interface®

The Center of **IoT**

On the cover: Calit2 is the research center equipped to assist those looking to participate in the IoT revolution.

Well-Connected

by Anna Lynn Spitzer

Calit2

POISED TO LEAD

THE CHARGE AS

THE INTERNET OF

THINGS REVAMPS

DAILY LIFE

Throughout the four-story Calit2 Building — and the institute's history on the UC Irvine campus, for that matter — runs a recurring and very active mandate: develop and integrate communication technology into devices and applications for improving the ways we live, work, play, and care for ourselves and others.

A stroll through the building provides insight. On the first floor, researchers design and manufacture sensors and electronics in state-of-the-art cleanrooms, while one floor up, students drop in to the MDP (Multidisciplinary Design Program) Lab to prototype integrated systems for applications, and the EVOKe Center to build ethical values into technology applications.

Ascend to the third floor's eHealth Collaboratory. Here are toys and musical devices instrumented with embedded sensors that help children with autism interact with each other and with their parents. Computer-assisted and Internet-connected devices are devised to aid in post-stroke and exercise rehabilitation, monitoring of premature infants, and balance issues in the elderly. Down the hall is the Center for Networks and Relational Analysis, where researchers examine networks from a variety of differing viewpoints and domains.

And on the building's fourth floor, in the CalPlug Center, scientists are making television set-top boxes smart enough to learn user habits so they can power down more efficiently and conserve energy. Next door is the Center for Digital Transformation, where researchers explore the use of "big data."

It turns out, to the surprise of no one affiliated with the institute, that all along, Calit2 has been on the forefront of what is now becoming a revolution of sorts. Called the "Internet of Things," it's a powerful force, sweeping up nearly all remnants of a soon-to-be archaic analog past and altering our daily lives in a way comparable to that of the Internet itself.

IoT, as it is familiarly known, is a network of connected devices, systems and even venues equipped with embedded sensors and controllers that communicate wirelessly via the Internet or intranet systems.

Whether it's an environmental monitor that conveys information about pollution levels or soil moisture, a refrigerator that notifies its owner that groceries are approaching their "use-by" date, or shoes that log the number of steps their wearers traverse, soon, almost everything with which we interact is going to have IP communication capabilities.

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We will wear it, drive it, fly in it, be empowered by it, and live in this IoT world, but we will no longer be responsible for inputting most of the information that informs it.

Today's World Wide Web, 25 years after its creation, is still almost completely dependent on humans typing, swiping and uploading information. Embedded sensors in the vast majority of IoT devices, however, will collect and input data autonomously, generating countless exabytes (an exabyte is a quintillion bytes) of data. Estimates suggest that we already create 2.5 exabytes of data per day, and that number can be expected to rise exponentially as the IoT evolves.

"Computing and communication has really reached into our daily lives," says Calit2 Irvine Director G.P. Li. "The Internet of Things is going to take us to the next level. It will enable us to get things done without having to access a computer."

The moniker "Internet of Things" is not new; it was coined in 1999. But the recent exuberance with which it is being embraced by industries and governments worldwide is driven by the confluence of three major factors: the availability of low-cost, highly sophisticated sensors and electronics; the maturity of a global communication infrastructure; and the emergence of a digitally savvy population. "This is a revolution, but it is not a revolution that happened overnight," says Calit2 academic affiliate and eHealth Collaboratory Director Mark Bachman. "It is actually an evolution. But now is the time."

Before that can happen, though, current Internet protocol, whose 32-bits of information allow room for only 4.3 billion Internet addresses, must give way fully to a new version. IPv6, with its 128 bits of information per address, can provide 3.4x10 to the 38th power more Internet addresses. That's enough to give an IP address to every atom in the universe and still have plenty left over.

"We thought 4.3 billion Internet addresses would be enough. But we ran out in 2011," Internet creator Vint Cerf said earlier this year in a Google Internet Hangout chat.

Cerf, vice-president and chief Internet evangelist at Google, and a member of Calit2's Advisory Board, is optimistic about the potential of IoT, but warns that we must stay vigilant. "While this opens up wonderful and interesting opportunities ... the one thing we should be very worried about is that the software that manages this stuff may be penetrated or compromised in some way," he said in the online interview. "We're going to have to build much more paranoid operating systems that will resist various kinds of attack."

Gene Tsudik is a UCI Chancellor's Professor of Computer Science and managing director of the university's Secure Computing and Networking Center. He agrees that, although IoT presents privacy and security concerns, this is really nothing new. "Any time a new kind of a device acquires connectivity, security and privacy issues must be carefully considered," he explains. "However, controlling things via the Internet is not new, and what we're seeing here is not radically different."

Regardless, there are no sure-fire solutions. "You can't guard against all types of attacks," he says, but suggests that device manufacturers will have to work closely with software security experts to prevent hacks. "One thing you don't want to do is put the intelligence of a laptop into specialized — especially, embedded — end-devices."

And what about privacy — which Tsudik describes as security's "fraternal twin: they kind of look alike but sometimes they oppose each other" — will it be compromised in this new paradigm of connectedness? Tsudik shrugs. "It never existed. We haven't had privacy since the birth of the World Wide Web," he says.

Although IoT may continue the trend of gradual erosion of perceived privacy as well as present more security challenges, Tsudik and his colleagues try to foresee possible malfeasance. "It's a never-ending cat-and-mouse game," he concedes. "Ideally, we'd like to stay a little bit ahead of the game by trying to anticipate the next attack or challenge."

HOW THE IoT WORKS

The Internet of Things already connects a wide range of devices and things.

ENERGY
HOME
AUTO & TRANSPORT
PERSONAL ELECTRONICS
INDUSTRY & ROBOTICS
WI-FI ROUTERS
SMART CITIES AND GRIDS
SHOPPING

Ways To Connect

person to machine

machine to machine

person to person

big data & cloud computing

wireless technologies
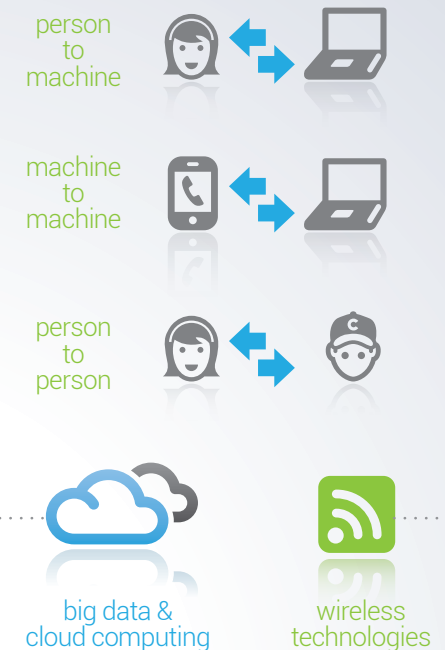
Connectivity Today

80 new things connect to the Internet every second

40% of the world population has Internet connection

99% of devices in the world remain unconnected

By 2023

250 new things will connect to the Internet every second

THE INTERNET **DOUBLES** IN SIZE EVERY **5.32 YEARS**

INTERNET OF THINGS

During 2008, the number of **THINGS** connected to the Internet exceeded the number of **PEOPLE** on earth.

