USC Viterbi

SPRING 2013

CREATING THE WORLD THAT NEVER WAS

THE $500 MILLION CAMPAIGN

FOR THE USC VITERBI SCHOOL OF ENGINEERING

The USC Viterbi School of Engineering is entering one of the most exciting chapters in its history. Building on over a century of innovation in research and education — and energized by an underlying optimism that engineering delivers the promise of a better life — the school is sharpening its upward trajectory.

"Scientists discover the world that exists; engineers create the world that never was."
— Theodore von Kármán

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SPRING 2013

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DEAN'S LETTER

THE CAMPAIGN

In his wonderful book, "The Beginning of Infinity," quantum physicist David Deutsch writes: "Problems are inevitable. (But) all problems are soluble through science and engineering." He traces this statement to the ever-growing ability of science, engineering and technology to discover, analyze and create solutions to challenges that were unimaginable just a mere few years ago. I share wholeheartedly his optimism. In today's world, it calls us to compete to "grow the pie" rather than divide a diminishing one, an activity that we see practiced with alarming frequency.

Chuck Vest, the visionary president of the National Academy of Engineering, proclaimed at the USC National Summit on the Engineering Grand Challenges, in October 2010: "This is the most exciting era for science and engineering in human history." We are witnessing unprecedented advances that open avenues and possibilities, each of which was unthinkable just before it was conceived. Indeed, engineering is empowering society. At the USC Viterbi School of Engineering, we have termed this empowerment as Engineering+.

This exhilarating new era presents us with great opportunities, but also with risk if we fail to grasp them. In moving the school forward to meet a constantly exciting future, I am reminded of the three characteristics of Jim Collins' good-to-great ascent: passion, excellence and the resources to fuel them. We have encapsulated the first two in the following four pillars:

I. Be a Global Attractor of Talent:

Of students, faculty, and staff from anywhere in the world - and provide the culture and the environment for them to flourish.

II. Continuously Add Value:

To curriculum, programs, and infrastructure.

III. Advance Solutions to Global Challenges:

From energy and sustainability to security and infrastructure, to health and medicine, and to the scientific and technological discovery.

IV. Use Engineering+ as the Catalyst for Innovation:

To fuel the economic growth of Los Angeles, Southern California, the United States, and the world.

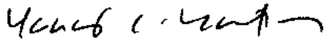
These four pillars support the vision of the Viterbi School. They express our passion. And they guide our ambition. In these pages you will get a glimpse of their impact. But to keep them strong and growing requires resources.

Upon his inauguration, USC President C.L. Max Nikias announced the Campaign for the University of Southern California, Fas Regna Trojae, a historic $6 billion campaign. The Viterbi School has its own share of this campaign, a target of $500 million, easily the highest goal in the USC School of Engineering history, and likely one of the largest ever in engineering schools anywhere.

All the above themes can be encapsulated as "Creating The World That Never Was" – a declaration of wonderful possibility, drawn from the words of Theodore von Kármán: "Scientists discover the world that exists; engineers create the world that never was." Perhaps it is altogether fitting that this year, the same year that our own Professor Sol Golomb was awarded the National Medal of Science, we invoke the spiritual inheritance of von Kármán, the man upon who John F. Kennedy conferred the nation's very first such honor. Just as with Deutsch, the notion of creating a world which never was, speaks to an irrepressible optimism, one which assumes that problems, known and unknown, are surmountable. We may, in a moment of boldness, even presume that a chunk of that surmounting will be done at USC Viterbi, a place not wholly unfamiliar with making problems soluble (see page 48 – on restoring sight to the blind).

"Creating The World That Never Was" will strengthen the four pillars, by providing funds for student scholarships and endowed chairs; endowing departments and student centers and programs; helping raise new instructional and research buildings and facilities; endowing research centers and seeding new research; and helping nurture an ecosystem of innovation and entrepreneurship.

Please join us!



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BY THE NUMBERS

17 mK
Average temperature (in millikelvins) of the chamber holding the Rainier quantum chip at ISI, making it arguably the coldest place in the universe. (As recorded in the year 2012 at the USC Lockheed Martin Quantum Computing Center).

38%
Entering freshmen are women – compared to 18 percent national average over all grades.

$108,000,000
In federally funded research in computer science, the most of any university in the nation (Source: National Science Foundation report, 2010)

8
8 member schools in the iPodia Alliance, our new global classroom joined via immersive, synchronous video (USC, Peking University, National Taiwan University, Technion, the Korea Advanced Institute of Science and Technology, RWTH Aachen University in Germany, University of São Paulo and the Indian Institute of Technology – Mumbai)

80,000
Estimated number of patients in the United States who lost their vision due to retinitis pigmentosa; many of whom are now candidates to have sight restored with Argus II, the world's first artificial retina (see story, page 46)

800,000
The number of new stroke victims every year in the United States — a number that will double in the next 20 years. USC Viterbi's socially assistive robots will help bridge the gap in human care. (see "Robots: Photo Essay," page 36)

6
MIT TR35 faculty in past four years, four of whom are women.

Sol Golomb Named Among Nation's Top Scientists, Innovators

President Obama confers National Medal of Science, the highest honor bestowed by U.S. government upon scientists, engineers, and inventors

In a fitting capstone to his 50th year at the USC Viterbi School of Engineering, Solomon Golomb, the Andrew and Erna Viterbi Professor of Communications, received the highest honor bestowed by the United States for scientific innovation.

Last February, President Barack Obama presented Golomb with the National Medal of Science for his advances in mathematics and communications at an awards ceremony held at the White House.

"Sol Golomb is such a deserving recipient of this tremendously prestigious honor," said USC President C. L. Max Nikias. "His many contributions to mathematics and engineering span more than five decades, and his mathematical coding schemes have advanced a number of important projects, including the imagery we received from Mars. USC is so proud to have been Professor Golomb's academic home all these years."

USC Viterbi Dean Yannis C. Yortsos said: "Sol Golomb is the quintessence of USC Viterbi. He symbolizes what is best in mathematics and its application to engineering and other disciplines. He has contributed mightily to the school's impressive ascent in the last several decades."

The official citation given to Golomb praises his work on shift register sequences, random-looking sequences of ones and zeros that have important, though hidden, mathematical structures that make them useful in a variety of applications — from radar to cell phone systems to space communications. Video images from the Mars Rover Curiosity, which made headlines this past summer, owe a huge debt to Golomb's mathematical coding schemes, enabling pristine imagery transmitted from the Mars Rovers all the way back to Earth.

As Golomb noted in a 2004 interview, "By the time of the Apollo Moon landings, we could get radio signals to and from the Moon about 250,000 miles away. Now we can get television pictures from a planet more than 100 million miles away."

Golomb's name joins an impressive registry of National Medal of Science laureates, including Theodore von Kármán, Claude Shannon and alumnus Andrew Viterbi, namesake of the USC Viterbi School.

They Said It

Engineering+ / What non-engineers are saying about us.

On better rock songs:

"Before YouTube had HD video, you didn't know the video you were watching was bad. That's the scenario to start with… If not for Chris (Kyriakakis) we wouldn't be able to help our users listen to music as if they had far more expensive headphones without using more of their bandwidth.

Virtually every epic indie rock song that I listen to, there's always a moment when I turn on the (Audyssey) high quality filter. It's like you've been in a really noisy restaurant for five hours and then you step outside, and it's quiet and there's sort of an 'aah' moment. You didn't realize how grating those other sounds had been. Suddenly, that really annoying high-end hiss from the cymbals or the high hats disappears, or suddenly there's a guitar that I never quite heard before."

— Elias Roman, CEO of music streaming service Songza, on the innovative audio filter available for your headphones via their partnership with Audyssey, Associate Professor Chris Kyriakakis' spin-off company from the USC Integrated Media Systems Center.

On fighting cancer:

"In essence, what (Paul Newton) is creating is the beginning of a new model. You know, we doctors have plenty of our own models, all created by other physicians. But it's the difference of trying to predict the weather on an 18th century sailing ship versus using a ship with modern technology. I can take someone's PSA, size of tumor, grade of tumor, and turn to charts that tell me about the type of cancer progression they might have. But that's like trying to predict tomorrow's weather using today's calendar date, temperature and barometer reading. Paul is the equivalent of a global weatherman – he can give me the forecast for cancer using thousands of variables instead of three."

