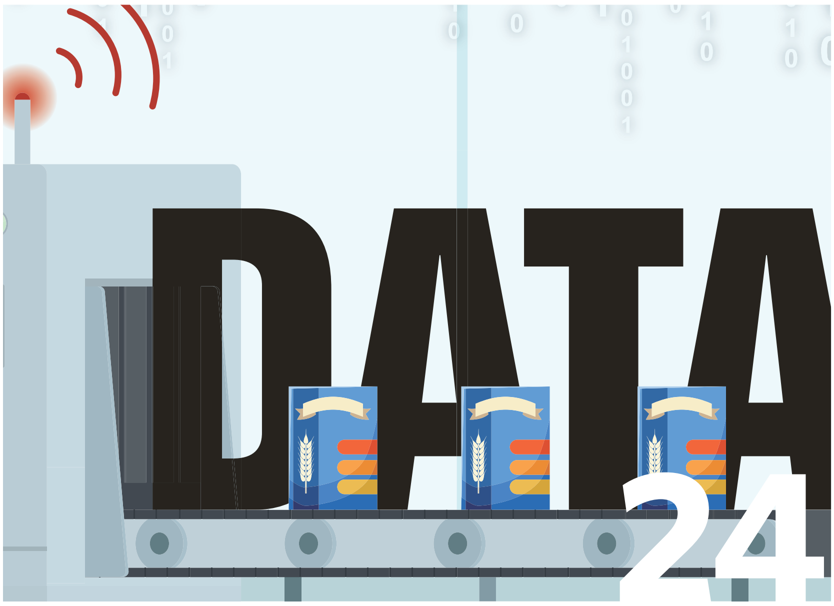

interface

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On the cover: *UCI students in CALIT2's EVoKE lab design a mixed reality experience allowing theatergoers to enter the world of "The Next Fairy Tale"*

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a year's worth of oxygen for 20 people

SAVES 17,128 gallons of water
enough for 1,016 eight-minute showers

SAVES 28,560,000 BTUs of energy
power for the average household for nearly four months

ELIMINATES 116 pounds of waterborne pollutants

ELIMINATES 1,895 pounds of solid waste
enough to fill more than 400 garbage cans

ELIMINATES 3,731 pounds of greenhouse gas

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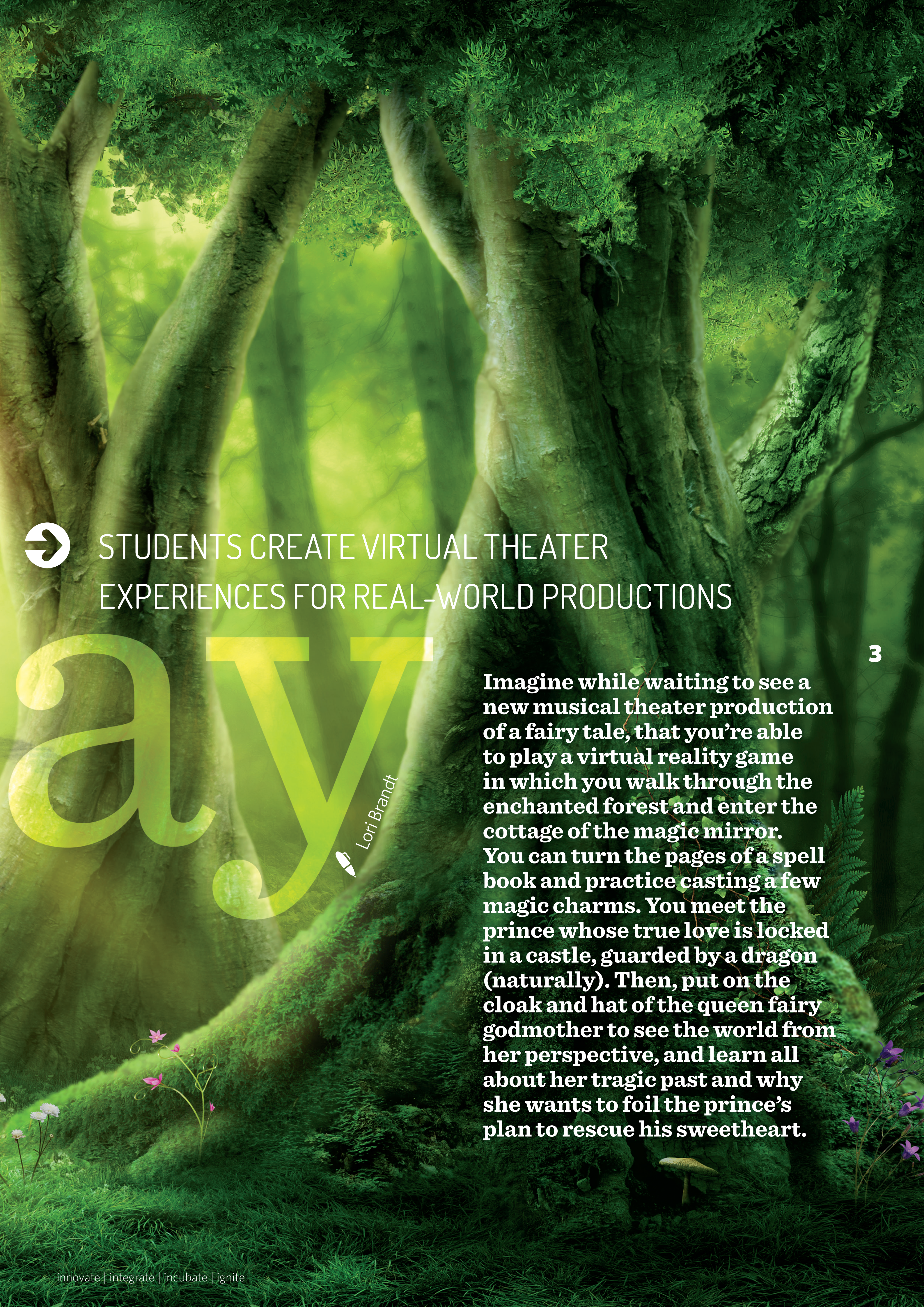


STUDENTS CREATE VIRTUAL THEATER EXPERIENCES FOR REAL-WORLD PRODUCTIONS

ay

Lori Brandt

Imagine while waiting to see a new musical theater production of a fairy tale, that you're able to play a virtual reality game in which you walk through the enchanted forest and enter the cottage of the magic mirror. You can turn the pages of a spell book and practice casting a few magic charms. You meet the prince whose true love is locked in a castle, guarded by a dragon (naturally). Then, put on the cloak and hat of the queen fairy godmother to see the world from her perspective, and learn all about her tragic past and why she wants to foil the prince's plan to rescue his sweetheart.

This mixed reality pre-theater experience is being designed by students working in the EVoKE Lab on the second floor of CALIT2. They are taking part in the inaugural session of an AR/VR Theater class being co-taught by Josh Tanenbaum and Tim Kashani '86. Tanenbaum, an assistant professor of informatics in the Bren School of Information and Computer Science, merges art with technology to help students explore the possibilities of transformative play. Kashani is a software executive turned Tony-award-winning Broadway producer.

The musical, titled "The Next Fairy Tale," is actually in development with Kashani's studio, and it is no ordinary fable. It's a love story about two princes. The UC Irvine students' interactive digital storytelling system is no conventional approach to theater either.

Tanenbaum sees storytelling as a fundamental cognitive tool people use to make sense of the world and to communicate their views with each other. Through his research, he seeks to better understand the pleasures that come from engaging in participatory storytelling and translate those results into creating powerful and moving experiences using digital technologies. He is particularly interested in how people navigate the shifting sense of identity when they inhabit a character in a game. Players can become so captivated, they begin to empathize with the roles they are controlling.

"When we change into a character, we have the opportunity to see the world through someone else's eyes, challenging our own complacencies and assumptions," he says. "I believe participatory media's ability to evoke this type of transformation makes it an invaluable tool for education, persuasion and social justice."

Tanenbaum's background in the performing arts inspires his work. Trained in a form of method acting known as the Meisner technique, he approaches game characters from the outside in, rather than the inside out. Instead of actors starting with their own personal experience and emotion to embody a role, Tanenbaum advocates embracing the character's way of speaking, moving, dressing, physical surroundings, etc., until the actor becomes the character.

The students are using Tanenbaum's research as the premise for their projects in the AR/VR Theater class. Twenty-two students are enrolled, and they are working in groups to develop three projects. Each one supports an actual production or product supported by Kashani. "The Next Fairy Tale" project is one of them.

"Informatics and computer science students learn a lot of great technologies in school," says Kashani, a UCI computer science alumnus. "But when you go out into the real world, none of that matters if you can't create a user-centered design in a way to connect with people on an emotional level."

Kashani founded IT Mentors, a consulting and training company that contracts with companies like UBS, Microsoft and other Fortune 500 organizations. Its success allowed him to pursue his passion of musical theater, and he has produced hits such as "Memphis," the revival of "Hair," and most recently the Tony-award-winning "An American in Paris." With his wife, Pamela Winslow Kashani (a Broadway actress), he co-founded Apples and Oranges Arts, which runs a startup-style incubator for new theater works called THEatre ACCELERATOR. By applying a Silicon Valley approach to developing pieces, the program hopes to meet its mission of "taking the starving out of artist." The THEatre ACCELERATOR uses insight from data analytics and audience testing to find the best-suited market fit for a piece. Through a two-phase development approach, they are able to accelerate the creative process and share diverse compelling stories that might otherwise not be developed.

One of the productions in phase one of this incubator program is another focus of the class. "Higher Education" is a new musical about a guardian angel whose mission is to help teenagers navigate the trials and tribulations of their senior year in high school. The UCI students are creating an interactive virtual reality experience set in the world of Higher Education, in which the player gets to step into the shoes of a guardian angel and protect a teenager.

"We are conceptualizing it in a way that allows the player to navigate a role, so they can experience the story from the inside," says Tanenbaum. "We want to give the player a presence in the fictional world not as a passive observer but as a character that exists inside the story."

The students' third project is a mixed-reality tool for set design using both smartphones and Windows Mixed Reality headsets. With Broadway shows, scenic designers build physical models of sets for discussion and visualization. "It's an immensely expensive process, in which everyone has to be in the same place to discuss," says Tanenbaum.

The Apples and Oranges Arts innovation initiative developed a prototype of the set builder that Kashani gave to the students as a starting point. "We wanted to create a more collaborative, flexible and less costly development environment," Kashani says. "The team is really running with it. The students are so passionate. Within a couple weeks, they had come up with ideas we had never thought about, even developing a way to use it on a smartphone. It's pretty exciting."

Eight undergraduates and 14 graduate students comprise the class roster, and they come from informatics, computer game science, information and computer science, drama, and film and media studies.