6.3 billion
2003
500 million

6.8 billion
2010
12.5 billion

7.1 billion
2013
13 billion

7.2 billion
2015 estimated
25 billion

7.6 billion
2020 estimated
50 billion

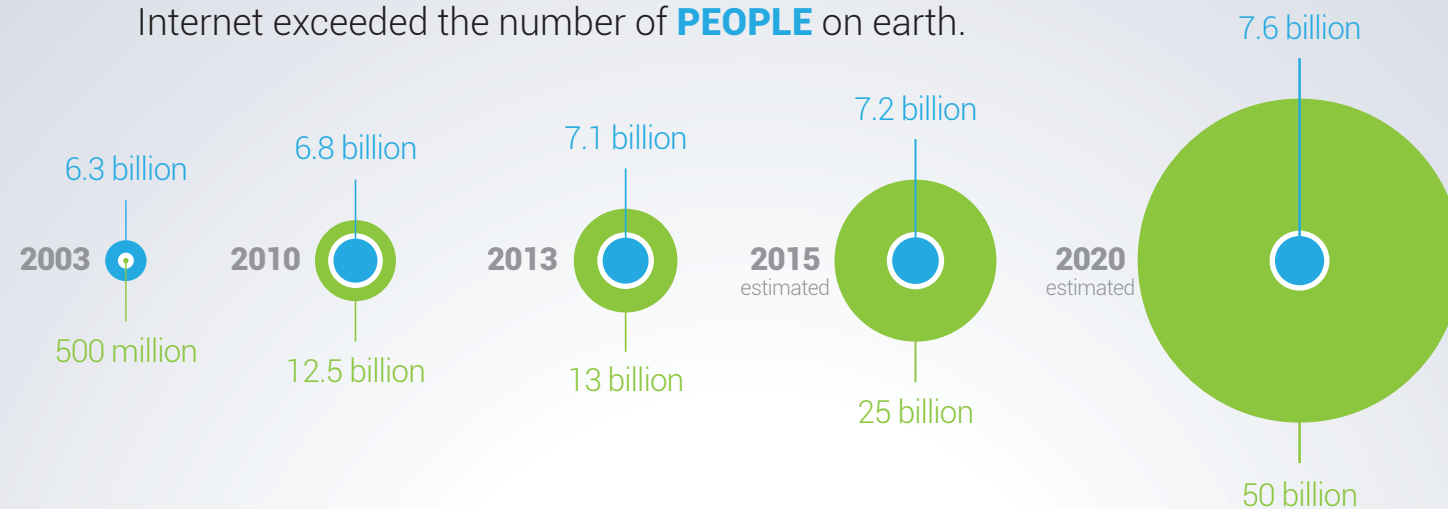| TO BE ABLE TO COMMUNICATE VIA THE INTERNET REQUIRES AN IP ADDRESS TO IDENTIFY EACH THING	**PROBLEM** In 2011, we ran out of IP addresses under the IPv4 system, which had 32 bit numbers, with 4.3 billion possible addresses.
	SOLUTION The IPv6 system was created and launched in 2012. These addresses are 128 bit numbers, and we now have **340,282,366,920,938,463,463,374,607,431,768,211,456** possible Internet addresses. That's 100 for every atom on the face of the earth or 3.4x10 to the 38th power.

Ready or not, though, experts across the board agree that IoT is imminent.

"You're already seeing lots of examples of it," says Vijay Gurbaxani, UCI professor of information systems and director of the Center for Digital Transformation. He cites Waze, an app recently acquired by Google Maps, which uses aggregate data from drivers' cell phone GPS systems to "know" when roads are clogged or closed and suggest alternatives.

Disney has introduced digital bracelets, which enable park access, ride priority, hotel entrance and electronic shopping. Sensor-equipped airplanes and cars send alerts when maintenance is required. Self-driving automobiles communicate information to other cars about traffic conditions. The list goes on.

By 2023, every person on the planet could be surrounded by 3,000-5,000 connected everyday items that impact their lives. "The efficiency of the U.S. economy is going to go up dramatically in terms of the ability to use assets," Gurbaxani says of IoT. "But I think we need to be alert. We have to be far more proactive with an eye toward the common good."

As the tide of technology swells once again, breaking into a powerful wave, both Li and Bachman marvel at Calit2's well-honed and rock-solid foundation, and its fortuitous placement as a center equipped to assist those on campus and in the community looking to participate in the momentum.

"Calit2 is the number one source of IoT on campus; it's what we do," Li says. "For years, we've developed technology that enables IoT, and we've studied telecommunications and the networks that support it. And we have put a lot of energy into understanding how people interact with technology."

Adds Bachman: "The great strength of Calit2 is that we're an independent broker on campus. We have experience building teams from disparate disciplines, producing applications that impact daily life, and commercializing new technologies. But we must also leverage our academic strengths to study and understand this movement, to inform policy and provide guidance to industry.

"When we talk about the Internet of Things, we're not talking just about this sensor or that security protocol or the newest application," he emphasizes. "Our strength is in providing end-to-end integration throughout the value chain. We have a lot of experience doing this; Calit2 is the center for IoT."

Have you heard of the "Internet of Things"?

Yeah. What's all the buzz about??

Come find out Thurs., Nov. 13, 2014 at UCI's Calit2 Building.

Join us Thursday, Nov. 13, 2014 to:

- Learn more about the role IoT will play driving our future "smart" lives;
- Envision a future where you can access anything from anywhere;
- See the technologies that are enabling IoT's promise;
- Understand the challenges inherent in realizing this interconnected world;
- Discover how stakeholders view IoT and how its expected applications will spark business opportunities.

The "Internet of Things" (IoT) is an increasingly popular topic of conversation. IoT refers to a totally connected world that not only has the potential to impact how we live, but also how we work. Analysts predict that new IoT products and services will grow exponentially in the next few years. But what exactly is the "Internet of Things" and what impact is it going to have on you?