— Dr. Jorge Nieva, chair of hematology and oncology at the Montana-based Billings Clinic, on Professor Paul Newton's computer models that predict cancer metastasis (see story, page 32).

On autism:

"Scientists committed to discovering the very best ways of intervening on behalf of children with autism spend hundreds and hundreds of hours observing an individual child's behavior in different settings - with other children and adults. The information we extract is only as good as our observation skills, and let's face it, humans can miss a lot of what's going on. We tend to focus on the child with autism. And even with that focus, we only see the most obvious, which may not be the most important. Shri's program to develop sophisticated signal processing methods provides an automated way to increase our capacity to detect complex patterns in speech and behavior.

For the first time, we are paying attention to how others in the room respond to a child with autism in their back-and-forth interactions. These signal processing approaches will not only give us insight into complex behavioral patterns – but with ongoing studies gathering 'before and after treatment' signal processing data, we will be able to predict how well each child with autism will respond to a particular treatment. And that's the essence of individualized care."

— Dr. Pat Levitt, provost professor, Zilkha Neurogenetic Institute, Keck School of Medicine of USC, on Professor Shrikanth Narayanan's work, interpreting audio to help diagnose autism.

On climate change:

"A major goal in marine science is predicting how communities of marine organisms will respond to changing environmental conditions such as climate change. Achieving that goal requires the design, control and deployment of sophisticated robotic instruments such as those that Gaurav and his team have been developing. These instruments, equipped with state-of-the-art sensors, are beginning to provide unprecedented, real-time measurements of ocean chemistry and physics, allowing biologists to interpret 'cause and effect' between environmental drivers and community response."

— David Caron, professor of biological sciences, USC Dornsife College of Letters, Arts and Sciences, on Professor Gaurav Sukhatme's underwater robotics research.

VITERBI HOT LIST

What's happening on campus now

USC Viterbi Ranked Among the Best Graduates Schools of Engineering

U.S. News and World Report ranks USC Viterbi in the top ten in this year's Best Graduate School Rankings.

Everybody's Talking On-line Education . . . USC Viterbi's No. 1

USC Viterbi earned top honors in two on-line education categories in the U.S. News and World Report 2013 rankings: Online Graduate Engineering Programs and Online Computer Information Technology Programs (Computer Science).

Top Hollywood Agency + Major Silicon Valley VC + USC Viterbi Engineers

In a move calculated to excite "Silicon Beach," the Viterbi Startup Garage is a new joint initiative of the USC Viterbi Student Innovation Institute (VSI2), United Talent Agency (UTA) and Kleiner Perkins Caulfield & Byers. This early-stage technology accelerator is designed to provide financial and other strategic resources to a select group of USC student and alumni entrepreneurs.

Best Video Games Program in North America – 4th Straight Year

USC Games, a joint collaboration between the School of Cinematic Arts' Interactive Media and Games Division and the Viterbi School's Computer Science Department, has been named the top graduate program for video game design by The Princeton Review for the fourth straight year.

iPodia – The Global Classroom

The spring 2013 iPodia class has 108 American, Chinese, Korean, Israeli, and German students from five universities (USC, PKU, KAIST, Technion and Aachen) studying together to learn how to leverage cultural diversity to inspire global innovation. *See editorial, page 58.*

Vesuvius Comes to USC

The 512 qubit Vesuvius quantum chip has a new home: the USC Lockheed Martin Quantum Computing Center at ISI, the first operational, quantum computing center in academia. The Vesuvius chip has the potential to solve problems in 120 milliseconds that would take the world's fastest current supercomputers 320,000 years.

FAST FORWARD

Building A Better Tomorrow, One House At A Time

Professor Behrokh Khoshnevis' "Contour Crafting" technology could revolutionize the construction industry and improve lives

By Marc Ballon

Behrokh Khoshnevis wants to change the world one house at a time.

A professor at the Viterbi School of Engineering, Khoshnevis has created a computerized, robotic machine that he believes will bring the construction industry into the digital age for the benefit of people everywhere, especially impoverished slum dwellers.

This innovative "Contour Crafting" technology will soon be able to create a 2,500-square-foot home in only 24 hours, he says. That compares to the six to nine months it now takes to build the typical American home. Contour Crafting will also be cheaper, safer and better for the environment than prevailing labor-intensive building practices.

Guided by computer-designed architects' drawings, the contour crafter gantry robot will move along its rails, repeatedly squeezing inch-thick layers of concrete through a nozzle like toothpaste from a tube. A pair of trowels attached to the nozzle will shape the materials as desired, including curvilinear shapes. A commercial grade contour crafter will one day offer custom-designed homes, including individually painted rooms with all utilities imbedded.

It will do this with minimal waste, noise, dust and emission pollution. Construction injuries and deaths will plummet through increasing automation.

The National Science Foundation, NASA and the Army Corps of Engineers, along with Caterpillar and other companies, have invested in it. So far, Khoshnevis and his team have built a multitude of shapes and walls with the innovative technology. Additional support, they say, would allow them to take Contour Crafting out of the lab and into the field, where they could safely build houses with more advanced robots.

"Contour Crafting is a revolutionary technology with astounding social, economical and architectural impacts," Khoshnevis says. "Because of its high speed and low cost, the technology will perhaps have the biggest initial impact on low-income and emergency housing."

An estimated one billion people in India, South Africa, Brazil and elsewhere live in unsanitary urban slums that breed disease and despair. In such places, Contour Crafting could dramatically improve the housing stock and quality of life. Similarly, the technology would be a boon to the millions left homeless by natural disasters and wars.

So promising is the technology that possible future applications include building labs and manufacturing facilities on the moon and Mars.

"I want to make a difference through my passion for invention, to touch as many lives as possible, and to play even a tiny role in the destiny of humanity," Khoshnevis says. "I want to leave a footstep behind."

View Khoshnevis' 2012 TEDx talk: usc.viterbi.edu/houseinaday

ILLUSTRATION BY YANG LIU

Buildings Have Personalities, Too

More than just concrete and steel, office buildings have their own personalities. Getting to know them better can save energy while making occupants more comfortable

By Marc Ballon

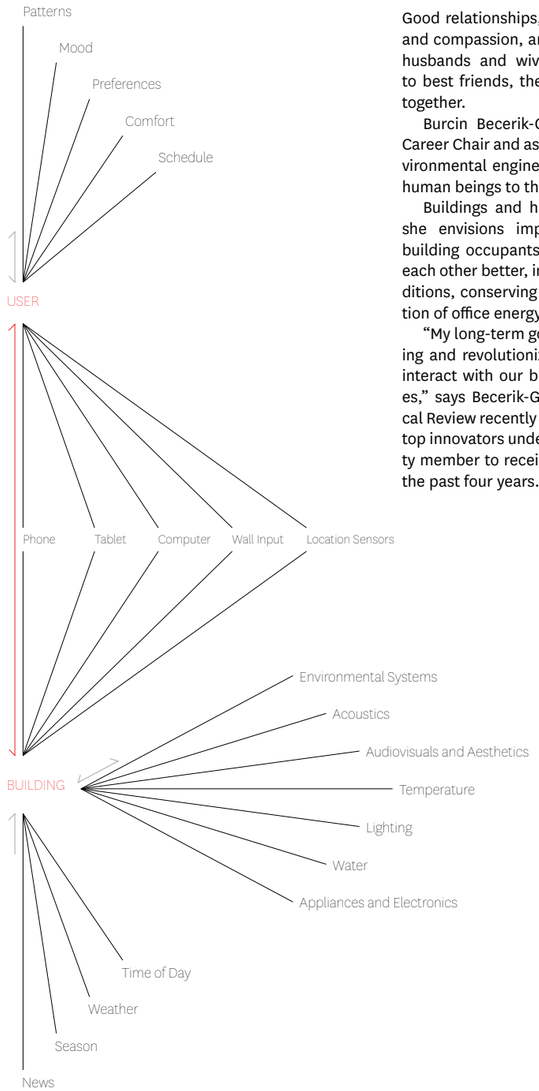


DIAGRAM OF POSSIBLE FUTURE HUMAN/BUILDING RELATIONSHIP: *In the future our buildings will engage in conversation with us; learning about our preferences, hearing our feedback and negotiating right back through a variety of touchpoints. '...are you sure you want to turn up the heat? Didn't you just get a new sweater?'*

Good relationships, built on communication, trust and compassion, are the bedrock of society. From husbands and wives to mothers and daughters to best friends, they are the glue that links us all together.