Melisse Andreana De Castro, a master's student in informatics, is working on the scenic design tool. She is glad for the chance to use her technical skill as well as creative eye. The class offers her an opportunity to collaborate with students from the school of arts. "It helps ICS students to collaborate with the very people who may be using their technology in the industry," she says. "Such chances are rare."

"This class has been the first time I have experienced absolute freedom to explore the topic of a course in ways that are engaging," says Ace Lowder, a third-year transfer student in computer game science. "I have learned more about how to function within a team than I have throughout my entire academic career."

Kashani advocates the real-world project experiential approach as an incredible learning experience for the students that prepares them for careers. "I love the energy in the class, and it's fun to watch them evolve," he says. "We are solving problems that are multigenerational. Age does not matter. There are no barriers. We are talking about a variety of things. They don't have to ask if they can try something. They can. There's nothing like trying out an idea and having it blow up, and then they come to class and tell us what they've learned."

Like many activities going on in the CALIT2 Building, the work being conducted in the EVoKE Lab by Tanenbaum brings together multiple disciplines to inspire creative projects that push conventional boundaries. "We couldn't do this research if we couldn't be in a place like CALIT2," says Tanenbaum. "This space is a luxury that allows us to create large installations and demonstrate our work."

For a couple of self-proclaimed theater nerds, it's the perfect space to get into character and spin a tale.

"When we change into a character, we have the opportunity to see the world through someone else's eyes, challenging our own complacencies and assumptions. I believe participatory media's ability to evoke this type of transformation makes it an invaluable tool for education, persuasion and social justice."

INTRO TO MEMES

The word "meme" comes from the Greek word mimeme, something imitated.

In 1976, evolutionary biologist Richard Dawkins introduced the term "meme" (mēm) in his bestseller, "The Selfish Gene."

Dawkins concluded that human behavior, particularly the evolution of cultures, is not simply the outcome of genetics, but rather the result of "units of cultural transmission, leaping from brain to brain," changing and evolving along the way.

Memes can be habits, skills, songs, stories or any other kind of information that gets copied from person to person.

While memes were originally intended as a serious scientific concept, Dawkins sees internet memes as a hijacking of the idea.

WHAT IS AN INTERNET MEME?

Internet memes are "units of culture," transmitted from person to person via the internet. They compete for dominance, reproduce and evolve. However, unlike Dawkins' concept, internet memes are intentionally altered.

WHY DO ALL MEMES USE THE SAME FONT?

In 1996, Microsoft included Impact as one of 11 core fonts for the web (fonts that would work across the internet) in its Windows 98 operating system.

Following the popularity of the "I Can Has Cheezburger?" meme, several sites with meme generators adopted the font and added a black outline.

THE FACE THAT LAUNCHED A MILLION MEMES

First shared in 2007, the "I Can Has Cheezburger?" meme is credited with launching the internet meme movement. One way this meme catchphrase has evolved is the Twitter hashtag #icanhazpdf (used to request access to academic journal articles that are behind paywalls).

LIFECYCLE OF AN INTERNET MEME

GENERATE

Free meme generators (online applications that allow users to add custom text to images) have made it easy to create and share memes.

1. Select image

2. Write caption

TOP TEXT

BOTTOM TEXT

GENERATE!

3. Generate meme

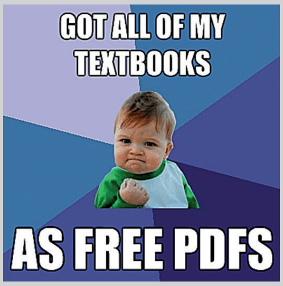
The first app of this kind was registered by Ferenc Somos on March 18, 2009.

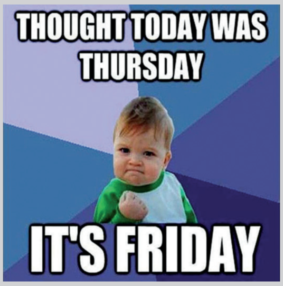
POST

Memes are posted on social media and often used as a vehicle for online commentary.

Sharon Henry

"Success Kid" is an example of an "Advice Animal" meme. It is defined as having a picture – usually representing some sort of emotion – and text to conform to that emotion.





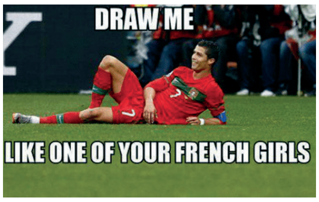
WHAT HELPS MEMES GET SHARED?

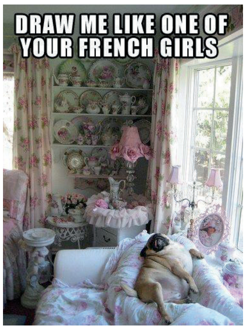
Meme online survival typically requires a major feature (such as the text or image) from the original meme to remain unaltered when shared.

FORMAT EXAMPLES:

SAME TEXT, DIFFERENT IMAGE

SAME IMAGE, DIFFERENT TEXT





"Draw Me Like One of Your French Girls" is a meme that uses dialogue from the 1997 film "Titanic." Its popularity spiked in January 2011.

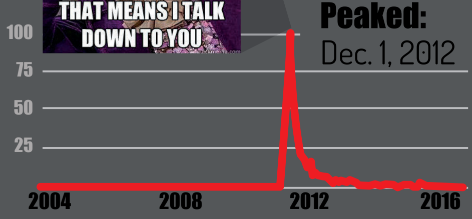
SHARE & EVOLVE

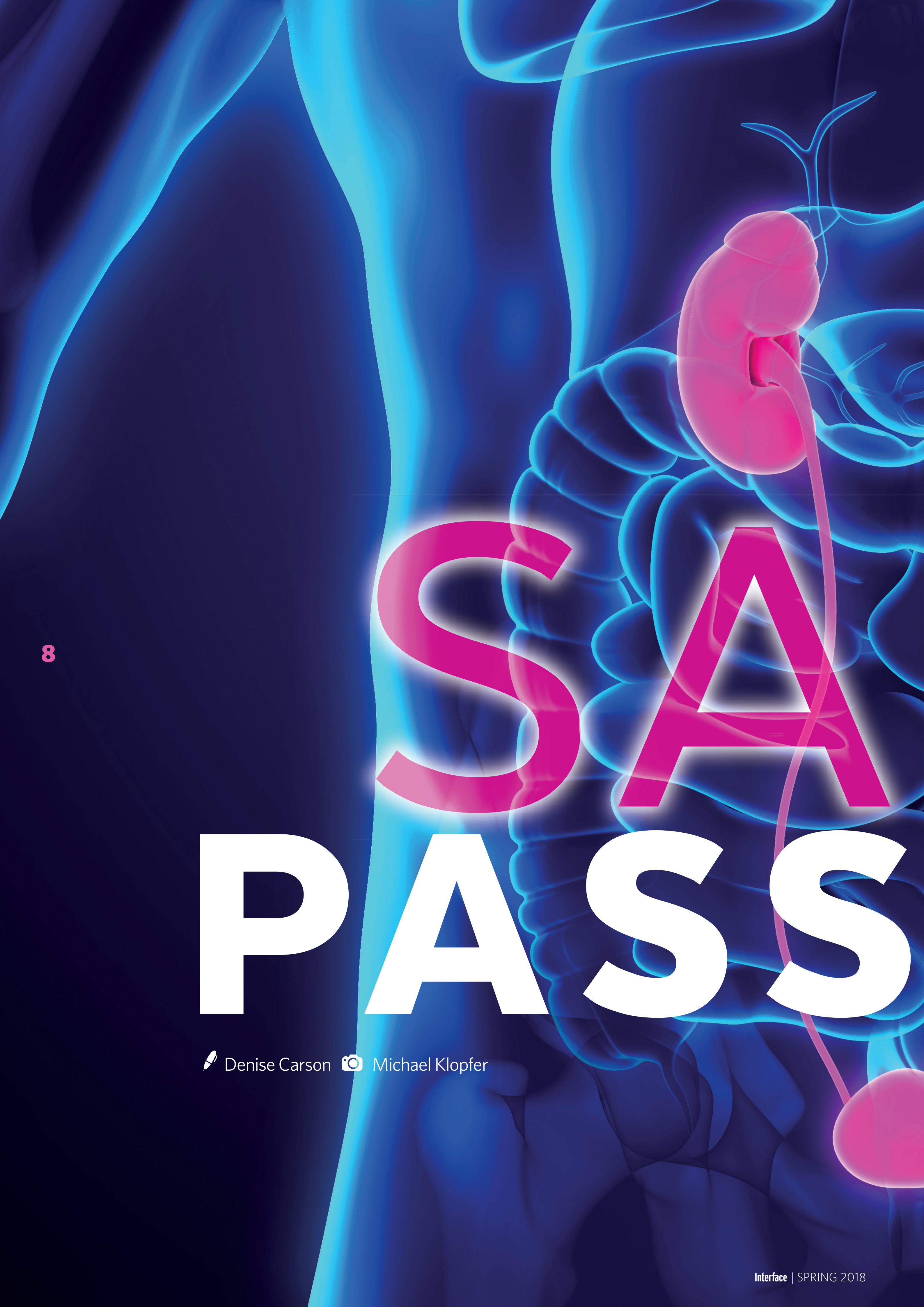
Memes are shared or altered in a way to appeal to a specific audience.

Researchers from the University of Memphis found memes that had swear words were **1.77 times less likely** to be shared.