Registration is required; visit www.calit2.uci.edu for complete details.

TV GUIDE

by Anna Lynn Spitzer

Putting usage information at customers' fingertips could reduce residential energy consumption

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A couple of years ago, when gasoline prices raced toward $5 per gallon, drivers made a conscious effort to reduce consumption. They consolidated errands, reduced road trips, carpooled and even traded in gas guzzlers for more energy-efficient cars.

Getting consumers to reduce residential energy usage is a little more difficult. Electricity is far less expensive a commodity, and most people don't think twice about plugging in their often power-hungry plug-load devices. Many don't realize that appliances, computers, electronics and lighting can cost upwards of $600 a year to keep charged and ready to use.

Enter the California Plug Load Research Center (CalPlug), located at Calit2. Formed in 2011, the center was established to improve energy efficiency in the design and use of appliances and consumer electronic devices.

One of its first projects, the "Wall of Power," is a simulated living room projected onto a wall and equipped with everyday plug-in entertainment and household devices. "Consumers" power devices on and off using an iPad, and watch in real time how that changes energy consumption.

"The Wall of Power was designed to be a physical-virtual interface that fuses the abstract concept of energy usage with concrete devices," says CalPlug Technical Director Arthur Zhang. "Home entertainment systems are responsible for about 60 percent of total plug-load usage. If you can see directly how your monthly energy bill will be impacted, presumably you will take action to reduce it."

Now, researchers are partnering with DIRECTV and Southern California Edison to create a product that will put similar capabilities directly into consumers' living rooms. With a click of their remote, Edison customers who also subscribe to DIRECTV will be able to access electricity usage data on their television sets. Consumers will immediately understand how much electricity they've used to date, what price tier that puts them in, and their remaining allotment if they want to stay in that tier. They'll also access billing cycle information and will be able to toggle between day-to-day and hourly usage figures.

CalPlug developed the software "widget" that runs with the DIRECTV set-top box software system, thanks to the company's third-party developer program. "This program provides the foundation for our partners to build innovative products and services," says Matt Thompson, DIRECTV director of software engineering. "Through open APIs, developers can create unique experiences that engage customers and deliver additional value."

CalPlug researchers demonstrated the prototype at DIRECTV's El Segundo lab last spring. Pending additional funding from Southern California Edison, a pilot program encompassing 100 homes is expected to begin later this fall.

Neha Arora, SCE project manager, says the collaboration is one of the utility's first steps toward understanding the impact of consumer behavior on overall energy consumption.

"As new technologies evolve, it is imperative that we understand how a consumer interacts with these technologies and how these technologies can impact the use of electricity [in buildings]," he says. "We are just venturing into this arena and hope to find some useful insights that we can apply to our energy efficiency programs that ultimately benefit our end users."

Edison will supply aggregated electricity usage data for each household in the pilot project, but eventually, smart meters will supply real-time data. The current prototype aggregates each home's total energy usage and displays it in a user-friendly way.

"You don't want to make the first product too complicated. You want to introduce consumers to the idea slowly, one function at a time," Zhang says.

An attractive, easy-to-use design is essential. CalPlug is discussing a partnership with the Transformational Media Lab at UCI's Center for Security Affairs to design an effective interface.

"As eco-feedback continues to grow in popularity, so will the importance of designing displays that are legible, pleasing and interpretable to users," says Beth Karlin, TML director.

For now, researchers are concentrating on user interfaces and bug fixes for the project's rollout.

During the one-year pilot program, user data will be collected via click rates, similar to the way website analytics are amassed, and additional feedback will be gathered through in-person and telephone surveys. All feedback will be incorporated into the design of a second phase, which Zhang hopes will grow to encompass 1,000 homes. "We're going to continue to refine the design," he says.

"This type of display has never been done before," Zhang adds, but researchers have good reason to bet on its success. "Nielsen statistics say Americans watch TV for five hours a day. This is an effective way to reach a large audience," he says.

"This project is aligned with what the utilities and the state want, which is to reach the greatest number of people who can be taught to adopt a more energy-efficient lifestyle."

Creating Connections. Powering Innovation. Boosting Efficiency.

WHIZ GRID

LOCAL ENERGY EXPERIMENT IS FUELED BY SMART TECHNOLOGIES

by Shari Roan

Some people might balk if they were asked to slash their home energy expenditure by half or more for at least a year. But Ursula and Glenn Levine were ecstatic when they were selected as part of the Irvine Smart Grid Demonstration (ISGD), a public-private project in which the Advanced Power and Energy Program (APEP), a Calit2 partner, is a key player.

(opposite page) Project researchers from the Samueli School and Southern California Edison are pictured at the ISGD large battery storage site on the edge of the UCI campus: (from left) Jack Brouwer, Fei Gu, Jerry Thode, Renee Cinar, Ed Kamiab and Scott Samuelsen.

A top-to-bottom endeavor, the ISGD encompasses innovative regional grid intelligence technologies, new substation and distribution circuit level technologies and individual homes outfitted with smart appliances, solar panels and electric vehicles.

One of the country's largest smart grid experiments, the project addresses mounting concerns over greenhouse gases, rising energy demands, increased penetration of intermittent renewable wind and solar generation, and charging loads from plug-in electric vehicles. The ISGD seeks to show that regional energy providers, local utility companies and consumers can work together to produce a grid that is more reliable, secure, cost-effective, dependable and environmentally friendly than those in use today.

The traditional electrical grid that has served us for decades is a network of wires, substations, transformers and switches that carries electricity from plants where it's generated to consumers. This grid is serviced by workers who go on site to read meters, fix broken equipment, alter switches and measure voltage.

Today, however, smart grid computer technologies, such as sensors and two-way communication systems, can be used to automate the system, ushering in a range of important benefits.

UC Irvine has been ahead of the curve. "The energy program at UCI began in 1970 and evolved over the 40 years into an unusually comprehensive program, probably unique in the country in terms of its breadth and strength," says Scott Samuelsen, the university's HORIBA emeritus professor of mechanical, aerospace and environmental engineering and APEP director. "We developed these tools and had them ready when the concept

of smart grid technology was evolving. There was a bit of fortuitous timing that allowed us to be in the right place when it was needed."

The ISGD project is led by Southern California Edison and funded by the U.S. Department of Energy. APEP is conducting core research for the project and manages, with Toyota, the deployment of electric vehicles. APEP also manages the other UCI groups that are involved, including facilities management, environmental planning, transportation services and the 38 University Hills homes that are part of the demonstration and are located adjacent to the campus.