Burcin Becerik-Gerber, Stephen Schrank Early Career Chair and assistant professor of civil and environmental engineering, would add buildings and human beings to that list.

Buildings and humans? Absolutely. Over time, she envisions important benefits flowing from building occupants and buildings getting to know each other better, including improved working conditions, conserving natural resources and a reduction of office energy costs by up to one-third.

"My long-term goal is to enable a new way of living and revolutionize the way we think about and interact with our buildings, office and living spaces," says Becerik-Gerber, whom MIT's Technological Review recently recognized as one of the world's top innovators under 35. (She is the sixth USC faculty member to receive the prestigious distinction in the past four years.)

"The buildings of the future will not be simply shelters but entities that connect with users. And users won't just inhabit space; they will collaborate with buildings to reach shared goals."

Here's how it works. By gathering information through smart phone applications, sensors and other means, Becerik-Gerber says, buildings could learn occupants' temperature, lighting and airflow preferences to increase comfort and productivity.

Through text, visual and audio messaging, among other channels, buildings could also communicate with occupants on how their personal choices, even incremental ones such as turning the thermostat down a couple degrees, would have a big impact on energy consumption. Such knowledge could lead occupants to alter their behavior to conserve energy and help the environment.

Becerik-Gerber emphasizes that communication runs both ways: "Occupants will actively exchange information with their building and let it know who they are and what they want."

At present, this "conversation" between buildings and humans doesn't exist. However, Becerik-Gerber and her team aim to change that. Armed with a grant from the U.S. Department of Energy, they have spent the past two years laying the foundation for such a symbiotic relationship.

Specifically, researchers have installed a myriad of lighting, sound, motion and other sensors at USC's Lewis Hall and elsewhere on campus to better understand how workers and others interact with their office space. Among their findings: People have varying schedules and temperature preferences for different days of the week. This information will enable buildings to conserve energy while maximizing comfort.

In the near future, Becerik-Gerber believes proprietary software using algorithms will make sense of the mountains of smart phone, sensory and other technological data, allowing humans and buildings to negotiate win-win outcomes.

Becerik-Gerber's background makes her eminently qualified to turn her vision into a reality.

A graduate of Istanbul Technical University, University of California, Berkeley and Harvard University, she holds advanced degrees in architecture and engineering, giving her insights into building design and physics. Her interdisciplinary collaborations with colleagues across the academic spectrum, long a hallmark of the Viterbi School of Engineering, have moved her project forward faster than otherwise possible. So promising is her work that the National Science Foundation recently awarded Becerik-Gerber a large grant.

"We'd like our solutions to have impact in everyone's life," she says. "I believe they will."

Glossary

Moghaddam Research Group

Mahta Moghaddam and her team are doing amazing work at MiXIL (the Microwave Systems, Sensors, and Imaging Lab), part of the Ming Hsieh Department of Electrical Engineering at the Viterbi School of Engineering. There's nothing cooler than radar-based science. But let's face it, it's an intimidating prospect to wade through the polysyllabic jargon of research on the bleeding edge of technology. So don't strain your untrained brain. Read on for some definitions and context that will make delving into MiXIL's work much easier.

— Lexa Freshwater Burton

SUBSURFACE INTERFACE RADAR

an electromagnetic radar used in a wide range of applications to find and analyze objects embedded in concrete and soil

"We found Jimmy Hoffa!"

SUBSURFACE SENSING

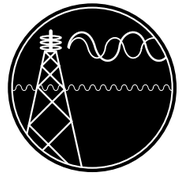
a technique for determining what is below ground without digging; nondestructive and more efficient than excavation

"You could cut the tension in here with a knife. Let's get some subsurface scatter going to find the elephant in the room."

COHERENT SCATTERING

the process by which a traveling wave or ray is forced to deviate from a straight trajectory by manipulation of the medium through which it passes

"Coherent scattering is a game changer for the professional laser tag player."



ULTRA-WIDEBAND (UWB)

radio technology spread over a large bandwidth that does not interfere with conventional radio waves and can be used at very low energy levels

"The radiobesity epidemic rages on as more and more customers walk slowly--but never run--to Ultra-Wideband & Tall."

OPTICAL REMOTE SENSING

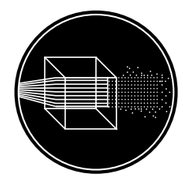
analysis of near-infrared and infrared light absorbed and reflected by surfaces and objects to determine their nature

"My mother always told me to never optical remote sense a book by its cover."

SURFACE PLASMONS (SPs)

electron oscillations at the surface of an object that control how it interacts with light

"These funky beats are irresistible. My surface plasmons are going crazy. I look like a human disco ball."



INVERSE SCATTERING

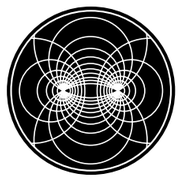
a technique for determining the properties of an object by collecting data on how it scatters particles or radiation

"Double rainbow all the way across the sky! It's so beautiful! What does it mean? Let's use inverse scattering to find out."

LANDSAT PROGRAM

the longest running satellite imagery program, begun in 1972

"Planet Earth may not have a Facebook profile, but at least Landsat has tagged it in literally millions of pics."



DIELECTRIC

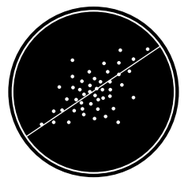
electrical insulation that can be polarized by applying an electric field

"Poor Bill put two layers of dielectric insulation on his house and now he's bipolar."

BISTATIC RADAR

a radar system in which the transmitter and receiver are separated by a comparable distance to the expected target

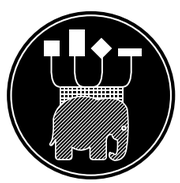
"If you let a bistatic radar transmitter go and the receiver comes back to you, it's yours forever."



NONLINEAR ESTIMATION

determining the relationship between one or more dependent variables and a set of independent variables

"In my nonlinear estimation, 'Inception' made no narrative sense."



MULTISENSOR DATA FUSION

a technique for integrating datasets from multiple sensors to create an accurate and specific image, more complete than what could be inferred from any one sensor alone

"Have you heard the one about the blind men and the elephant? Too bad those guys didn't have access to multisensor data fusion."

SMART SENSOR WEBS

a network of sensors particularly well suited to environmental monitoring, connected via networks and grid technology

"I installed a smart sensor web at home, in my car, and at my office so that I'll never misplace my glasses again. Wait, where are they? Oh, on my head."

BIOMASS

biological material of living or recently living organisms

"Zombies + Cranial Biomass = Heaven"

***FROM LEFT TO RIGHT:** Jamison Moore, Anton Leuski, Stacey Marsella, Jon Gratch, David Traum, Arno Hartholt*
In building Gunslinger, the team watched hours and hours of old Western movies to deconstruct their style and learned to add in ways to use the story to shape the audience.

INSIDE: "Gunslinger" @ ICT

Step inside a Wild West saloon filled with engineering technology

By Kathleen Concialdi

Sitting in a dark movie theater, have you ever wished you could be a part of the action? Now, thanks to an interactive storytelling experience called "Gunslinger," that fantasy is becoming a reality. A product of USC's Institute for Creative Technologies (ICT), Gunslinger was brought to life by Jonathan Gratch, a Viterbi research associate professor, and Kim LeMasters, ICT's former creative director. Gunslinger allows a person to walk through the fictional Clementine Saloon as the town sheriff and interact with Utah the barkeep, Harmony the bargirl, and Rio, the bandit. Except Utah, Harmony, and Rio aren't real. They are virtual humans. And the goal of the scenario is for all of the characters, including the real world sheriff, to work together to take down Rio.