SURVIVE OR FADE AWAY

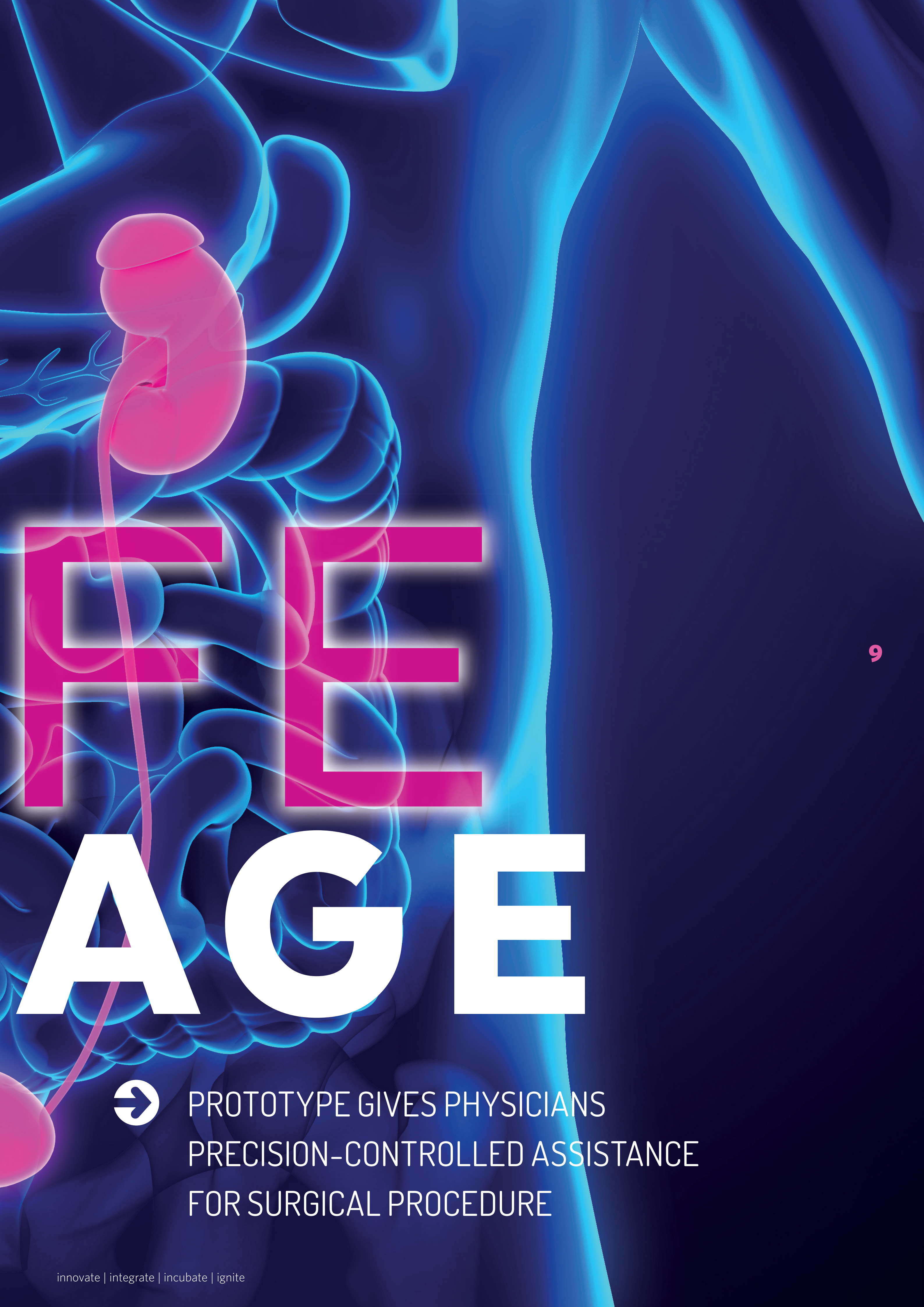
Websites such as *KnowYourMeme.com* research, document and track the popularity of memes.





SA PASS

Denise Carson Michael Klopfer



FE

AGE

PROTOTYPE GIVES PHYSICIANS PRECISION-CONTROLLED ASSISTANCE FOR SURGICAL PROCEDURE

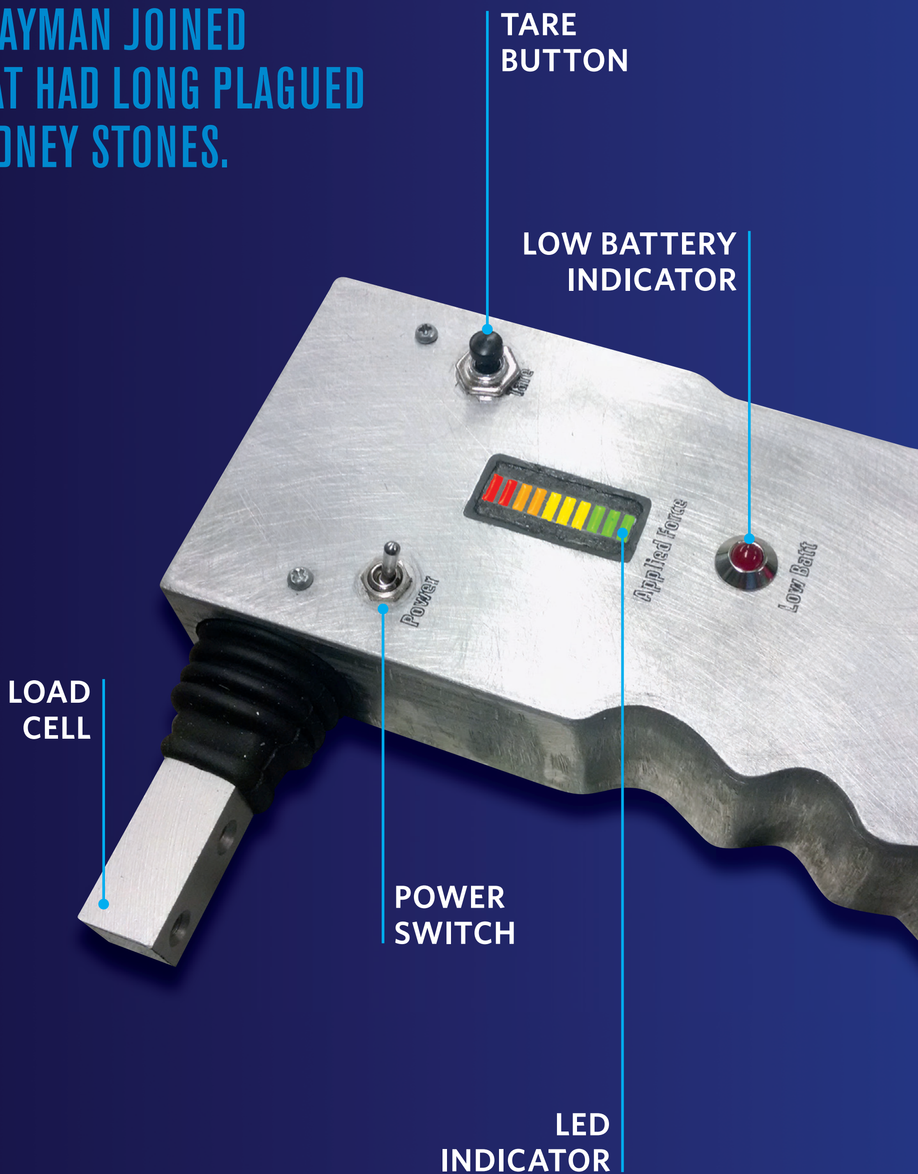
IN THE FALL OF 2016, UC IRVINE BIOMEDICAL ENGINEER MICHAEL KLOPFER AND PHYSICIANS DR. KAM KALER AND DR. RALPH CLAYMAN JOINED FORCES TO SOLVE A PROBLEM THAT HAD LONG PLAGUED SURGEONS TRYING TO REMOVE KIDNEY STONES.

In just 18 months, the trio developed and tested a device that improves the safety of a procedure known as a ureteroscopy.

The ureteroscopy eliminates the need for an incision, because instruments are passed through the urinary tract. Sometimes, however, the procedure can result in damage to the urinary tract's sensitive tissue. The procedure involves inserting a ureteral access sheath (UAS), which serves as a protective tube for doctors guiding instruments through the patient's ureter, a pipeline of smooth muscle through which urine passes on its way from the kidney to the bladder. In addition to protecting the tissue, the UAS opens a clear passageway from outside the body to the kidney, allowing doctors to more easily remove the stones.

Clayman, urology professor and dean emeritus of the UCI Medical School, pioneered the development of the modern-day UAS in the late 1990s, reducing operating time and enabling more urologists to utilize the minimally invasive procedure to remove the stones. Today, there are more than 10,000 ureteroscopies performed in the U.S. each year, and they are on the rise due to an aging, diet-challenged population.

"Once the sheath is in place, my mother-in-law could pass the ureteroscope into the kidney," Clayman jokes.



The Safe Passage prototype was developed at CALIT2, progressing from a CAD design to software programming and finally, circuit board integration. Klopfer and his engineering students milled the device case from a solid block of aluminum, then assembled the device, including the load cell, power supply and circuitry. The prototype passed preliminary testing with flying colors; in ureteroscopies on 34 patients, not a single ureteral tear or complication occurred. The team currently is at work on phase 2 – a disposable device, about the size of a 35 mm film canister, which can disengage force when it exceeds a predetermined level.

“

WE CREATED A FEW PROTOTYPES, BUT THE SURGEONS CHOSE THE SIMPLEST DESIGN; THEY HAD VERY FEW REVISIONS BECAUSE OF OUR EARLY MEETINGS AND OBSERVATIONS IN THE OPERATING ROOM. AS DA VINCI SAID, ‘SIMPLICITY IS THE ULTIMATE SOPHISTICATION.’

”

“

HELPING STUDENTS GROW WHILE HELPING THE COMMUNITY IS WHAT CALIT2 IS ABOUT. THIS IS WHAT MAKES ME EXCITED TO COME TO WORK EVERY DAY.

”

The problem was that inexperienced surgeons – and sometimes even those with experience – could inadvertently split a patient's ureter or otherwise damage the tissue by applying too much force while inserting the sheath. In fact, medical research publications concluded a couple of years ago that urologists should consider eliminating use of the UAS device because there were too many injuries.

Kaler and Clayman conceived the idea of a device that could measure the force applied by the surgeon's hand when deploying a UAS. But first, they had to define how much force was enough to damage a ureter during the insertion process. Lab experiments determined that a surgeon applying up to eight newtons of force was not in danger of causing damage, but any force beyond eight newtons could tear or even split the ureter.

The physicians brought their idea of a force-measurement device to CALIT2.

Klopfer, a CALIT2 technical manager, worked with Clayman and Kaler. He and his engineering team of students originally envisioned a glove embedded with sensors that could measure force during the procedure. After observing a kidney stone surgery, however, Klopfer, no stranger to translating laboratory research into technical devices, realized that their original idea of a sensor glove would interfere with the surgeon's workflow. He and his team worked closely with the physicians to develop a prototype that attaches directly to the UAS.

The sensor device, which they named Safe Passage, is equipped with load-cell technology – similar to the technology used in a kitchen or bathroom scale – that weighs and converts force into an electrical signal. That signal sets off an LED color-coded alert system that illuminates green, yellow, orange and eventually red. The lights correspond to progressively insistent beeping sounds that inform the surgeon whether he or she is applying safe force or entering the danger zone. The surgeon can see and hear the alarm system while guiding the UAS into place.

The load-cell sensor device connects to a smart tablet using Bluetooth technology, but can be operated independently of the tablet during surgery. “The load cell is so sensitive that it will pick up the weight of a piece of dust,” Klopfer says.

Klopfer and his engineering students developed the device in-house at CALIT2, progressing from a CAD design to software programming and finally, circuit board integration. They milled the device case from a solid block of aluminum, then assembled the device, including the load cell, power supply and circuitry.