That's where the Levine family resides. "When we were selected and offered this, I felt like we won the lottery," says Ursula Levine, a dentist. Husband Glenn is a UCI professor in European Studies. "The project included receiving a number of new appliances — a refrigerator, dishwasher and washing machine — as well as solar panels on the roof. As a family, we are oriented toward energy savings and going green. So this was very welcome."

The demonstration project is divided into four blocks of homes, "each with its own personality," says Samuelsen. Three of the blocks comprise 22 smart grid technology homes and the fourth block has 16 control group homes. The smart grid homes are outfitted with smart appliances, smart thermostats, plug-in electric vehicles, smart electric vehicle chargers and rooftop photovoltaic solar panels.

And the homeowners have devices that allow them to monitor and manage their energy usage. "There's a device in the home that allows you to select the economic profile you want to have for your utility cost," explains Samuelsen. "If you want your cost to be the lowest possible, the smart grid does some things on your behalf. It doesn't allow
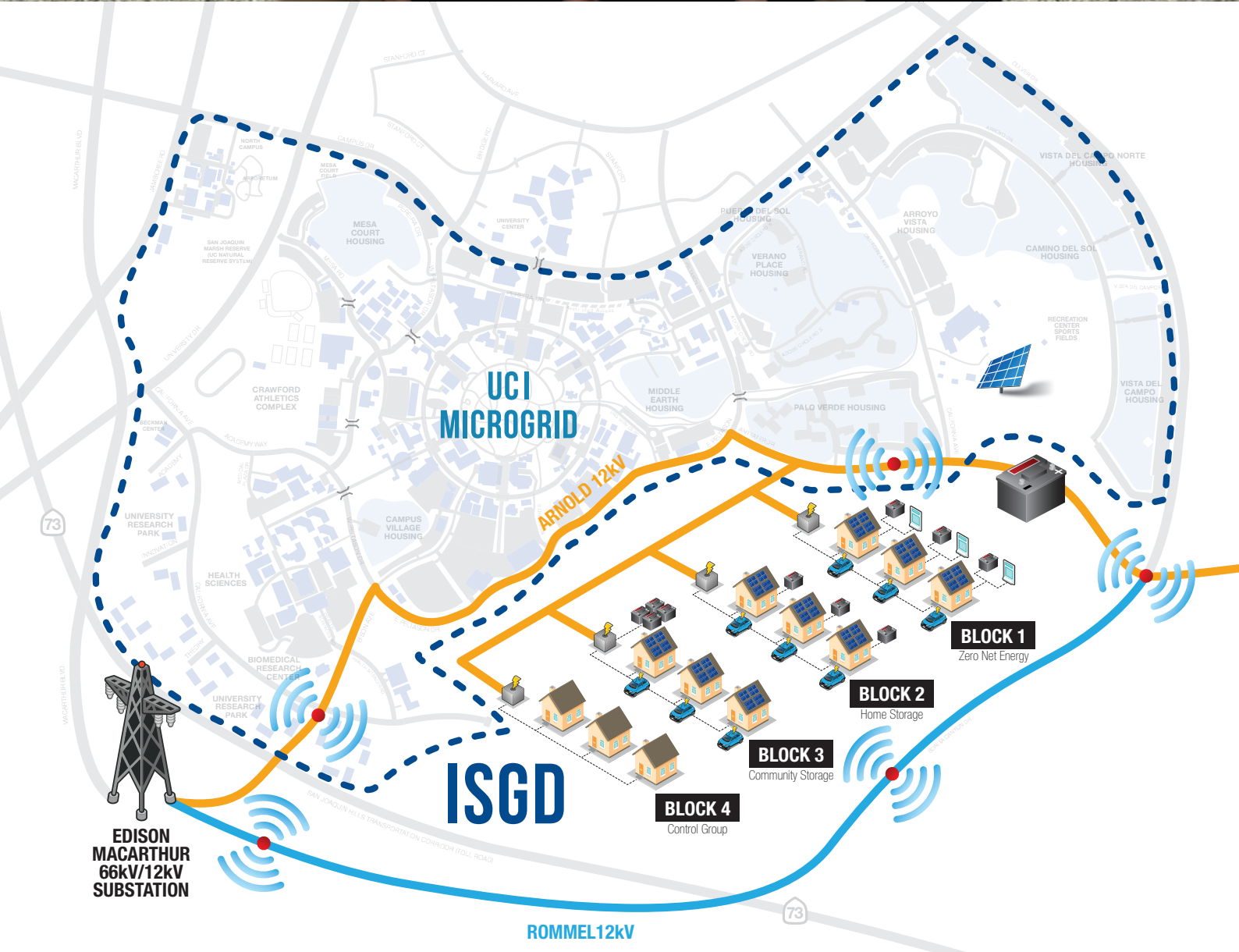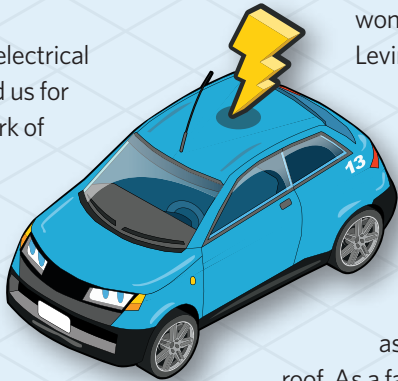
ISGD — Irvine Smart Grid Demonstration Project

URCI: Universal Remote Circuit Interrupter

Battery Storage

Transformers

Solar Car Shade

Rooftop Photovoltaic

Upgraded Building Materials

Electric Car

UCI Microgrid Boundary

(right) Renee Cinar, APEP graduate student, evaluates performance of a residential electric vehicle charger and (below) tests a home battery storage unit deployed in half of the ISGD homes; the other participants are using a community battery system (one battery that serves a block of homes).

the washing machine to turn on when you put clothes in at certain [high energy demand] times. You push a button, but it says the clothes will be washed at 6 a.m., not right then at 8 p.m."

After comparing energy usage with a neighbor, the Levines made some adjustments. The couple and their three sons only do laundry during the day and pay more attention to turning off lights.

"I think it's amazing and wonderful that UCI is facilitating this," Ursula Levine says. "I'm excited about the changes to come. I can see the benefits of it. The whole family has become so much more aware of our energy usage."

As the research partner, APEP undergraduate and graduate students are using state-of-the-art computer codes, developed by UCI engineers, to model the 12 kilovolt circuits serving ISGD, the feeder circuits and transformers supporting each of the four blocks of homes, and the actual dynamic performance of the homes. The goal is not only to better understand and improve the smart grid behavior associated with the current project, but also validate the codes and models for use in research to explore the future of smart grid technology

Increasingly, homes must be able to access renewable energy, says Bob Yinger, ISGD chief engineer at Southern California Edison. "We recognize that things are changing in the grid world," he says. "People are using rooftop photovoltaic systems and purchasing plugin vehicles. The grid as it was designed many years ago didn't really consider any of those things."