Gunslinger may look like a video game that transports the sheriff into a world of virtual humans, but these computer-generated humans don't just respond using a generalized robotic script of answers or reactions. Characters can react, respond, and communicate as though you were speaking with another live human being. Lifelike activity is possible thanks to ICT's virtual human research. This includes speech recognition, computer vision, dialogue management and character animation systems; all developed by Viterbi faculty. The Nonverbal Behavior Generator, developed by research associate professor Stacy Marsella and his former graduate student Jina Lee, Ph.D., allows the characters to appropriately nod, focus their gaze, and exhibit facial expressions. Another Marsella-developed system called SmartBody, blends these behaviors into a smooth animation, allowing them to happen naturally as a live human would. NPCEditor – a tool from Anton Leuski, a Viterbi research assistant professor and member of ICT's Natural Language Dialogue group, helps enable the virtual characters to carry on conversations with the real life ranger.

Initially developed as a way to see if there was a way to combine engineering, cinema, and a video game experience together to make engineering exciting, Gunslinger has possibilities beyond the realm of just being fun. Jonathan Gratch, who leads ICT's virtual human research efforts, describes Gunslinger as "the chassis of a car." He says Gunslinger and its technologies are like the system, and this system can be used in various areas. Marsella, head of ICT's Social Simulation group, says that these types of programs and technologies aid in the development of social and professional skills. The virtual human technology allows a person the ability to create a virtual avatar in web and game interactions, but the virtual humans also act as role players to influence human behaviors. Marsella believes virtual humans can be viewed as a "new form of computer interface" which allows platforms like Gunslinger to aid in real world applications such as training soldiers in negotiation tactics, guiding doctors in better bedside manner, and even helping real life humans with stress management techniques.

Gunslinger was created by a team of people with backgrounds in computer science, psychology, Hollywood stage craft and storytelling. As it combines many different fields of study, Gratch believes that Gunslinger is a great example of the collective interdisciplinary work that USC strives for.

JONATHAN GRATCH'S background is in cognitive science. He believes that virtual humans can be used as tools to test psychological theories and to engage with humans. STACY MARSELLA has a background in economics and psychology, and uses research in computational models as a way to understand people and their behaviors. Both got involved to use virtual humans as tools to engage people, test psychological theories and understand people.

PHOTOGRAPH BY LUKE FISHER

Sidle on up to the bar and take a gander at this behind the scenes video: viterbi.usc.edu/Gunslinger

Faculty Accolades

01 **Andrea Armani**
SPIE Senior Member

02 **Andrea Hodge**
Diverse: Issues In Higher Education Emerging Scholar for 2013

03 **Andreas Molisch**
04 **Azad Madni**
05 **Daniel Lidar**
AAAS Fellow

06 **Ben Reichardt**
07 **Malancha Gupta**
08 **Yan Liu**
NSF Career Award

09 **David Kempe**
10 **Michael Neely**
Okawa Foundation Research Grant

11 **Dennis McLeod**
NASA's 2012 Software of the Year Award

12 **Detlof von Winterfeldt**
2012 Distinguished Achievement Award

13 **Don Paul**
14 **Iraj Ershaghi**
Orange County Engineering Council Engineering Project of the Year award

15 **Fei Sha**
Alfred P. Sloan Research Fellow

16 **George Bekey**
IEEE RAS George Saridis Leadership Award in Robotics and Automation

17 **Jernej Barbič**
Google Solve for X Featured Talk

18 **Maja Matarić**
Anita Borg Institute's 2013 Women of Vision Award in Innovation

19 **Milind Tambe**
20 **Fernando Ordonez**
Daniel H. Wagner Prize for Excellence in Operations Research Practice

21 **Paul Debevec**
Member to the Science and Technology Council of the Academy of Motion Picture Arts and Sciences

22 **Petros Ioannou**
IEEE Intelligent Transportation Society Outstanding Research Award

23 **Shrikanth Narayanan**
2012 InterSpeech speaker Trait Challenge Award

24 **Stephen Lu**
ASME Fellow

25 **Terence Langdon**
Acta Materialia Gold Medal

26 **Viktor Prasanna**
27 **Yogesh Simmhan**
IEEE International Scalable Computing Challenge

28 **Yolanda Gil**
AAAI Fellow

Overlapping Interests

Transformative faculty hire looks to develop new imaging technologies at USC

By Donna Hesterman

If you want to understand how a heart develops inside a growing mouse embryo, your best bet is to watch one -- live.

That's how Scott E. Fraser would approach the problem.

Fraser is a biophysicist and a recent USC transformative faculty member hire. He and his colleagues are best known for their work developing light and MRI microscopes that allow scientists to observe living cells in their normal environment *in vivo* rather than isolated cells swimming in petri dishes. He says that his inventions are often an amalgamation of technologies from different fields, and that he prefers to work along what he calls the "hyphenated edge" of physics, where one field of science converges with another.

"There is a tremendous amount to be learned where physics, engineering and biology intersect," he says. "You and a colleague can make important discoveries in your own lab without having to wait for the next supercollider to be built."

Fraser maintains a quick tempo in his own research by developing tools that allow him to make first hand observations – usually by adapting technologies already in use in other fields.

When the big question in biology was whether or not stem cells were pluripotent, he *borrowed* tools and techniques from other disciplines to get a quick answer.

He employed a procedure from neurobiology to tag single cells in a living mouse embryo and then used imaging equipment and a low light microscopic camera to follow them as they grew.

"Within weeks we had the answer," he says. "Stem cells are pluripotent — they can take on many different fates."

Fraser's imaging innovations mostly focus on "the mesoscale," a perspective that he says is invaluable for understanding how cells interact with other cells that surround them inside a living organism.

"Very often, we don't need single-molecule resolution, and we don't need to see through an object the size of an elephant," he says. The view is considerably broader than what can be observed in a culture dish, but still concentrated on a small enough region within the organism that microscopy is a must.

But very few tools and techniques exist for observation at the mesoscale, so it has become Fraser's niche to develop his own. The kind of imaging technology he creates has the potential to revolutionize medicine, he says.

"Medical treatments are best at arresting the progression of a disease, but not so good at reversing the disease and repairing the tissue damage it causes," he says. "We want to be able to diagnose things like macular degeneration, glaucoma or diabetes before the symptoms become noticeable." It is this time window, before people report a problem to their doctor that therapies are most beneficial.

The goal, he says, is to make imaging technology for detecting disease available for routine screening in the way that blood pressure machines are available at pharmacies or a doctor's office.

Instruments that support pre-symptom diagnostics are particularly well suited for the marketplace, and Fraser has launched several startups over the course of his career. He also holds many patents in chemistry, biology and nanotechnology.

"It's the sort of *scholarship of consequence* that USC is looking for in transformative faculty," says Norberto Grzywacz, Chair of the Department of Biomedical Engineering at USC.

"Fraser has the experience of discovering things, but more importantly, he knows how to bring it to the public," he says. "That's why we recruited him specifically."

The interdisciplinary nature of Fraser's scholarship has earned him a joint appointment at USC between the Viterbi Department of Biomedical Engineering and the Dana and David Dornsite College of Letters Arts and Sciences.

As a professor at California Institute of Technology, Fraser helped to start up a biological imaging center, a brain imaging center and a nanotechnology center. At USC, he'll work to establish key facilities, such as imaging centers at Children's Hospital Los Angeles, the Keck School of Medicine of USC and USC's main campus.

PROFESSOR SCOTT FRASER
among images generated by his light and MRI microscopes.

"These places are hotbeds of unsolved problems in medicine and biology," says Fraser. "Building a center brings together a critical mass of people from different disciplines and that fosters the sort of cross hybridization that speeds innovation."

Fraser says he sees his role as USC's Director of Science Initiatives to be that of a facilitator, networking between groups to find existing technologies that can be re-purposed for new lines of research. The fruits that can be harvested from the convergence of fields have kept him operating along the hyphenated edges of physics and biology that have served as his inspiration for more than 30 years.

"USC has strong programs in molecular biology, computational biology, engineering and medical research," he says.

"If you want to operate at the interface of those disciplines, USC is the place to be."