Klopfer chose to house the load cell in a rubber boot from a motorcycle mirror to protect it during the surgical sterilization process. When asked how he came up with the idea, he professed that the junkyard is to the engineer what the art museum is to the artist. He often tells his students to walk through the junkyard to see a myriad of old and new designs.

After Klopfer and his team designed the device, Kaler took it for a sensor test drive in their lab models. “We created a few prototypes, but the surgeons chose the simplest design; they had very few revisions because of our early meetings and observations in the operating room,” Klopfer says, adding, “As da Vinci said, ‘Simplicity is the ultimate sophistication.’”

The definitive test came when the device entered the operating room. The surgeons used it in ureteroscopies on 34 patients, reporting not even one split ureter or ureteral complication.

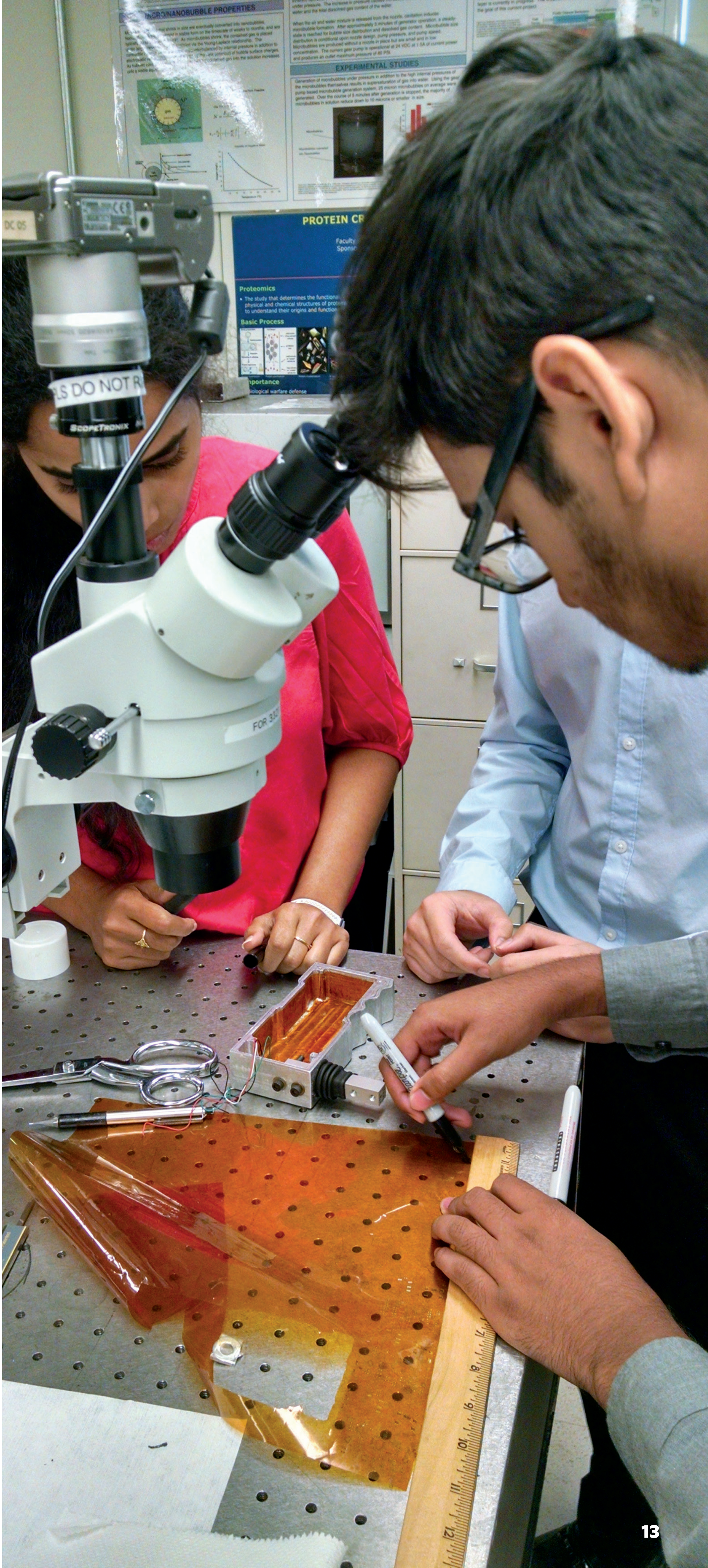
"We are already onto the next generation," Clayman says. Klopfer and his team are designing a small, disposal variety of the device, which is about the size of a 35 mm film canister. It is spring-loaded, to measure force with a mechanical scale, has chimes and includes a threshold fail-safe that disengages force above a pre-determined level.

Clayman, Kaler and the UCI Endourology Laboratory team are focused on reaching their goal of using the device on 200 patients and conducting additional lab research. Their findings were recognized recently with a second-place award for best science paper at the 2017 World Congress of Endourology, held last September in Vancouver, Canada.

"We no longer have to hit our heads up against the wall when we have an idea of how to solve an operating-room problem," Clayman says. "We have CALIT2 and Michael and his team of engineers to transform our concepts into devices and UCI's Applied Innovation to turn our prototypes into patents."

The next step, according to Clayman, may be licensing the technology or creating a company to make the device readily and inexpensively available. "Our mission is to develop devices and techniques to empower more urologists to do a better job for more patients."

As for Klopfer, who takes great pride in training students to solve technical problems, urologists and patients are not the only beneficiaries. "The students involved in Safe Passage feel a great sense of accomplishment in knowing their device can help people," he says. "Helping students grow while helping the community is what CALIT2 is all about. This is what makes me excited to come to work every day."



Klopfer takes pride in teaching students to solve technical problems. "[They] feel a great sense of accomplishment in knowing their device can help people," he says of those who worked on Safe Passage.

RISKS & REWARD$

ADVICE FROM A SEASONED VENTURE CAPITALIST

Lori Brandt

WITH AN UNEVEN ECONOMIC RECOVERY AND A NEW ADMINISTRATION IN WASHINGTON, INTERFACE MAGAZINE ASKED VETERAN VENTURE CAPITALIST RANDY LUNN TO TAKE STOCK OF HIS INDUSTRY.

A member of CALIT2's TechPortal Oversight Committee, Lunn has 40 years of experience. As managing director of Catalina Ventures, Lunn consistently finds, finances and supports creative entrepreneurs who grow businesses that become leaders in their fields. Over the years, he has raised and managed over $1 billion in funds for startup and early-stage technology and life science companies. With his partners, he has completed approximately 250 deals, resulting in 44 IPOs and around 160 mergers and acquisition events.

Q: YOU'VE BEEN KNOWN TO FIND AND SUPPORT COMPANIES THAT ARE STILL IN THEIR CONCEPT STAGE. WHAT MOTIVATES YOU TO TAKE THE RISK AND INVEST IN THEM?

A: I got into the business by being one of two founders of Texaco's venture capital subsidiary. My educational training is two engineering degrees and an MBA with an emphasis on finance. I have always loved technology, new markets, new products and the company-building process. Building value and growing a new company while guiding and financing talented individuals has been my life-long passion. This is why I do not retire.

Q: WHAT ARE SOME OF THE MAIN CRITERIA YOU LOOK FOR WHEN DECIDING TO INVEST IN A STARTUP?

A: Growing a new company brick by brick is not an easy task, so you need to do your homework to maximize the chances for success. In broad terms, I use my "four M" process to screen deals. I look at a company's market, management, margins and momentum. I want to see a large existing or potential market. Management needs to have had direct experience in the field they want to pursue. The product initially must be able to carry large margins to support growth and finance additional research and development. Finally, a new company must be able to generate early adoption and sales momentum. Is the customer willing to try and buy the new product? Is there an existing problem that must be overcome? Can the new product integrate well into the customer's workflow and strategic objectives?

During my due diligence, I do not look for reasons to kill a deal. I focus on identifying all the relevant risks. What are the key elements that must be overcome to be successful? Then I outline a plan that will allow the new company to manage these risks over time. What are the resources and people needed? How can I add value? Then I make a decision as to whether I want to invest.

Over time, a company shifts from being technology centric to being customer centric. Technology leads lessen or even evaporate over time, but market share and customer relationships can be defended. Helping a company anticipate this transition helps keep them focused on customer needs and how to sell more to them.

Q: FOR YOU, WHAT HAS BEEN THE MOST REWARDING ASPECT OF FINANCING EARLY-STAGE COMPANIES?

A: The most rewarding aspect of venture capital is seeing a vision come true and seeing people succeed. I get a big thrill when a first-time team of entrepreneurs buy their first fancy cars, wonderful new homes and sign up for the boards of local charities. The biggest lesson in venture

> MY GREATEST REGRET IS NOT ACTING SOONER IN ADDRESSING ISSUES. A SENSE OF URGENCY IS THE MOST IMPORTANT QUALITY FOR AN ENTREPRENEUR AND VENTURE CAPITALIST TO HAVE.

capital is that the world is not a zero-sum game. New value and wealth are created. We have made the world a better place and given more choices to people.

Q: WHAT SHOULD STARTUPS THINK ABOUT BEFORE CONTACTING A VC?

A: Before an entrepreneur approaches a venture capitalist, he or she needs to do some research. How much capital do they need and what type of venture capitalist do they want? One of the ironies of the venture capital business is that the very best venture funds manage too much money to make many startup investments. Multibillion-dollar funds must get their capital to work in big chunks. A VC partner can only sit on six to eight boards at a time. He cannot use up many slots on startups that also take more of his time than later-stage deals.

Look not only at the VC firm, but also the individual partner you would like to work with. You do not always have the ability to pick a partner, but try to get a sense of who has the skills and contacts that will most help you.

There are a growing number of small and medium-sized funds, so be sure to meet their minimum requirements or be quickly growing into these metrics before approaching them. An introduction is helpful if you can get one.

Q: WHAT IS THE VALUE OF A PRE-INCUBATOR LIKE CALIT2'S TECHPORTAL TO A STARTUP COMPANY?

A: An incubator is a perfect way to learn from experienced people how to grow your company. A team of advisers can help you set objectives, recruit key team members, make potential customer/ strategic partner introductions and guide you in the capital-raising process. The value can be amazing but do not expect miracles. You still have to manage and grow the business. It is hard work but fun work.

Q: WHAT INDUSTRIES ARE HOT RIGHT NOW, CATCHING THE EYE OF INVESTORS?

A: There are always hot new markets but by the time a new market is hot, there are usually many competitors.

Currently the internet of things (IoT) market is getting lots of play. This space is the next phase of connecting everything to the internet. The IoT market provides many entry points from semiconductors to IoT-enabled products to IoT monitoring software with AI interfaces to send alerts or provide feedback.