Adds A. Edward Kamiab, the ISGD project manager at Southern California Edison: "The grid is going to go through a larger evolution in the next 10 years

than it went through in the previous 100 years with all these new technologies for energy-efficiency."

For example, the ISGD is testing smart switches in feeder circuits that ferry electricity to neighborhoods. The smarter switches are designed so that if a fault occurs, only a small number of houses experience a power outage instead of a large swath of the town.
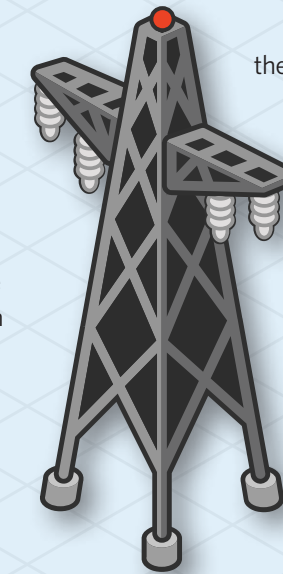
A smarter grid should also have the ability to move electricity from one area to another in an emergency.

In an earthquake or wildfire, "local communities, like the UCI campus where we generate our own electricity, can be called upon to supply electricity to hospitals or fire stations or gasoline stations in the community," Samuelsen says. "Today we can't do that. It requires a lot of manual switching of circuits. In the future, the smart grid will allow such actions to occur instantaneously."

In addition, researchers are hoping that the ISGD project, which concludes next year, will offer some insights into what it will take to reach California's goal of all new residential construction meeting Zero Net Energy standards by 2020. One block of the smart grid homes is not only equipped with the smart technologies but has upgraded building materials, including far greater insulation and high energy efficiency windows.

"Zero Net Energy means that at the end of the year, you've generated as much electricity as you've consumed in the home," explains Samuelsen. "What we're doing in this project with Edison is seeing just how close we can come to meeting that concept."

"I THINK IT'S AMAZING AND WONDERFUL THAT UCI IS FACILITATING THIS," URSULA LEVINE SAYS. "I'M EXCITED ABOUT THE CHANGES TO COME. I CAN SEE THE BENEFITS OF IT. THE WHOLE FAMILY HAS BECOME SO MUCH MORE AWARE OF OUR ENERGY USAGE."

CALL OF THE WALL

by Anna Lynn Spitzer

Rising entrepreneur finds an unforeseen future halfway around the world

18

19

photo: Paul R. Kennedy

SUNG-JIN KIM MAY HAVE MAJORED IN MATH AS A UNIVERSITY UNDERGRADUATE, BUT EVEN HE COULDN'T HAVE CALCULATED THE WAY HIS LIFE'S EXPERIENCES WOULD ADD UP.

Arriving at UC Irvine in 1999 with a bachelor's degree from Korea University and a master's from the University of Chicago, the Korean-born Kim planned to earn a doctorate in engineering, and then return to his native country to teach. His mother had been a middle-school English teacher and is currently working on a Ph.D.; his father was a university professor, who directed a foundation that gave top students scholarships to study abroad. From a very early age, Kim says, he knew exactly in what direction his career path was leading.

Or so he thought.

"I had been seeing this practically since I was born," he says. "Bright students going to the U.S. and coming back with Ph.D.s. My whole life, it just seemed the natural thing to do. It was kind of expected, actually."

But along the way to his doctoral degree in electrical engineering and computer science, Kim discovered two things that would change his mind and ultimately, his career choice. One: he didn't have a passion for teaching. "I realized I'm not really very good at it, and I didn't like administrative aspects of the job," he says.

More importantly, perhaps, he recognized where his passion did lie: with a technology he had helped create during his graduate studies — a software platform that requires nothing more high-tech than a personal computer, some monitors and an available network to create and display spectacularly detailed, ultra-high-resolution, three-dimensional images and streaming video across an endless number of adjacent screens.

That software, along with a couple of forward-thinking business partners, a receptive market and some support from Calit2, has propelled Kim into the role of

photo: Steve Zylius / University Communications

> "I HAD BEEN SEEING THIS PRACTICALLY SINCE I WAS BORN," HE SAYS. "BRIGHT STUDENTS GOING TO THE U.S. AND COMING BACK WITH PH.D.S. MY WHOLE LIFE, IT JUST SEEMED THE NATURAL THING TO DO. IT WAS KIND OF EXPECTED, ACTUALLY."

Kim (above) spent a couple of years at the University of Chicago. He and his wife, Kyongboon Oh, pictured circa 1998, prefer Southern California's climate to Chicago's winters.

successful entrepreneur. The co-founder and chief technology officer of Hiperwall, Inc., he guides the multimillion-dollar company's product development strategy.

The idea was conceived in 2005 and born as a research project in the Calit2 Building's second-floor Visualization Lab. At the time, the distributed visualization, grid-based display called HIPerWall was the world's highest-resolution display wall. With 200 million pixels — and custom software and middleware — it allowed researchers to visualize and manipulate massive data sets in stunning detail.

Two UCI assistant professors, Stephen Jenks and Falko Kuester, designed the wall and obtained National Science Foundation funding. Graduate student Kim developed the original software that displayed interactive, high-resolution imagery, and later videos and other content, on the wall.

Kim received his doctoral degree in 2006 and found himself smack up against a not-uncommon existential dilemma. "I was trying to decide if I should go looking for a job or continue what I had started," he says. "I knew this could be more, that this technology had a lot of potential."

The wall won. Knowing that Calit2's mandate was to help researchers turn innovative technology into commercial success stories, Kim began working as a postdoctoral scientist at the institute.

Kuester eventually left for UC San Diego, but Jenks and Kim kept refining the software and improving its capabilities. "Sung-Jin was very dedicated to making his software more capable and flexible, while being completely open to integrating the components I was

HIPerWall's continuous popularity in the Calit2 Visualization Lab led company founders (from left) Greenberg, Jenks and Kim to realize it could be a commercial success as well.

"On the night before CNN did its live broadcast, Sung-Jin stayed in the lab all night making the code faster and more stable so it looked perfect on live TV," Jenks recalls. "Everything went off without a hitch."