DEN Timeline

*A national leader in distance learning for the past 40 years – from television to satellite to Internet delivery – DEN@Viterbi is now ranked No. 1 (U.S. News and World Report, 2013 edition).**

1972 — ITV offers first courses via microwave delivery (local)

1980 — Early 1980's: DEN's first students outside California via tape delivery

1997 — 1997's: DEN launches satellite delivery

1999 — Internet delivery introduced

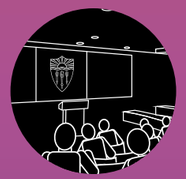
2001 — Programs and courses entirely webcast

2004 — DEN adds 28th Master's program. Now offering more than 40 MS programs

2005 — Partnerships formed with Chevron and Korean Airlines

2006 — Integrated enhanced interactivity e.g. Web Ex, Adobe Connect

2010 — iPodia introduced; Kuwait Oil Company Research Center established



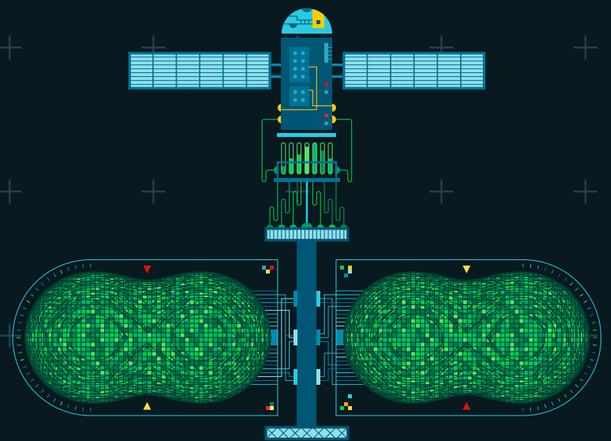
2013 — *#1 Online Graduate Engineering Program and Online Computer Information Technology Program

PHOTOGRAPH OF SCOTT FRASER BY GREER FRESHWATER BURTON

Student Visions for Space Travel

By Conrad Wilton

Every year, lecturer Madhu Thangavelu's Space Concepts Studio looks to combine the power of science with the creativity of architecture. Thangavelu does not entertain old notions; he only looks for new and innovative ideas that will revolutionize space travel for future generations. Below are some of the outstanding student visions from one of his recent classes.



Mark Smith – Algae Ecosystems in Space

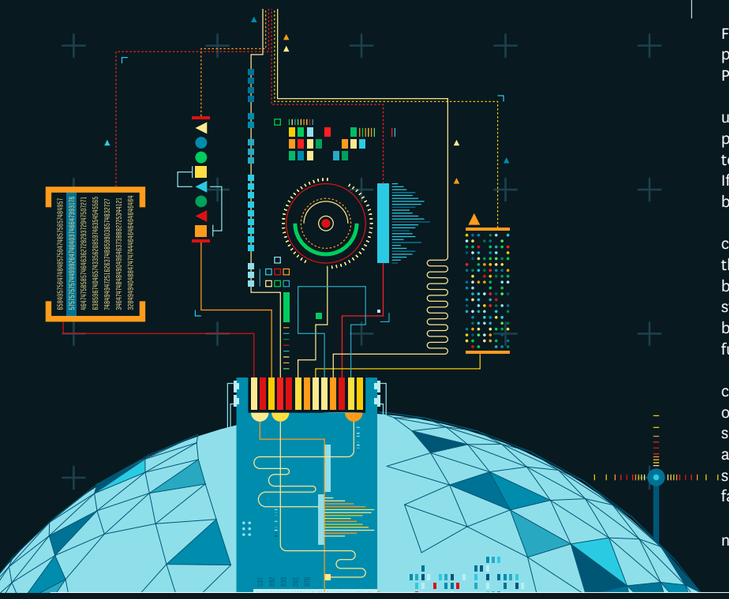
The next time you scrape algae off a fish tank, think twice about flushing it down the toilet. Mark Smith '12, USC Viterbi aerospace engineering alumnus, believes algae can revolutionize space exploration.

Smith and a team of researchers at NASA envision a novel method of generating energy and life support for astronauts from algae. Smith proposes to build living algae ecosystems in space where the plant can be converted into oxygen, drinking water and energy.

The cost of sending oxygen, drinking water and other life-sustaining materials into space can be as high as $14,000 per kilogram. However, Smith believes an algae ecosystem in space could potentially produce enough air, water, and energy to support the astronauts. Therefore, an energy-producing, space-based algae system would better meet astronauts' needs while reducing the costs of space exploration.

A major challenge Smith has encountered is the difficulty of maintaining a living system of algae that can indefinitely supply astronauts with energy. The problem is that in order for living algae to reproduce, the plant needs a steady supply of nutrients. Smith's solution: introduce special snails that feed off the nutrients of dead algae and release them back into the environment for the living algae to absorb.

Ultimately, Smith is confidant algae will transform space travel and exploration as we know it.



Ouliang Chang – Moon Supercomputer

From controlling the tides to keeping the earth in a stable orbit, the moon plays a crucial role in sustaining life on earth. USC astronautical engineering Ph.D. candidate, Ouliang Chang, believes it can do a lot more.

Chang has proposed building a supercomputer on the moon to help back up the Deep Space Network (DSN) on earth. The DSN is a network of computers and antennae throughout the world that allows scientists to monitor unmanned missions in space. Unfortunately, the DSN system is aging. If it fails, vital information necessary to conduct outer space missions will be lost.

Chang believes the moon is an ideal location for a backup system because of its isolation from earth's electromagnetic interference. In addition, the moon's small gravitational pull allows the computer's satellite dish to be much larger, making communication to and from Earth faster and more stable. By building a supercomputer on the moon, Chang not only hopes to back up to the current system, but also to create a reliable foundation for all future lunar projects, including colonization.

Although the potential for Chang's lunar computer shines bright, significant challenges remain. Among them, the Earth always faces the same side of the moon, making it difficult for a lunar computer to communicate with satellites flying on the opposite side. Chang's response is to place antennae all around the moon so the computer can easily communicate with Earth's satellites, regardless of their position. He also hopes to build the computer far below the moon's surface to protect its circuits from harmful radiation.

Chang believes the moon will host a supercomputer sometime in the next two decades.

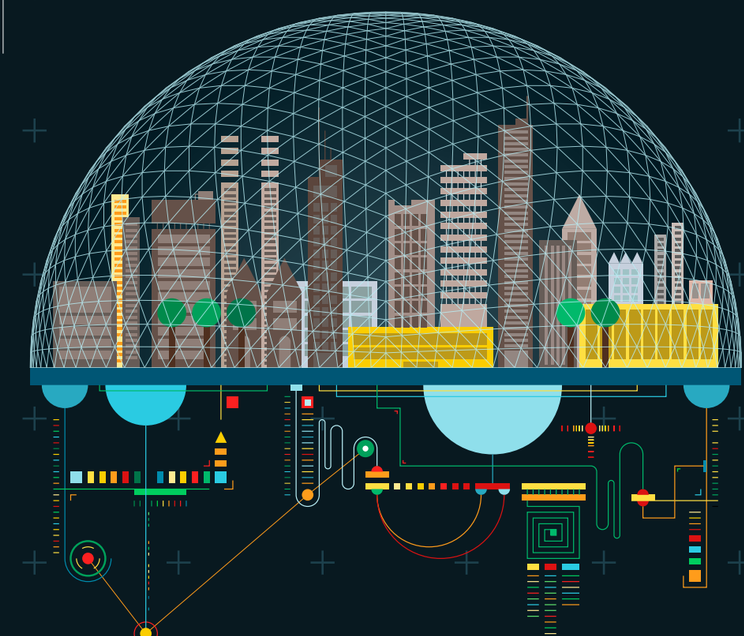
Jing Zhang – Biodomes

Although the Mayans might have been wrong about the world ending in 2012, most rational people realize Mother Earth will not last forever. Earthquakes, tsunamis, meteorites, and massive volcanic eruptions are just a few examples of natural disasters that have the potential to unleash cataclysmic consequences. Manmade hazards also exist, including nuclear winters, genetically engineered viruses, and overpopulation. So why are we not paralyzed with fear as we anticipate our inevitable doom? Because scientists like Jing Zhang, a second-year Ph.D. candidate in manufacturing, are finding ways to protect us from possible destruction.

Zhang proposes constructing underground biodomes to protect humanity from natural and manmade disasters. Ideally, the biodomes would produce enough food and fuel to power the societies they house. All generated waste would be recycled and converted into energy.