The home segment is clearly in front of us with Amazon's Alexa and numerous competitors, but the industrial markets will also offer large and significant returns. Think IQ is a clear leader in this space and is a leading company in the UCI Cove Fund. Think IQ has already saved its first major customer over $20 million by monitoring one of its major supply chains.

Another growth area over the last decade has been connecting people. This trend will continue. We will see more consumer apps and games. We will see if the current leaders like Facebook can morph with the evolving market. Will new leaders emerge? How the internet affects people is one of the most important topics in society today. We are still struggling to figure how it can help us and not divert us.

There also is a revolution going on in condensed-matter physics and chemistry with new materials. The quantum world is being exploited with products such as quantum dots that are already finding their way into TV sets and displays. Superfluidity, superconductivity, new catalysts, attosecond chemistry, quantum computers, spintronics, quantum Hall effect devices, topological insulators and other science breakthroughs are slowly but surely coming.

I believe that new 2-D materials such as graphene will revolutionize many markets from faster, smaller and more linear semiconductors to new properties for sports equipment, industrial components and even clothes. Other 2-D materials that will be coming soon including transition metal dichalcogenides, HexBN and more.

In the medical markets, we will see new approaches to antibiotics and drugs for cancer and autoimmune diseases. CRISPR and Cas technologies for gene editing are just appearing. We will see epigenetics capabilities emerge in the methylation, histone modification and micro-RNA areas. The understanding of the human biome will lead to effective methods to balance out the gut and protect it from attack. We will learn to live better with the diseases we have and possibly cure them.

Q: SINCE YOU BECAME A VENTURE CAPITALIST, WHAT HAS BEEN YOUR BIGGEST MISTAKE/REGRET AND LESSON LEARNED?

A: The biggest lessons are (1) getting a great team as soon as possible, (2) focusing on what is truly important by performing the critical tasks first and (3) investing your cash wisely to live as long as possible if setbacks arise ... and they will.

My greatest regret is not acting sooner in addressing issues. A sense of urgency is the most important quality for an entrepreneur and venture capitalist to have.

Q: FIRMS IN CALIFORNIA, MASSACHUSETTS AND NEW YORK ACCOUNT FOR 83 PERCENT OF THE COUNTRY'S VENTURE CAPITAL. GOING FORWARD, DO YOU SEE OUR HOME STATE CONTINUING TO BE GOLDEN?

A: Southern California is clearly on the rise and an exciting place to be. California, New York and Massachusetts will remain the centers of entrepreneurship because the complex infrastructures exist and the leading academic institutions are there. Several secondary markets will remain important including Texas, Minneapolis, Seattle, Salt Lake City and others.

Q: IN YOUR VIEW, WHAT IS THE BIGGEST HYPE AT THIS MOMENT AND WHY?

A: Bitcoin. The use of bitcoins in normal economic transactions is emerging but concerns remain. What the world wants is a stable store of value, but the bitcoin market is currently a speculator's dream (or nightmare). There is no intrinsic value to them other than the energy burned creating them. An economist would value a bitcoin at the marginal cost to produce one. This is why many bitcoin miners have established themselves in locations where they have cheap hydroelectric power like Iceland and the Pacific Northwest. Today, the amount of bitcoins you can earn using a home PC would be dwarfed by the electricity bill.

The underlying technology however is of great value. The distributed general ledger technology and other competing solutions such as Hashgraph and Hyperledger Fabric are going to happen. Most of the major financial institutions have experimented with distributed ledger technology and focused on three major concerns: technical (low transactions per second, and cost), regulatory (FATCA compliance) and security. One area that will hugely benefit from distributed ledger solutions is health care. Electronic medical records could be the first big win for the technology.

The bitcoin world will evolve and several successes will emerge, but it will be a bumpy ride.

Q: ANY CLOSING THOUGHTS?

A: It has been a pleasure to be a venture capitalist. I have enjoyed all of its components and the many people I have gotten to know. I believe entrepreneurship fueled by venture capital will continue to be the engine that drives jobs, new products, new markets and national wealth.

Thank you for the opportunity to share some of my experiences.

PERPET MOT

WHETHER SCIENCE OR SPORT, RICHARD DONOVAN TACKLES THE SUBJECT WITH SWIFT DETERMINATION

UAL
TION

Anna Lynn Spitzer Adam Johnson | brocket, inc.

RICHARD DONOVAN IS A MAN ON THE

MOVE.

From his childhood in Montana to universities in three states and jobs in six.

From hotshot firefighter to professor, scientist and entrepreneur. From technical center director to head of research development.

From fishing, windsurfing and power lifting to biking, cross-country skiing, surfing and open-water swimming.

Even in conversation, he is in motion: tapping a foot, drumming his fingers, bouncing a knee.

Donovan is relentlessly curious. He thrives on exploration and discovery – and whether the venue is a classroom, a lab, a trail or a Great Lake, it's all the same to him. "The stuff I'm interested in as a scientist is the stuff I'm paying attention to when I'm out playing around in the world," he says. "There's all this science and mechanics to motion. I have many friends who are really good windsurfers, and I always joke to them that they're really good engineering mechanists too."

The director of research development for the UC Irvine schools of engineering and information and computer sciences, Donovan, whose office is in the CALIT2 Building, is the institute's liaison on a number of initiatives and projects.

Most recently, that means CESMII – the Clean Energy Smart Manufacturing Innovation Institute – a multidisciplinary, multi-institutional initiative originated by the Obama administration to enhance U.S. manufacturing productivity and global competitiveness while safeguarding sustainability.

CALIT2 is at the core of UCI's CESMII membership, serving as the Southern California demonstration center and a referral source for proposals, one of which Donovan recently submitted on the institute's behalf.

The "Smart Connected Worker Program" proposes a multidisciplinary approach to using technology and processes to create a more productive, safer and more worker-connected manufacturing environment. "It's not all about the Google glasses and the fancy sensor networks," Donovan explains. "It's about giving people the right kind of information to make good decisions."

CALIT2 Irvine Director G.P. Li worked hand-in-hand with Donovan on the proposal. In fact, Li learned that Donovan had his phone number on speed-dial late one night when Li received an unintended pocket dial. "I could hear a lot of background noise, but no talking,"

Donovan leads a group of CESMII affiliates through CALIT2, which serves as the Clean Energy Smart Manufacturing Innovation Institute's Southern California demonstration center.

Li laughs, before turning serious: "There have been a lot of intensive interactions; I would get phone calls from him at night and on the weekends. To me, that demonstrates his commitment to the project.

"He brings a lot of value in the area of sustainability," Li continues. "It's not simply about doing research and developing technology; you have to think about the long-term impact on the environment and on society. That is what I view as one of Richard's major contributions – bringing that perspective into our proposals."

Energetic and wickedly witty, Donovan rarely misses an opportunity to inject a wisecrack or double entendre into the conversation. Asked to describe himself, he deadpans: "Tall, dark, handsome ... and very modest." (He admits later this is a family joke, inherited from his dad.)

Born and reared in Hamilton, Montana, in the heart of the state's scenic Bitterroot Valley, he was the fifth of six children. Donovan's father was a high school math teacher and his mother an administrative assistant at the Rocky Mountain National Lab. He describes an idyllic childhood – aside, that is, from the four older brothers and sisters who "cramped my style all the time."

Growing up in a large family made him independent. It also taught him punctuality. Dinner was at 6 p.m. sharp. "You knew you better be there at 6:00 because with five brothers and sisters, dinner was over by 6:20," he laughs.

After completing one year of college in Montana, he visited his older brother Kevin in Austin, Texas. The visit convinced Donovan that it was time for him to broaden his own horizons. He transferred to the University of Texas, Austin, where he completed his undergraduate degree in civil engineering.

Top: Donovan's office in the CALIT2 Building serves as command central for engineering and information & computer science research proposals, as well as CESMII coordination. Bottom: In his role as research development director, Donovan often assists faculty members with their proposals. Here, he meets with Lee Swindlehurst, electrical engineering and computer science professor.

He spent summers fighting fires on a hotshot crew in Idaho, a gig he dismisses as just another job. "Yeah, I guess it was kind of dangerous," he says, "but I never really thought much about it. I like exciting things … and I don't scare easily."

That becomes evident as he details favorite leisure activities – former and current. In college, he was on the national-champion powerlifting team (lifting 617 pounds in the deadlift). These days he bikes, surfs, windsurfs, open-water swims – the list goes on – and has scars from numerous surgeries as testament.

Donovan's bachelor's degree was followed by a master's degree in civil engineering at Montana State, then employment at a Santa Fe, New Mexico, structural engineering firm. "It was a great job," he says, but after four years, it was time for another change. "By the third year, all the excitement of learning how to be an engineer and then knowing what to do turns into your boss wanting you to come in and do that every day," he says dryly. "I was like, 'Wait, didn't I do all that last year?'"

He enrolled in a doctoral program in mechanical engineering at the University of Wyoming. A few years later, doctorate in hand, Donovan joined the mechanical and civil engineering faculty at University of Evansville, in Indiana.

"It was a super great experience, but there was not much of a research infrastructure there," he says of Evansville, where he stayed for four years. "I was more interested in doing hands-on-science type of things."

So the professor became an entrepreneur, returning to Montana and starting a company dedicated to developing business-to-business networks. His plan was to form collaborative networks with groups of small companies, allowing them to pre-negotiate joint venture agreements for more complex projects than those they could manage by themselves.

Ultimately, however, he returned full time to teaching and research. "It turns out it's really hard to start a business," he quips. "I finally got out of it because I realized I'm just not a business kind of person."

He took much of his newfound experience with him to a faculty position at Montana Tech. There, he taught classes and served as director of the Rocky Mountain Agile Virtual Enterprises Technical Development Center, a National Science Foundation-funded institute focused on precision fabrication, homeland security and composite materials modeling.

David Hobbs, at the time an assistant professor at Montana Tech, is now head of its Department of Chemistry & Geochemistry. He and Donovan worked closely together on a number of projects. "Rick works (and plays) very hard. He is great at seeing beyond typical academic boundaries and barriers, to bring together successfully a diverse group to work on innovative projects," Hobbs says.

He adds that Donovan liked to hire students from different disciplines to work on projects. "So at any one time we had engineering, chemistry, geophysics, computer science and technical school students working successfully together. In my opinion this produces students who are likely to see beyond a job or particular project, and use new ideas to innovate."

Next stop: Michigan Technological University in 2009. Donovan was operations manager, senior engineer and scientist, overseeing work at the university's Sustainable Futures Institute. He loved returning to hands-on exploration, collaborating with researchers from multiple disciplines to develop new biofuels and bio-energy programs. An added bonus: his location in Houghton on Michigan's Upper Peninsula was just a few miles from Lake Superior, where he could regularly challenge the swells on his sailboard.