Also in 2007, the researchers acquired a couple of significant acquaintances. Samsung USA, whose domestic operation was headquartered in Irvine, approached the HIPerWall team about using the software to power its own display-wall products. Around the same time, Jenks and Kim were introduced to Jeff Greenberg, a UCI alumnus who specialized in commercializing academic technology. The trio began discussing a spinoff, and Hiperwall, Inc. (the spelling was changed to differentiate the company from the academic version) debuted in February 2008, with co-founder Greenberg as CEO.

Kim and Jenks are a well-oiled software-development machine. "I do more the visualizing part and Steve does more the distributed computing part," Kim says. "The end result is that the two parts sync; they work very well together." Version 4.0 is on deck for release later this year.

Duy-Quoc Lai, a Hiperwall software engineer, has worked with Kim since 2007, when Lai was a graduate student in the Visualization Lab. "Whatever Sung-Jin sets his mind on doing, he does it to the best of his ability. He is very meticulous," Lai says. "Sung-Jin foresees potential problems and handles these issues before they become bugs."

Software bugs are not the only critters Kim is trying to head off. He and his wife, Kyongboon Oh, bought a house recently in a Southern California subdivision. "Being a homeowner is the craziest thing," he laughs. "I have lived in apartments my whole life. Now I'm like 'Oh my god, there's ants in the yard!' Our biggest concern is how we can maintain the lavender plants."

Some days, Kim feels the stress of running a startup company, but he reminds himself how fortunate he is. "I try to remember to be more grateful," he reflects. "I am living the American dream. I'm extremely lucky to be in this position."

As for his parents, they're adjusting well. Initially surprised and a bit disappointed at their son's career divergence, they "understood that I had to try this," Kim says. "In their hearts, they want me to come back to Korea but they understand what I'm doing and why I'm staying. They're happy I'm doing something I like and that I'm having some success."

(opposite page) In 2007, CNN's news show "American Morning" featured the wall, with Christopher Lawrence reporting live from the 200-million-pixel tiled display.

(left) Earning his doctorate in 2006 was a proud moment, but Kim still had some big decisions to make about his future.

developing," says Jenks, Hiperwall co-founder and chief scientist. "He had a habit of working overnight to develop and implement an idea we had come up with the day before. I would arrive in the morning and he would show off a new capability."

Researchers clamored to use the system, and visitors to the Calit2 Building wanted to know how they could buy one. Thus was planted the seed of potential commercialization.

"This support from Calit2 was very valuable, because Sung-Jin could dedicate his efforts to greatly enhancing the capabilities of the HIPerWall software, and could support the many demonstrations and visitors that came to see the system on an almost daily basis," Jenks says.

Joerg Meyer was a UCI engineering assistant professor in Calit2's Visualization Lab who worked closely with Kim. Currently a principal systems engineer at Magic Leap, Inc., Meyer calls Kim "the mastermind" behind many of the advanced features of the Hiperwall system. "He conceptualized many of the early features and converted the system from a proof-of-concept prototype into a consumer-grade product."

2007 was a pivotal year. Kim developed a groundbreaking program that allowed Google Earth satellite images to be displayed interactively on the wall. The project was featured in a variety of media outlets, including a live feed from CNN's "American Morning;" a story on Spanish-language television station Univision; and an article in the Los Angeles Times.

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Making Moguls from Middle Schoolers

STARTUP SEEKS TO EMPOWER GIRLS, INTRODUCE THEM TO ENTREPRENEURSHIP

by Lori Brandt

photo: Paul R. Kennedy

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Siblings Gina and Jenae Heitkamp, winners of UC Irvine's 2014 Merage Business Plan Competition, are breaking glass ceilings: first all-female team to win, first sister team to make the finals and first toy idea to take the 11-year-old contest.

Their company, iBesties, is a line of books, dolls and online entertainment that aims to inspire entrepreneurship and technology learning in girls, ages 6 to 10. The multimedia brand tells the story of six middle school girls who end up in the fast-paced world of Internet startups after their blog becomes an accidental overnight success. The six best friends, or besties, learn how to juggle middle school friendships, homework and their own social networking site — all while keeping it a secret from their parents. They are "middle schoolers by day... moguls by night."

"There are a lot of programs out there encouraging girls to get interested in entrepreneurship, science and technology, but most start later, in high school," says Gina. "Our goal with iBesties is to start younger and through aspirational play, show girls some of the many opportunities that exist."

It was their own experiences that motivated the two women to start the company. Gina, with an MBA from UCI's Paul Merage School of Business and several years of working on social networking startup companies, noticed the lack of women at industry events. Jenae, who has spent a decade as a child therapist and is a mother of a young daughter, often wished that the young girls she worked with had more role models and would dream bigger when it came to choosing a career.

Each of the six characters in the iBesties story has a middle school persona and a corresponding mogul role in the startup business. The smart techie serves as the group's computer whiz, the social butterfly becomes the social media guru, and the head cheerleader contributes her savvy business sense. The group's blogger is a book lover-dreamer, the publicity mastermind is a prankster-tomboy, and the graphic designer is an artsy diva.

David Ochi, a veteran early stage company executive with over 20 years of entrepreneurial and fundraising experience, served as a judge for the business plan competition. He said it was a tough choice. Typically, the entries are high-tech companies, biomedical or engineering related. iBesties is decidedly low tech. But it stood out for several reasons.

"The iBesties team had a well-developed business concept, not just an idea," says Ochi. "They had a product — a book and a doll — with storyline and characters. They'd done their research and thought through the details. Plus, they delivered a solid presentation with a clear feel-good social message. iBesties gives girls a different role model than Barbie. Their point is, you can be a high achiever and entrepreneur and still be cool. It's a nice cultural shift to address the needs of young girls."

With the $15,000 prize money, the Heitkamps both quit their current jobs to focus full time on building their company. Gina heads up business operations and Jenae directs product development.

"When we saw that other people, grown men, could get behind our idea, we realized that this could be more than just our hobby," says Jenae.

In October, they moved into TechPortal, Calit2's business incubator; and with help from Women in Toys, a professional networking group for women in the toy industry, they've met with potential buyers at the Fall Toy Preview in Dallas. The sisters are looking for a doll fashion designer and have been drafting designs for the iBesties toy office.

With a website, two books, a rough 3-D doll prototype and a tight elevator pitch, the sisters are talking to potential investors and buyers. They hope to beat the statistics. According to Bloomberg, 8 out of 10 entrepreneurs who start businesses fail within the first 18 months.

"iBesties has all the characteristics for success," says Ochi, executive director of the UCI ANTrepreneur Center. "With hard work and a little bit of luck, they will do well, and we will all have a lot to be proud of."