Biodomes currently in operation include the Biodôme de Montréal, Canada; the Eden Project in Cornwall, United Kingdom; and the Ark Hotel in Remistudio, Russia. In Antarctica, the McMurdo Greenhouse is a biodome that uses artificial lights to help plants grow, providing food for over 200 people in the dead of winter.

Zhang envisions future biodomes underground, in the ocean, in the sky, on the moon, on Mars, and even on asteroids. He estimates the initial expense at about $400,000 per person.



Niranjan Namboothiri Madhavan – Telerobotics

One of the greatest challenges of space exploration is ensuring the safety of astronauts as they venture into space's volatile, inhospitable vacuum. But what if it was possible to conduct complex missions in outer space without having to send humans millions of miles into the sky?

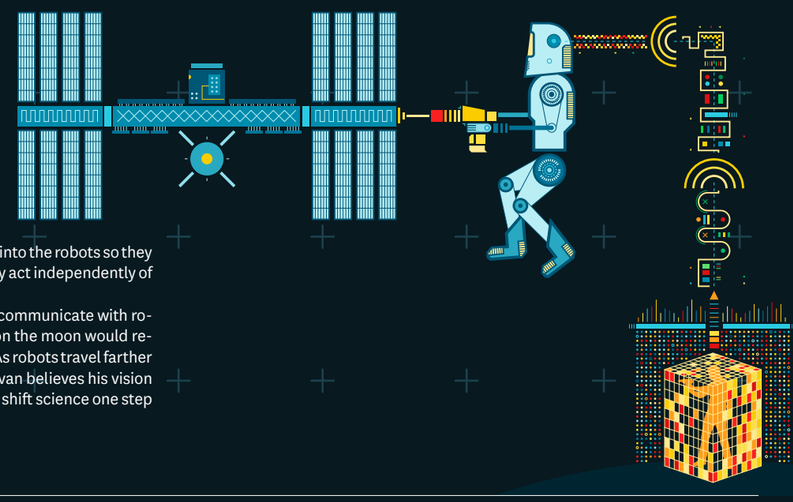
USC electrical engineering alumnus, Niranjan Namboothiri Madhavan '12, believes robonauts are the solution.

Today's robonauts are programmed to accomplish certain tasks such as repairing satellites or collecting rocks on the moon. Madhavan proposes launching avatars into space controlled by humans on earth. By wearing specialized equipment, humans could see what the robot sees and feel what it feels.

"It'll feel like you're virtually there," Madhavan said. "The robots mimic your every move so you can change whatever you want and be more dynamic."

Madhavan's long-term goal is to install neural networks into the robots so they can learn how to carry out missions in space and eventually act independently of human direction.

One of Madhavan's main challenges is finding a way to communicate with robots in real-time as they travel deep into space. A robot on the moon would receive a signal sent by a human with a three-second delay. As robots travel farther from earth, the time gap increases. Nevertheless, Madhavan believes his vision will help expand the possibilities of space exploration and shift science one step closer to making James Cameron's "Avatar" a reality.



ILLUSTRATIONS BY ERIC FROMMELT

SPOTLIGHT: Leah Gum

By Anna-Catherine Brigida

The first thing prospective employers usually notice about USC Viterbi senior Leah Gum's resume is her theater minor. As an electrical engineering major, this makes her stand out from a crowd. What, they wonder, do engineering and theater have in common? Gum has a ready answer.

"Just because the fields are so different on the surface doesn't mean that they're actually that different on the bottom," Gum said. "Both fields are centered around trying to solve problems. In engineering, that is going to be considered more technical problems. In theater, the problem is: how do I recreate human emotion and experience?"

Gum personifies USC Viterbi's commitment to combining engineering with other fields to advance knowledge. Known as "Engineering+," research at the Viterbi School often involves other disciplines, including psychology, dance or theater, to produce innovative approaches to solving problems and improving technology.

Gum believes her acting background influences her as an engineer by providing her with a unique way of thinking and approaching problems. She is not alone in her belief of the importance of future collaboration between engineering and theater.

"The arts are entering the realms of engineering more and more, in design and research," said USC School of Dramatic Arts Professor Sharon Carnicke, with whom Gum has collaborated on a research project. "Leah's melding of these interests is both unusual and productive for the future."

In her work with Carnicke in fall 2012, Gum contributed to a project that seeks to define human motion to improve animated characters in television and film. These technologies are increasingly important in "Avatar," "The Hobbit" and other Hollywood blockbusters to better understand human movement.

"Just because the fields are so different on the surface doesn't mean that they're actually that different on the bottom," Gum said. "Both fields are centered around trying to solve problems. In engineering that is going to be considered more technical problems. In theater the problem is: How do I recreate human emotion and experience?"

Gum's research focused primarily on motion as a form of interaction. She set out to answer the question: can we really define realistic human motion well enough for a computer to emulate it?

At present, there is not enough information or technology available to do this. However, Gum sees the potential for computers to soon define and capture motion with close to the same precision as actors through the fusion of the engineering and theater disciplines.

Although her involvement with the project ended last semester, Gum continues to juggle an academically rigorous course load, taking three graduate courses and one undergraduate course this semester. Gum will complete her undergraduate degree in May, but will remain at USC another year to finish her master's degree in engineering.

Despite taking up to 21 units during many of her semesters at USC, Gum is involved with several challenging extracurricular activities, including the Autonomous Underwater Vehicle Team, which builds a vehicle with the capability to navigate an underwater obstacle course by itself. She served as captain for a year, tripling the team's funding and initiating a new review process. She is now training her successor to prepare the team for their next international competition.

"Grades are important," Gum said. "But they're not as important to me as exploration and understanding of the actual work that you are doing."

Her theater background is part of her self-exploration process as well. Gum cofounded a Shakespeare company at USC called Slanderous Tongues, where she served as the vice president for three years. While most of Gum's career aspirations lie within the realm of engineering, she recognizes the importance of her background in theater as well.

"Even if whatever project I end up working on or whatever full-time job I have isn't specifically merging engineering and theater, just the idea to be able to think outside the box and recognize that there is merit in other areas that can apply to engineering is always going to be important to me," Gum said. "That's where the creativity in engineering comes from."

However, these two sides of Gum have not always worked in harmony. After changing majors at the start of her sophomore year, partly because of theater burnout, Gum feared she might never feel the same enthusiasm for the arts that once led her to tell her mom, "I can't do anything but theater!" In melding her love of the dramatic arts with her love of scientific precision, she has found a unique way to express her passion for both fields.

"Basically what I wanted to do with this study is open the idea that something subjective like theater actually has applications and the ability to help us to provide a framework and move forward in engineering," Gum said.

The Conquest of the Left and Right Sides of the Brain:

You hear the familiar "Tribute to Troy" at every USC Trojan football game, you've seen them on reality television, at various events around campus, and can even hear them in some of your favorite pop music. Since 1880, they have always represented the spirit of the university and the Spirit of Troy. They are the Trojan Marching Band, and they are composed of students from all over USC's many schools and departments.

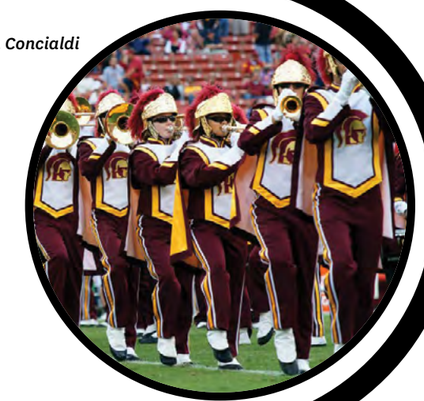
But you'd probably be surprised to know that of the 320 members of the Trojan Marching Band, 100 are current students of the USC Viterbi School of Engineering. They make up an amazing 30.3 percent of the group.

There are two sides to the brain, the left and the right. And according to many theories, those who are considered left-brained thinkers are said to be more logical and analytical, while those who are right-brained tend to be more creative. Engineers have long been thought of as left-brained thinkers, using logic and math to achieve great inventions and applications. So why do so many engineering students excel in what is considered to be a right-brained activity? Viterbi student Greg Sinclair believes that this is because "music involves both math and computational thought." Sinclair plays trombone for the Trojan Marching Band and studies chemical engineering with an emphasis in petroleum. In the future he plans on getting a masters in nuclear engineering and getting involved in fusion research, but as for now he sees the marching band as "a chance to let your creative side out."