"I had some epic windsurfing days on Lake Superior," he says. He recounts adventures involving 20 foot swells, 40-knot winds and a good deal of adrenaline. "Pretty epic," he repeats.

Former boss David Shonnard, Michigan Tech chemical engineering professor and director of the SFI, remembers Donovan as an independent thinker with many research interests and a sunny outlook, who "made a big difference in our successes." Shonnard credits him with helping SFI salvage a $20 million NSF proposal that was the victim of Congressional budget cuts; Donovan reworked the application into several smaller proposals, resulting in $8 million in research grants for biofuels development.

"Rick was always ready to pick up the phone when I called, no matter what," Shonnard says, recalling one particular call. "[He was] at the beach on Lake Superior. The wind was up and waves were high, so Rick was holding office

Below: Donovan sets sail on Lake Superior.

Far right, top to bottom: Donovan with his dogs Bill and Sparky in the Highland Mountains near Butte, Montana, circa 2008; wife, Katie, with a relative's pup; posing with his younger sister, Susie, outside the family home in Hamilton, Montana, circa 1969; on a recumbent bike during a 2012 triathlon in Michigan.

hours on the beach that day. Simply put, that is Rick. Sometimes you've just got to answer another type of call."

It's probably no surprise that Donovan juggles, is a skilled dancer and has competed in several triathlons. He's somewhat adept on a surfboard too. "I have pretty good board skills from windsurfing, and I'm a strong swimmer from doing triathlons, so I can paddle onto some pretty big waves," he says. "But I have no judgment at all."

(Last year, that deficiency sent him flying into a sandbar, resulting in painful pinched nerves – what he calls "a big ding." Donovan won't let that stop him, however. "It's just too much fun," he says.)

In 2013, Donovan saw an advertisement for his current job. He remembers thinking, well, why not? "A student of mine once commented that I was a change junkie," he says. "I do like starting up new things, getting them rolling. It's a big part of my personality."

So is gratitude. "It's a great time to be in science and engineering," he says. "And I think I've been pretty lucky in that I've more or less known what I wanted to do as a career from as early as I can remember."

He recounts the moments, when as a child, he began to understand the concepts of gravity and flow, and knew positively that he would be a scientist. "There are a lot of people in the world who don't get to do what they want, or what they think is most interesting."

Donovan is not one of them. "The stuff I'm interested in as a scientist … is deeply embedded in many places. There's always something interesting for me personally in most of the stuff I work on."

Then, he leans forward and in an exaggerated whisper, adds: "Dumb luck. Don't tell anybody."

CALIT2'S LATEST USER LAB OFFERS A PLAYGROUND FOR EXPERIMENTAL DISCOVERY

GOT

DATA?

Sharon Henry

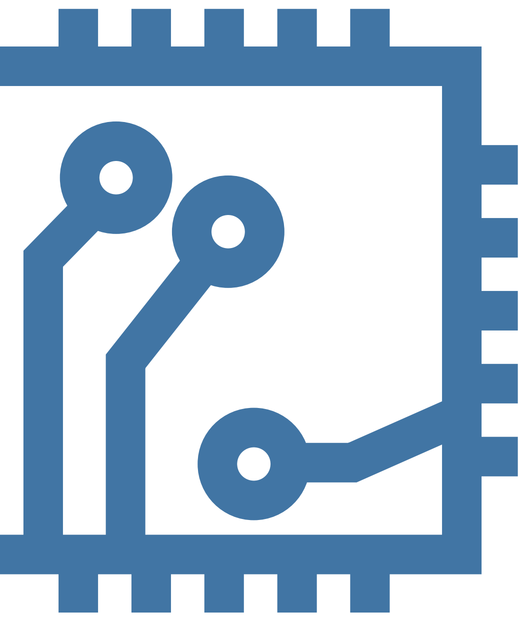
Should you find yourself inside a cereal-processing plant in the not-too-distant future, you may notice – along with conveyor belts moving heaps of grain to be steamed, dried, shredded, baked or toasted – that a revolution is underway.

Motors running the conveyor belts are deciding when production lines will speed up, slow down or stop. The machinery gets real-time data on environmental factors, schedules, staffing, incoming orders and other variables that affect productivity and energy use. Without any human input, the motor processes this information and decides what action to take.

This is all possible due to a microprocessor chip embedded in the conveyor belt motor. About the size of a postage stamp, the chip serves up a wondrous bit of programming based on collected data and a machine-learning algorithm. The algorithm provides the motor with a "model of the world," which is packed with every contingency it might encounter in its environment and a correct response to each.

Is it humid today? What is the weight difference for each grain due to humidity? How much more or less energy is needed?

The motor also monitors its own performance specifications. Is this vibration excessive? Is the bearing lubricant too hot? These are all questions the motor can answer and act on.



It's not only motors that are smart; sensors, actuators and countless other pieces of machinery are "thinking" and acting on their own. All of this activity is generating massive amounts of data as every movement and observation is recorded and stored. This is the industrial internet of things (IIoT).

Smart devices and systems are operating in thousands of factories, processing plants and warehouses. As industries become more adept at working with data and connecting to IIoT, manufacturers will increasingly rely on machine learning and smart applications to help deliver maximum productivity and energy efficiency.

CALIT2 Director G.P. Li is prepared to advance these types of energy-saving, smart manufacturing applications when CALIT2's new Data Engineering Infrastructure Lab opens this summer.

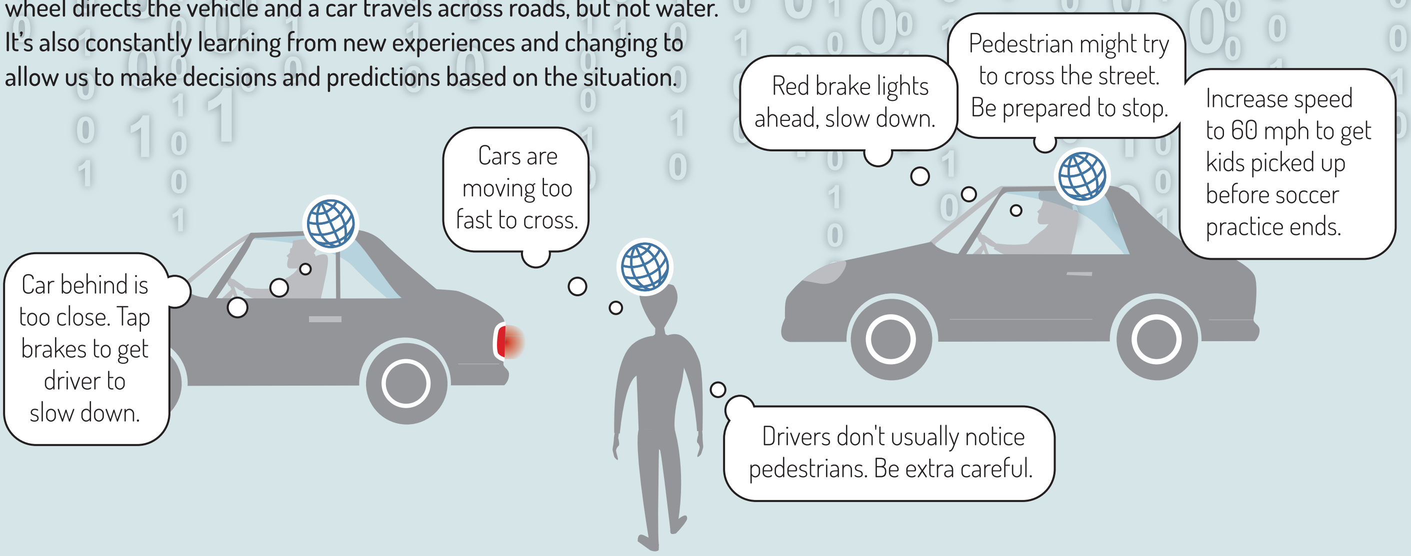
Housed on the second floor of the CALIT2 Building, the 3,000-square-foot, state-of-the-art high-performance computer lab will be equipped with neural network processors, collaboration tools, visualization software and a brand new class of hardware designed expressly for machine learning, AI (artificial intelligence) and deep learning exploration. Faculty, students and industry scientists will have a playground for experimenting, Li says.

The lab was funded by UC Irvine, CALIT2 and CESMII (the Clean Energy Smart Manufacturing Innovation Institute). In 2016, the U.S. Department of Energy established CESMII to work with industry to reduce the energy cost of manufacturing through the application of smart manufacturing technologies. CALIT2 is the CESMII Southern California Regional Demonstration Center.

What is a model of the world?

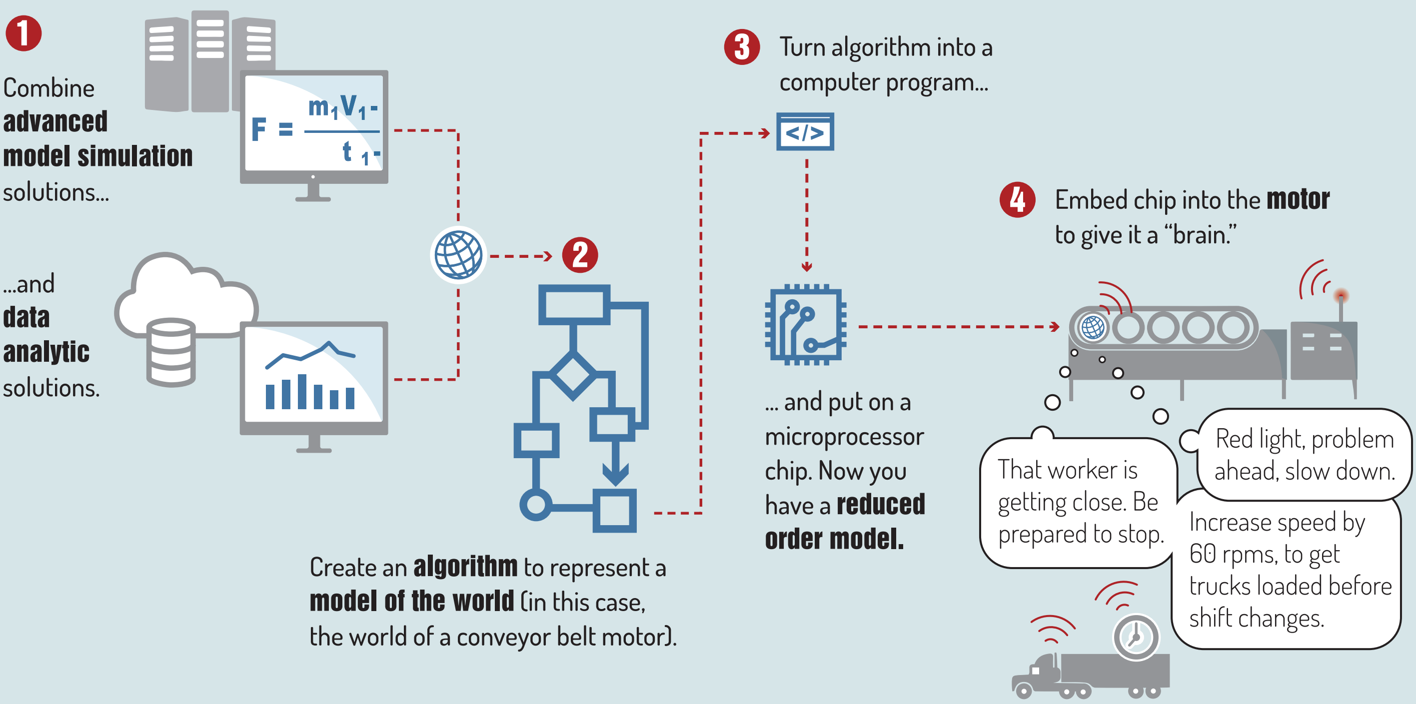
A **model of the world** guides a person or machine in its interactions with its surroundings.