Next up for the sisters is the Blackstone Launchpad Demo Day Competition in New York. One of 20 teams, selected out of 75, iBesties will vie for the $25,000 grand prize.

In starting a company aimed at inspiring young girls with role models, Gina and Jenae have, themselves, become examples of smart, savvy, ambitious women, pursuing their dreams.

Watch out for more falling glass.

(previous page) Sisters Gina (left) and Jenae Heitkamp plan to show their company, iBesties, at February's Toy Fair 2015 in New York City.

"iBesties has all the characteristics for success. With hard work and a little bit of luck, they will do well, and we will all have a lot to be proud of."

The annual Calit2 summer undergraduate research fellowship program — dubbed SURF-IT — culminated in August with 10 participants presenting their project results. As varied as the topics were, so too were the Fellows' majors and interests, making for a richly diverse and rewarding 10-week experience.

28

positiveoutcomes

compiled by Shelly Nazarenus

(left to right) Marie Gilbert, Stefan Wenth, Soheil Arkhavan Masouleh, Diane Shin, Joseph Mehrabi, William Stone, Vasu Sharma, John Delshadi, Devin Held, Dominic Scarmardo

Access to the Internet and Mobile Applications in a Mixed-Population Emergency Department

Diane Shin (human biology)

My SURF-IT project focused on finding out what percentage of patients who come into the UCI Medical Center emergency department have access to the Internet and mobile devices. Essentially, we wanted to quantify the patients' accessibility to these resources to improve patient education within the emergency department. We looked at numerous factors regarding the different types of access our patients had to the Internet, the various devices they used, whether they used these devices to look up health information and how comfortable they were with using these resources to further communicate with the physicians and medical staff. The information obtained from the surveys will help us improve our patient-education efforts within the emergency department by better utilizing the technological resources that are accessible to the sample patient population.

CodeGlass

William Stone (computer game science)

CodeGlass deals with issues professional programmers face in the work environment. It is often difficult for programmers to focus on their work because the environment they work in is so cluttered with extraneous information. In addition, it is difficult to keep track of what the rest of the team is working on in a convenient way. We want to alleviate some of these issues by offloading information from the programming environment to the Google Glass, including useful information about what the other team members are working on so conflicts don't arise. We hope this project will eventually become a software development tool that programmers can use.

Modeling of the Vestibular System Using the Arduino Due

Vasu Sharma (biomedical engineering/premedical)

The vestibular system is responsible for stabilizing the body and eyesight and helping to understand spatial orientation. A damaged system can make the slightest movements disorienting and disabling. My SURF-IT project involved trying to understand the functionality of the vestibular system and finding a way to model it. During the summer, we programmed a microcontroller to take input from a gyroscope and then convert it into the appropriate pulses. Our microcontroller uses the algorithm to generate the pulses for a single axis of rotation. Further work will involve transitioning the device to process all three axes of rotation, comparing different mechanical and mathematical approaches to achieve a functional vestibular prosthesis.

Designing a Task-Awareness App for College Students

Devin Held (computer science)

The goal of my project was to design and develop a mobile application that allowed users to reflect on their task management, as well as their stress and productivity. There are countless task-management applications on the market, but there aren't any that focus on integrating reflection techniques to motivate students to become more productive. My role was to come up with a design for the application, write a thorough design document, fully develop and test the application, and analyze user survey data. Initial test results indicate that users benefited from the morning and evening reflections, despite whether they previously used other scheduling techniques or not. This suggests that the additional reflection may motivate users to complete tasks and to improve overall productivity.

An Improved Graphene Transfer Process for Large-Scale Graphene Transistors

Dominic Scarmardo (electrical engineering)

My project is centered on graphene, a relatively new material with very unique properties. Graphene's optical and electrical properties make it a promising material in a variety of applications, from plasmonics to security-screening technology. The research involves improving the transfer process of graphene to create large-scale graphene transistors, which are a convenient way to evaluate certain benchmarks of optoelectronic devices. I was responsible for carrying out the transfers of graphene, as well as investigating different techniques and methods that could produce desirable data. The ultimate goal was to discover what techniques to tweak, add to, and/or remove from our transfer process in order to reach benchmarks of an optoelectronic graphene device.

Supporting Under-Resourced NGOs in the Global South

Marie Gilbert (informatics)

Many health and education services in the global south are provided by nongovernmental organizations; however, many NGOs struggle with scarce resources and limited technical expertise. In the global north, reservoirs of technical expertise, if made accessible, could significantly help under-resourced NGOs in the global south. This project aims to design an effective, scalable, knowledge-sharing tool for these two groups. In the initial research stage, we did literature reviews to better understand mobile use in Africa, NGO technology-supported knowledge-sharing practices, and online question-and-answer communities. We found open-source discussion frameworks readily available in the global south. In the next phase, we will conduct surveys and interviews to better understand NGOs' needs in order to design a technological solution.

The Evaluation of Requirements Engineering for Sustainability

Joseph Mehrabi (business information management)

My project aims to develop the requirements specification for a software system and analyze how the consideration of the five dimensions of sustainability (human, economic, environmental, social and technical) impact each step of the requirements-engineering process. The system under development is called Project Cognatio; it aims to improve medication adherence among medical patients through a two-tiered software system involving a mobile application for patient use and a desktop application for doctor use. My role in the project was to elicit and specify the requirements from the medical-practice perspective. I found that the consideration of sustainability does impact certain artifacts of the requirements specification, and more effort must be taken to adhere to these requirements.

stakeholder needs system vision
usage
models

Arduino to Monitor Sustainable Aquaponics

Stefan Wenthe (chemical engineering)

Aquaponics, the combination of aquaculture and hydroponics, uses natural water-cleaning processes to produce food with minimal protein-, water- and land-use requirements. This project uses inexpensive microcontrollers called Arduinos to monitor system variables. Currently, air and water temperature, humidity and light are measured to provide the user with alerts and information via a Web app for more effective management. While Arduino tank-monitoring systems have been developed by hobbyists, we hope to implement ours in parallel, identical systems in which the Arduino has control over a variable, such as water flow rate, and measures the resulting equilibrium shift in the other variables to optimize performance. The ultimate goal is to apply this technology in the Aquaponics system under construction at the UC Irvine Arboretum.

automated data collection
infinitely
economically viable design scalable

Evaluating the Use and Affordance of the iPad for Standardized Patient Encounters during Clinical Skills Examinations

John Delshadi (informatics)