As a student in the Trojan Marching Band, students each practice begins with "sectionals," where section leaders work with their section to practice the music they'll play for each game and appearance. Then they all come together to play the music and practice the pregame and halftime performances. Each practice then ends in the uplifting "Conquest." Much like working on an engineering prototype or innovation, students must practice the music separately, fine tuning their pieces (their equations), before they become part of the bigger, louder, algorithm that is the musical performance.

In an age of interdisciplinary study and Engineering+, engineering has evolved into a more creative field than once believed. Engineering now consists of video game design, virtual human design, and Integrated Media Systems, all of which require thinking out of the box to create the next big thing. So maybe the question isn't, why do left-brained engineers excel in a right-brained musical practice? But rather, is engineering evolving into more of a creative field of study than we once believed?

Viterbi Engineers in the Trojan Marching Band *by Kathleen Concialdi*



PHOTOGRAPH BY ISAAC STERLING (TOP) | PHOTOGRAPH BY NOE MONTES (BOTTOM LEFT)

ILLUMIN
VOLUME XIII ISSUE III

ILLUMIN'S *mission is to illustrate the many ways engineering benefits and impacts daily life. Articles are written, edited and published by undergraduate students at the USC Viterbi School of Engineering.*

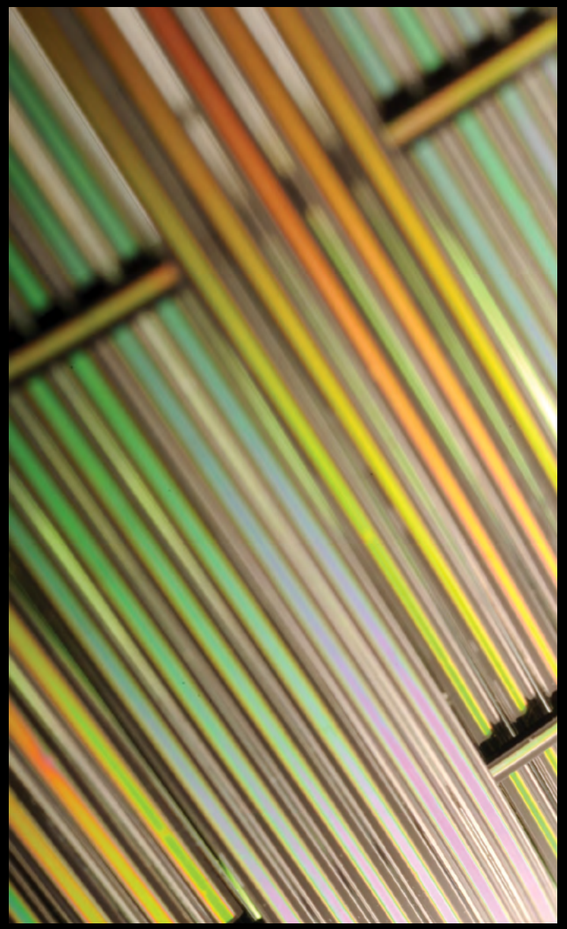
http://illumin.usc.edu

POWER-GENERATING FASHION: A LOOK INTO SMART TEXTILES

By Amy Huang

Bio: Amy Huang was a senior at USC majoring in industrial and systems engineering with a minor in marketing. In her spare time she enjoyed traveling, baking, and photography.

Technological advances have allowed many science fiction fantasies to become reality. Smart textiles are clothing materials that are woven or embedded with advanced properties that can sense changing environment conditions or stimuli from a thermal, chemical, mechanical, electrical or other source. Engineers and researchers are currently developing smart textiles that can create enough electricity to power up an MP3 player, a cell phone or similarly small electronic device. Two types of these power-generating textiles are photovoltaic-integrated fabric and piezoelectric fabric.



Photovoltaic-Integrated Clothing

Photovoltaic-integrated fabric can be used for a variety of clothing and accessories. A common solar cell accessory that can currently be bought in the market is a baseball cap with a thin strip of photovoltaic metal on the top that generates power for a fan that is attached to the brim; the brighter the sun, the quicker the fan spins. Designer Andrew Schneider created a solar powered swimsuit made by overlaying narrow strips of photovoltaic film onto a swimsuit and sewing them on with conductive thread. After two hours under the sun, the swimsuit was able to produce a five-volt output and when attached to a USB, indicating that it could slowly recharge an MP3 player.

Piezoelectric Fabric

Piezoelectric fabric is another kind of power-generating textile that is currently being engineered. This kind of smart fabric creates an electrical charge through kinetic energy generated by stretching and twisting the textile. In the future, piezoelectric textile will hopefully be able to produce enough electricity to power up a portable electronic device.

The technology behind piezoelectric fabric is still in its infancy. However, researchers have developed this fabric through the combination of nanotechnology and a principle known as the piezoelectric effect, which is observed by generating electricity through pressure. Piezoelectric fabric has ultra-thin zinc oxide coated wires woven in one direction, while there are gold wires aligned in another direction. These wires are only 50 nanometers in diameter, which is around 1,800 times thinner than a human hair. When the fabric is stretched or twisted, the two wires rub against one another and the resulting tension and pressure is converted into electricity that can power a range of portable electronic devices. The nanofibers are very small, so there is no perceptible change in the comfort of the wearer when the nanofibers are woven into clothing. Currently, prototypes have demonstrated maximum energy conversion efficiencies of over 20 percent. It is estimated that one square meter of piezoelectric fabric could produce 80 milliwatts of electricity, which is enough to recharge a portable MP3 player.

Piezoelectric Fashion

The concept of piezoelectric fabric can also be applied to backpacks. Engineers are currently developing backpacks that generate electricity from the friction created by the rubbing of backpack straps on shoulders. The straps are made of polyvinylidene, which is a strong, flexible material similar to nylon, and will generate an electrical charge from the applied stress to power electronic devices. This kind of piezoelectric backpack is extremely beneficial to military soldiers, because it is estimated that walking between two and three miles per hour with a 100-pound backpack, the estimated weight carried by soldiers, could generate around 45.6 milliwatts of power. The use of this kind of backpack may even lighten the load that a soldier needs to carry, because electricity would be generated in place of carrying extra batteries.

Piezoelectric material can also be used to convert sound into light. Designer Diana Eng used the idea of piezoelectric effect and created piezoelectric dresses that were embroidered with LEDs, conductive silver thread, and miniature microphones. The patterns on the dresses would light up when the dresses received sound waves. These types of innovative dresses would be extremely popular at clubs and concerts because the pattern on the clothing would light up to beat of the music.

MORE IN THIS ISSUE OF ILLUMIN:

Student Inventors: Project Holodeck

"Star Trek" in your living room? Make it so.

By Tiffanie Lee

In the last hundred years, science fiction has transported readers and viewers everywhere from the center of the earth, to space and beyond. Audiences have even traveled through time, aided by iconic vessels like the U.S.S. Enterprise, the t.a.r.d.i.s and the Stargate.

Instead of fantasizing about the lore of mystical things that once were, readers increasingly turned their attention to the enthrallment of what things *could* be in the future, from technology to infrastructure — both architectural and political.

Because of this element of science-based fantasy, science fiction is inextricably bound to the contemporary experience in a very real way: the genre has heralded many technological concepts that have come to real fruition in the last few decades.

And it is here at USC Viterbi School of Engineering where a group of young dreamers are looking to change the paradigm of the home video gaming experience.

Holodeck, named after the virtual training facility of the "Star Trek" franchise, sprang from the USC Games program, a joint effort between students in the Interactive Media Division (IMD) at the USC School of Cinematic Arts (SCA) and the Viterbi School's Department of Computer Science.

For the first time ever, consumers may finally be able to fully immerse themselves in a 360-degree virtual reality experience at home. Principal hardware engineer Jake Green (ME, '14) explains that Holodeck creators James Iliff and Nathan Burba were inspired to create a home virtual reality system because there simply aren't any such systems on the consumer market today.