Example: When driving a car, our model of the world tells us a steering wheel directs the vehicle and a car travels across roads, but not water. It's also constantly learning from new experiences and changing to allow us to make decisions and predictions based on the situation.



How does a model of the world make machines smart?

A **reduced order model** uses a tiny computer program made from an algorithm to give a device "intelligence."



"CESMII's purpose is to develop a program to help manufacturers across all sectors take advantage of the explosion of data from IIoT that's available to them," says Richard Donovan, director of research development for UCI's information and computer science, and engineering schools. "There is all this data being generated in these plants so now the question is, 'How can I use this data to make manufacturing more energy efficient?'"

Donovan, who worked with Li to design the lab, notes a common obstacle for small and medium-sized companies. "The technology is so new, many of these companies don't fully understand what to do with the data," he says.

To meet the needs of CESMII companies, the lab will facilitate heavy calculations required to create reduced-order models, Donovan says. [Reduced-order models are scaled-down versions of physics-based simulation results and real sensor data that can provide the system with a model of the world from which it can make decisions (remember the conveyor belt motor in the cereal plant?)]. These simple programs use little energy. They don't take a lot of memory or need a complex processor, Donovan says. "Any time the device wants to know something, it will say, 'Here's the current state, tell me what will happen next,'" he adds.

CESMII will be the first project to utilize the data lab, but the facility will also take on challenging data projects across many domains. Configured with advanced networking infrastructure, and computer hardware and software specifically designed for large-dataset machine learning, it will offer clients fast processors, lots of memory, and sophisticated computer programs for molecular dynamics, computational fluid dynamics, or sophisticated heat-transfer simulations, to name a few.

Li calls this explosion of data the fourth generation of the industrial revolution. "We are creating an ecosystem for these efforts," he says. "This latest revolution is marked by breakthroughs in emerging fields such as analytics, artificial intelligence and IoT, and builds on the digital revolution era started in the 1980s.

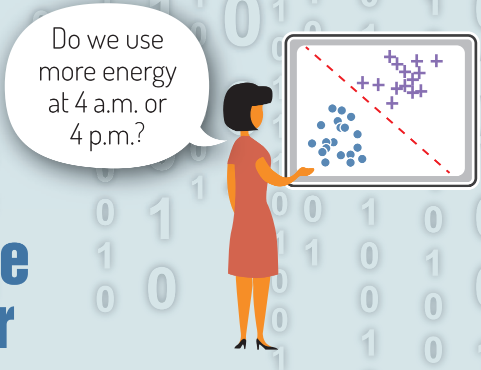
"The Data Engineering Infrastructure Lab will position UCI and CALIT2 to provide essential services as we embark on this new era."

5 questions data science can answer

1 Is this A or B?

CLASSIFICATION ALGORITHMS

Useful when there are two possible answers



2 Is this weird?

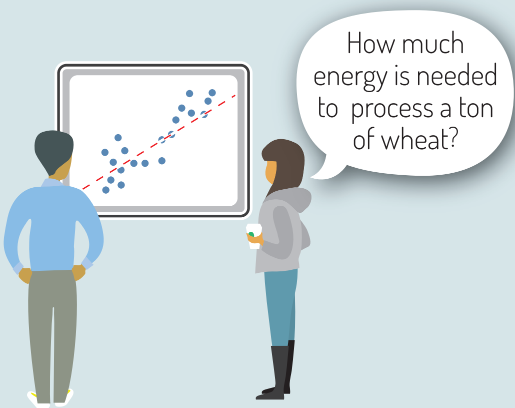
ANOMALY DETECTION ALGORITHMS

Flag unexpected or unusual events

3 How much or how many?

REGRESSION ALGORITHMS

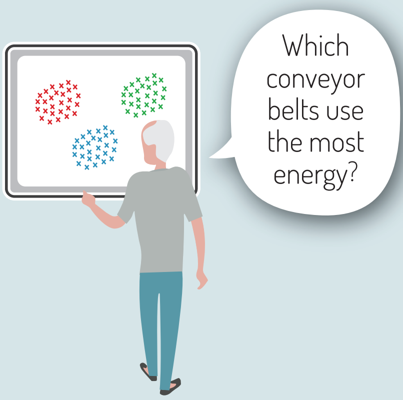
Make numerical predictions



4 How is this organized?

CLUSTERING ALGORITHMS

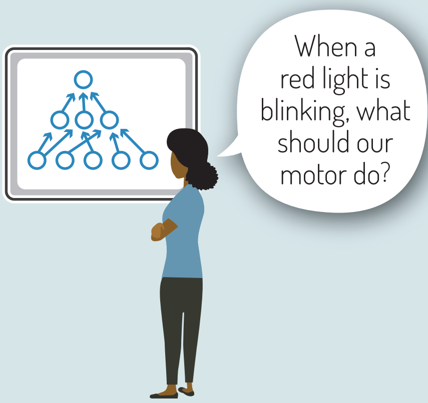
Separate data into natural clumps



5 What should I do now?

REINFORCEMENT LEARNING ALGORITHMS

Gather data as they go, using trial and error



CALIT2's semiannual Igniting Technology program will feature industry and academic experts discussing trends from semiconductor chip design to novel approaches in system architecture. Learn how the emerging data engineering infrastructure is making machine learning readily accessible to scientists and program developers.

Join us Thursday, May 24, 2018

5:30 p.m.	Presentations
7:00 p.m.	Panel Discussion
7:30 p.m.	Networking Dinner

UCI CALIT2 Building

Details and registration: www.calit2.uci.edu

CUSTOM-BUILT SENSOR AND SOFTWARE SYSTEM JUMPSTARTS FACTORY OF THE FUTURE CAPABILITIES

FORGING AHEAD

Anna Lynn Spitzer Paul Kennedy

It's not easy to keep clean rooms operating at peak efficiency.

These highly sterile facilities, including UC Irvine's Integrated Nanosystems Research Facility (INRF) and Bio-Organic Nanofabrication (BiON), strictly limit contaminants, requiring filtered and recirculated air to preserve the integrity of the micro- and nanofabrication processes that occur within.

Temperature, humidity and air pressure are held to strict standards and must be monitored constantly. Tools and settings must meet certain specifications. Users need comprehensive knowledge of chemicals, gases and procedures. Expired materials must be disposed of and replaced with fresh supplies, which can take weeks to arrive.

There are 118 instruments, eight equipment-support areas, 505 material safety data sheets and at last count, 214 users in INRF alone. It's a lot to manage. That's why INRF and BiON now rely on a custom sensor and software system called Forged to monitor and automate almost all operations.

Developed by UCI alumnus Everardo Camacho in partnership with Jake Hes, who manages the two clean room facilities, the system is built on a customized programmable-logic-controller platform. It encompasses a series of modules that help keep the clean rooms – and the research within them – humming along.

"We're always lean and mean around here, so we were looking for a way to automate the facilities to minimize staff activity for routine things," Hes says. "We are a 24/7 facility but we don't have staff 24/7."

The system monitors lab conditions, including temperature, humidity and air pressure. It tracks air handlers, process chilled water, deionized water, chemicals, liquids and gases located inside the facility. Forged controls access to tools, schedules equipment use, and logs and analyzes usage time for each instrument. It supplies a live feed from each lab area, tracks inventory, procures supplies and automatically bills users. It compiles, analyzes and visualizes financial data.

"It's interactive so we can see how everything is going," says Marc Palazzo, INRF operations manager. "We know when supplies will arrive, we can follow them through the process, recharge is easy, and it shows me visualizations of everything. It's giving us information that before I would have to crunch numbers to get."

Housed on a publicly available website, Forged is available from any computer or smart device. Clean room administrative staff have full access to all its features. Facility users, including those from UCI, other universities and commercial entities – in the U.S. and abroad – have access to certain modules, including equipment schedules. Users also can view individual pages for each tool, which contain equipment profile and specifications, standard operating procedures, real-time operational status and the name of the lab member responsible for its maintenance.

The system sends email and/or text alerts to staff when any indicator is out of spec. "If we can get to a problem right away, before it gets out of hand, it's a lot more cost effective," Hes says.

Forged also automatically notifies users if a machine they have reserved becomes unavailable.

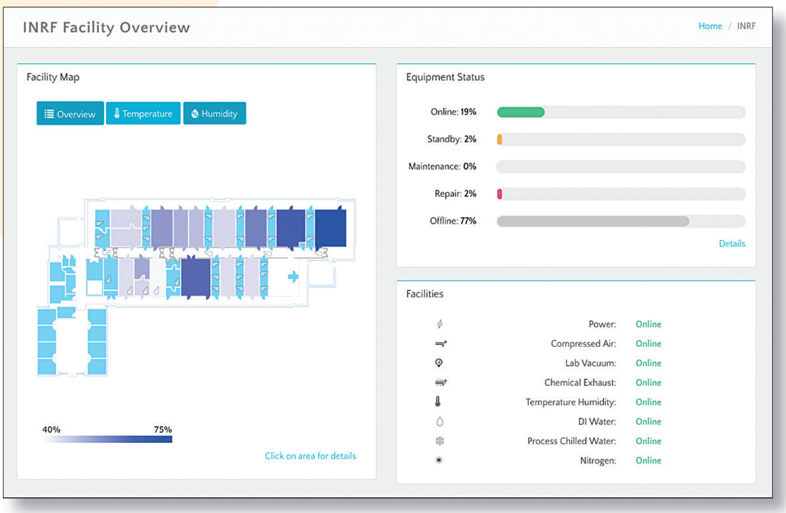
"Some of the lab's external users have to drive an hour or two to get to the facility," Camacho says. "If anyone is scheduled to use a tool and it goes down, he/she receives an immediate notification."