While there is a growing push for mobile technology in a clinical setting, technology etiquette, effective usage and technology's effect on patient interaction remain under-examined areas. The project I worked on this summer focused on understanding how iPads can be used for patient education in the clinical setting, with the goal of introducing mobile technology into more areas of patient interaction in an effective and consistent fashion. In general, my role was to ask questions as "an outsider," providing a non-clinician view by observing video recordings of iPad usage by doctors during examinations. Our research suggests seamless integration of mobile technology into everyday patient interaction is achievable through directed physician training.

personalization supplemental
tools **interactive opportunities**

Study and Implementation of a Wireless Sensor Network Using Motes

Soheil Akhavan Masouleh (electrical engineering)

The objectives of this project can be summarized into two parts: 1) constructing a wireless sensor network, and 2) implementing existing algorithms to optimize the performance of the network. A sensor network includes some sensor nodes and a fusion center. In our design, the fusion center is a laptop that is used to join sensors, and the nodes are our TELOSB sensors. This summer, I was able to construct a wireless network including two motes and program wireless sensors to successfully send data packs to each other. My programs now can be easily extended to more than two motes.

event driven synchronization
component
based

APRIL

8 Calit2 hosts the spring Emerging Technologies Summit, organized by regional utility companies to assess promising energy-efficient technologies that will benefit California customers.

21 Three company representatives from Taiwan-based Wistron ITS visit CalPlug to learn more about the center's software development for energy-efficient solutions.

22 Assistant professor Sung Chul Bae (right) from South Korea's Ulsan National Institute of Science and Technology visits the eHealth Collaboratory.

24 Smart labs, green buildings and energy-efficient retrofits were among the topics discussed at a UC systemwide facilities managers meeting hosted by Calit2.

MAY

12 CalPlug Advisory Board Chair Brad Meister leads a discussion during the board's annual meeting.

13 Vojin Zivojnovic, co-founder and CEO of AGGIOS, presents his company's energy-management and design solutions during the semiannual CalPlug workshop.

14 Advisory board members from UCI's Center for Digital Transformation take a tour of Calit2, including a stop in the Visualization Lab to hear from Professor Aditi Majumder.

20 Retired Rockwell CEO and entrepreneur Don Beall shares life lessons with students participating in the Multidisciplinary Design Program.

22 A group visiting UCI from the University of Bordeaux stop at Calit2, where Director G.P. Li explains the goals of the eHealth Collaboratory.

29 The semiannual Igniting Technology event partners with Gov. Jerry Brown's GO-Biz innovation series to highlight the regional entrepreneurial ecosystem.

JUNE

3 Calit2 Bio-Nano Metrology Lab Manager Peter Burke receives the 2014 Samueli School of Engineering Innovator of the Year Award from Dean Gregory Washington.


3 UNIST Provost Jung Mooyoung and UCI Vice Chancellor for Research John Hemminger sign an MOU, forging collaborative research opportunities for Calit2.

5 Graduate students from around the world participating in the Broadcom Foundation University Research Competition tour CalPlug.

12 Students in Professor Franco De Flaviis' research group experiment with software simulation tools generously donated to UCI by ANSYS, Inc.

JULY

17 Two company representatives in the University-Industry Demonstration Partnership program stop by TechPortal to learn about the startups residing in the incubator.
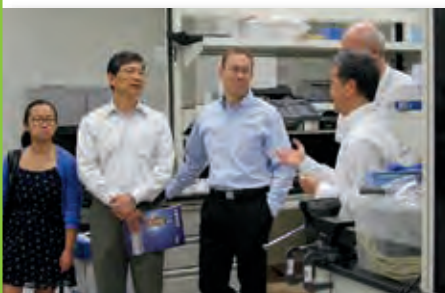
23 High school students participating in COSMOS, a summer science and math program for high-achievers, experiment with robotics in the EVoKE Lab.

23 Students from the Korean Advanced Institute of Science and Technology studying at UCI learn more about Calit2's microscopy capabilities.

AUGUST

7 A group from Beijing University of Posts and Telecommunications explores demonstration projects in the eHealth Collaboratory.

8 John Hammer, investment director for Monsanto Growth Ventures, is outfitted with the MusicGlove prototype, which is being developed by UCI startup Flint Rehabilitation.

11 UCI graduate students in the Chemical and Materials Physics program receive training on the microscopes in the LEXI facility.

14 A CalPlug project is demonstrated for students from Qatar participating in UCI's Center for Educational Partnerships program.

22 Jessie J. Knight (center), executive vice president of external affairs for Sempra Energy, visits UCI to meet with Calit2 Director G.P. Li and APEP Director Scott Samuelsen.
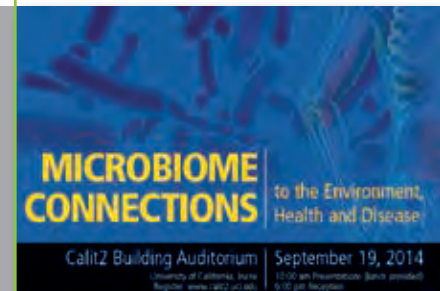
SEPTEMBER

4 Representatives from the Samueli Institute receive an update from the eHealth Collaboratory team working on a project supported by the organization .

19 The second annual Microbiome Connections symposium features experts studying the relatively new field. Topics range from the environment and ecology to health and medicine.

17 Calit2 hosts this year's new UCI faculty orientation session in the building auditorium, with Director G.P. Li encouraging the incoming Anteater professors to get involved in multidisciplinary projects.

22 LEXI Lab Manager Jian-Guo Zheng holds the first session of a week-long lecture series to acquaint potential users with the full capabilities of the microscopy facility.

24 Dan Cregg, CTO of smart home automation company INSTEON, meets with Director G.P. Li and tours the CalPlug Center.

25 A delegation from global security company Northrop Grumman learns about a CalPlug home-management energy-efficiency system from Technical Director Arthur Zhang.

Under the direction of Professor G.P. Li, Calit2@UCI develops information 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 healthcare, energy, the environment and culture.

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Resources & Advice from Upperclass(wo)men
Wednesday, Nov. 5, 2014
4:00 – 6:00 pm, reception following

Internships & Research Opportunities
Wednesday, Jan. 14, 2015
4:00 – 6:00 pm

Entrepreneurial & Career Opportunities
Wednesday, April 15, 2015
4:00 – 6:00 pm

Women receive more than half of the bachelor's degrees awarded in the U.S. in biological sciences. They receive far fewer, however, in computer sciences (18.2%), engineering (18.4%), and mathematics and statistics (43.1%).

Women remain underrepresented in the science and engineering workforce. They comprise only 13% of all engineers and just 25% of computer and mathematical scientists.

Minority women comprise fewer than 1 in 10 employed scientists and engineers.