The system also maintains a database of users, including photo id, contact information and clean room permissions. Users log on at large touch screens located in the gowning areas for access into the facilities. Once inside, they use notebook computers connected to each individual tool to operate equipment.

INRF and BiON have used Forged for more than two years. Camacho began constructing the system when he was an engineering student. It started as a proof-of-concept, monitoring only lab temperatures, then he continued to add more features. Camacho now heads a software-consulting firm that oversees and maintains the system, which will continue to evolve. Eventually, every tool will contain Forged integrated sensors and Bluetooth technology.

Forged is an important first step in CALIT2's long-term goal of digitizing industry to make it smarter and more efficient, an initiative known as Factories of the Future. "This system is a great platform for starting that effort," Hes says. "Once it gets fully operational, I don't see that anybody can match it."

Housed on a publicly available website, http://www.inrf.uci.edu/facility/forged-system/, Forged is available from any computer or smart device.

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A SOCIAL ECOLOGIST EXPLORES HUMANS' MOST SIGNIFICANT NEW ENVIRONMENT

SPHERE

Aaron Orlowsky Patricia DeVoe

By 2030, the cybersphere could account for half of the world's total energy usage and 23 percent of emitted greenhouse gases, according to some estimates.

The cybersphere encompasses not just the endless flow of digital information across the internet, but also the hardware that transmits, receives and interacts with that information.

Since the 1980s, the cybersphere has expanded rapidly as digital technology has become an increasingly integral part of daily life. The energy and attention demands of the billions of cellphones, computers, cloud servers, routers and other devices used continuously around the globe are making a tangible impact on the physical world and on human society, from raising the temperature of the planet to affecting how people's minds function.

Studying those impacts and correlations will be crucial in the coming decades, predicts Daniel Stokols, founding dean of the UC Irvine School of Social Ecology and author of "Social Ecology in the Digital Age," published in October 2017.

"You can't understand social ecology and environmental sustainability without taking into account how people relate to the cybersphere. These connections are pervasive, though many of them are invisible," says Stokols, Chancellor's Professor Emeritus of psychology & social behavior and urban planning & public policy. Stokols is an active member of the CALIT2 UCI Division Council of Advisors.

Ecological science first emerged in the field of biology about a century and a half ago with Charles Darwin's observations of plant and animal species' adaptations to their environments. During the early 20th century, ecologists began to focus more broadly on human communities and people's adaptations to their surroundings. Until now, the cybersphere has largely been omitted as an environmental domain, but charting the relationships between it and the natural, built and sociocultural dimensions of the ecosystem is the next frontier of ecological science.

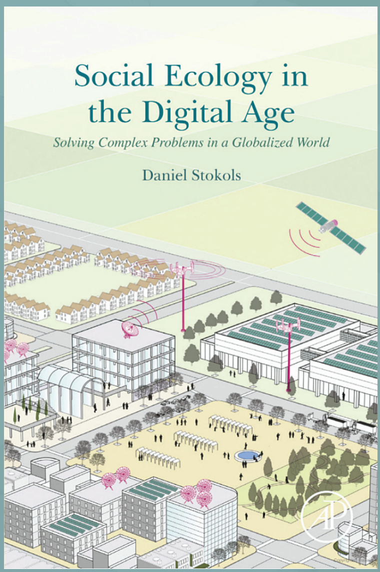
"Social ecology is an evolving field because our surroundings are ever-changing. The internet has accelerated globalization and forged stronger links between different regions of the world. It's important to study the cybersphere as a major influencer of biological and human systems," Stokols says.

Digital technologies hold enormous promise. Devices connected to each other over the internet can operate with greater efficiency. Smart urban water and energy networks with built-in sensors can reduce waste. Autonomous cars linked by the internet to each other and to "smart highways" may reduce traffic congestion and increase road safety, though there are many technical and ethical issues that must be resolved before these new technologies are adopted widely.

Information workers are a major part of the economy, and scientific collaboration is now accomplished largely over the web by teams whose members are based in different countries, cultures and time zones. Stock trading has become increasingly computerized, with transactions carried out autonomously according to predetermined algorithms.

People can now instantaneously access health information on the web with the touch of a button. Soon they'll be able to self-diagnose with greater accuracy as at-home digital health kits

In a recently published book, Stokols uses principles of social ecology to provide a new framework for environmental problem-solving in the digital age.



> **"You can't understand social ecology and environmental sustainability without taking into account how people relate to the cybersphere. These connections are pervasive, though many of them are invisible."**

proliferate. They can find mental and physical health support groups online and access various therapies.

But digital technologies are also causing strain in human interactions, with little-understood effects on human psychology, social behavior and health. Today, "friendships" no longer signify close, lifelong confidantes; people can have hundreds or even thousands of "friends" they've "met" only through Facebook. Teens often compare their lifestyles to those idealized on social media, raising anxiety levels.

Young people who multitask and engage in fewer face-to-face interactions are less able to read facial expressions, studies have shown. Indeed, the mere visible presence of a cellphone during a face-to-face conversation decreases feelings of intimacy and satisfaction, according to a study conducted by social ecology Ph.D. alumna Shalini Misra.

"We might be losing our capacity for wisdom because attention is now so fragmented," Stokols says. "We're under so much information overload that we don't even realize it. Our capacity for deep thinking, reflection and solitude is dwindling in the face of continual cyber interruptions and distractions. People often don't recognize the effects of cyber technologies on kids, but focused studies are helping to unveil these impacts."

This transformed and fast-changing world requires rigorous scholarship. And social ecologists are uniquely positioned to tease out the connections among digital and physical spaces, internet interactions and individual minds – and help us understand the influence of the cybersphere on society.

A Parting Shot

Move over, Pokemon Go.

Augmented reality, which provides an enhanced view of the environment by overlaying virtual elements on what users see, already is a mainstay of gaming, advertising and retail businesses. Soon, it may assume an important role in smart manufacturing facilities as well.

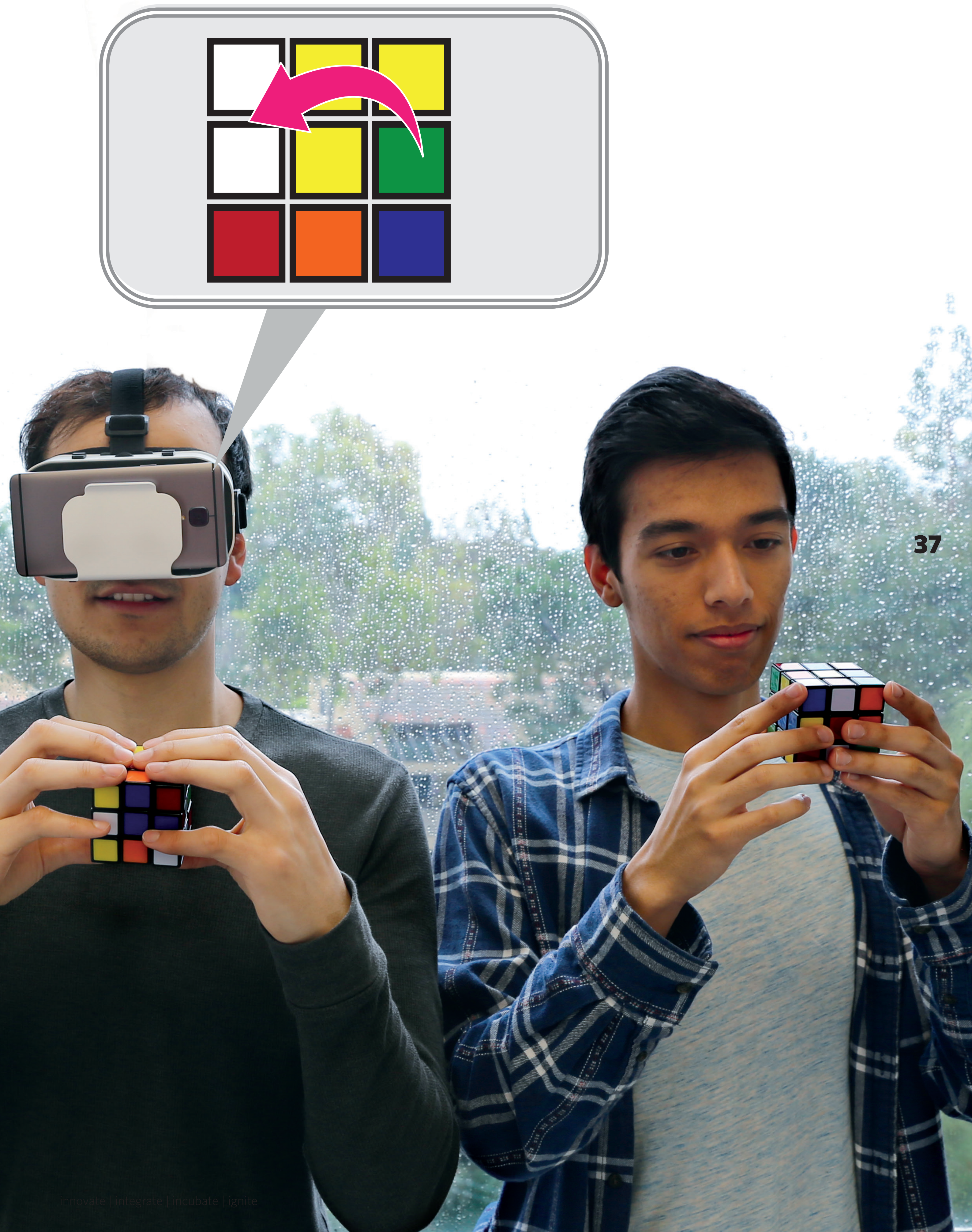
A proof-of-concept application, developed by UC Irvine undergraduate computer engineering students, could be modified for use as a training tool, enhancing worker productivity and safety as well as adherence to quality assurance standards.

In its current iteration, the app assists those trying to solve a Rubik's Cube puzzle. The user, wearing AR goggles, manipulates the puzzle as the app guides his/her movements. Turn the top row to the left, twist the middle row twice to the right, and so on.

This digitally manipulative approach can be adapted to train workers in assembly protocols and other training procedures, says CALIT2 project scientist Sergio Gago, who mentored the three student app designers, (pictured from left) Faustino Aguirre, Fabian Garcia and Kian Bayati.

In addition to providing real-time directions to the user, the app can offer an assessment by analyzing past movements.

"This could be used in any type of training that relates to learning," says Gago.



Under the direction of Professor G.P. Li, CALIT2@UCI develops IoT technology-based innovations in a multidisciplinary research environment. By integrating academic research with industry experience, the institute seeks to benefit society, incubate new technology companies and ignite economic development. CALIT2 focuses on the digital transformation of health care, energy, the environment and culture.

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