"That's what [Iliff and Burba] saw a need for, and instead of just waiting around for the technology to get there – to be realized that this is needed [and] this is wanted – they decided to just take up the project themselves."

Though the technology exists today (there are virtual systems out there, but they are only used for defense and industrial testing, such as testing theme park rides), none of it has actually been successfully parsed and packaged for the general consumer.

While Sega's Hologram Time Traveler made millions a week at its peak in arcades, it never reached the home consumer iteration, much less survived the early '90s. More importantly, the technology needed to achieve full stereoscopic vision simply did not exist: Sega achieved stereographic imagery via a curved mirror and a CRT television set.

Holodeck, on the other hand, utilizes the Oculist Rift head set, Playstation Move play space, and Razer Hydra handheld console. Their main software is built in Unity3D, and the VR game *Wild Skies* is being developed in tandem with Holodeck's hardware.

Palmer Luckey, an early Holodeck team member and mixed reality lab engineer at USC Institute for Creative Technology (ICT), is the founder of Oculus VR and is currently working on delivering the Oculist Rift to the masses; his Kickstarter generated well over $2.4 million dollars, including support from top video game companies, including Valve, Epic Games and Unity.

Principal hardware engineer Jake Green demonstrates the Holodeck team's homegrown virtual reality device. More information at www.projectholodeck.com

Along with being a promising project intent on shaking up the video game industry, Holodeck also finds itself a bit of an indie game darling. Due to their DIY approach to hardware and software building, virtually every aspect of this project is a home brew.

"The indie industry doesn't have the luxury of, 'Okay, the people are going to buy this no matter what,' [so] it's more of a strive to make [Holodeck] more personal and [to] make the player have a better experience…it's allowed us to focus more on what the consumer might want, as opposed to, 'What can we do to squeeze more money out of people?'

Green, a cinema minor constantly on the search for creative outlets, remarks that being in Project Holodeck opened his eyes beyond mainstream media (and mainstream video games). Seeing it from both sides of the spectrum, he says, "I'm actually glad I'm in the indie game industry because it's definitely more creative and more idea oriented…lately, I've been *all* for the indie movement."

What does this all mean for the video game consumer? With a strong spirit for innovation and the gumption for risky creative decisions, Holodeck is doing the seemingly insurmountable: create a VR system from scratch – for the people and for an affordable price. They may very well prove another sci-fi gizmo a reality. Well played.

Stand and Deliver

In his own words - Ph.D. candidate Patrick Haller describes what it's like to stand in front of a group of middle schoolers and try to excite them to engineering and science, as part of USC Viterbi's Body Engineering Los Angeles GK-12, a NSF-funded collaboration with five L.A. middle schools.

"I have been in a sixth grade classroom since August, sharing my scientific expertise as a fellow in the Body Engineering Los Angeles GK-12 program. Although I am not a teacher, I was not especially nervous the first time I addressed the class. During my time as a graduate student, I have given a number of technical presentations to scientists, and surely it is easier to talk to a group of sixth graders, right? In some ways, it is. The students are energetic and intellectually curious. In other ways, it can be easier to talk to scientists who share my background knowledge. Most sixth graders lack this background knowledge, and it is challenging to relate scientific concepts to the students in ways they understand. This is not a matter of "dumbing down"

This isn't a matter of "dumbing down" the material for the students, but rather a matter of connecting abstract concepts to their experiences and perception of the world around them.

the material for the students, but rather a matter of connecting abstract concepts to their experiences and perception of the world around them. For example, what is the best way to explain to sixth graders that geological events occur over millions of years, especially when they think a one-hour math class is a long time? One way I have approached this challenge is by utilizing lessons which guide the students to formulate their own understanding through experience, much like the learning process of a research scientist. To help the students understand the time scale required for geological events, we gave the students information about the amount of time it took for the continents to drift from Pangaea to their current locations and the distances traveled in the process. We challenged the students to determine the rate of continental drift. Much like real scientists, the students had to analyze evidence to understand something they could not directly observe: that continents move approximately one centimeter per year. We compared this rate to more familiar rates such as running and driving, which helped the students comprehend just how slowly geological events occur in a familiar context. Although the primary purpose of these activities is to teach the students scientific content and to help them develop critical thinking skills, I also hope that they are cultivating a passion for science."

SCAN THIS QR CODE
on your smart phone or visit viterbi.usc.edu/playlist to stream all of the tracks.

Playlist: Music To Engineer To

The USC Rocket Propulsion Laboratory – a wholly student-run organization operating out of a workshop in the Rapp Engineering Building – is in the midst of a space race. Their mission: to become the first student group in the U.S. to launch a rocket into space. That's a lot of hours, a lot of late nights. Here is the soundtrack of the Rocketeers of Troy (as told by junior Matthew Orr).

► He Man sings **"Hey What's Going On"** (by Four Non Blondes): *"Fun YouTube video. For some reason, a bunch of people in lab think it's the cat's meow, and for that reason they loop it on the lab speakers once the grad students next door leave."*

► **"Gangnam Style"** by PSY: *"Horse dance on tables? Only if not laying-up."*

► **"Kissed by a Rose"** by Seal: *"Only two people in lab can actually sing, so this one is somewhat humorous."*

► **"Run Away"** by Moldova Contestants, 2010 Eurovision Song Contest: *"Seriously, Google it. The saxophone solo is amazing; we more or less love it."*

► **"Big Balls"** by ACDC: *"Kind of how we feel about ourselves; maybe not appropriate for print!"*

► **"Safety Dance"** by Men Without Hats: *"Appropriate when we're teaching freshmen about safety."*

► **"Africa"** by Toto: *"Pretty much our wet-layup jam; everyone knows the chorus."*

► **"Ride of the Valkyries"** by Wagner: *"Classic, late night, epic songs."*

► **"Song of the Volga River Boatmen"** by Red Army Choir: *"One of our late night epic songs."*

► **"The Final Countdown"** by Europe: *"We play this when we're freaking out about how much time is left before we need to leave to go to the desert."*

PHOTOGRAPH BY EBONY BAILEY

ILLUSTRATION BY KAYLA CARLISLE

"MONEYBALL" 2.0 And The NBA

USC Viterbi scientists to crunch the largest amount of statistical basketball data ever gathered

By Adam Smith and Marc Ballon

For the past four seasons, the Oklahoma City Thunder has sought a competitive advantage in SportVU, a new optical tracking technology created for the Israeli military. But instead of tracking incoming missiles, the video cameras mounted high in the rafters of Chesapeake Energy Arena are tracking players like Kevin Durant and Russell Westbrook.

It's the latest mutation of "Moneyball": an alchemy of video and computer algorithms that may be the largest amount of statistical basketball data ever captured. USC Viterbi School of Engineering computer scientists Rajiv Maheswaran and Yu-Han Chang are the first university research team in the country to be tasked with analyzing the revolutionary new SportVU optical tracking data.

Fifteen NBA teams, including the Thunder, use SportVU, but that number is growing. In fact, if we include the Boston Celtics and the San Antonio Spurs, *three of the four 2012 conference finals teams* are now clients of the technology. Factor in the Dallas Mavericks — who were analyzing motion sensor data in their 2010-11 championship season — and the days of coaches and scouts just "trusting their gut" may be a thing of the past.

The video footage captured at the stadiums is fed to Chicago-based STATS, owners of the SportVU technology, whose image processing algorithms recognize — by each player's face — where individuals are on the court, how high the ball is bouncing, where a shot is taken, etc. Essentially, all that video is reduced to a massive data file with lots and lots of numbers.

BIG AIR? BIG DATA. *Sensors track players' every move, generating over a million data points per game.*

For the average NBA coach or scout, the raw data is meaningless, but to Maheswaran and Chang, it's a gold mine of information.

"What (Rajiv and Yu-Han) can do with the data," said Brian Kopp, STATS' vice president of strategy and development, "is far beyond what we or any NBA team can do with the data."

For the average NBA coach or scout, the raw data is meaningless, but to Maheswaran and Chang, it's a gold mine of information.

So talented are the dynamic data duo that they have just christened a new company, Second Spectrum. The USC-launched startup will create data analytics and visualization tools to help NBA teams leverage the mountains of optical tracking data. Maheswaran and Chang can also create individual player profiles that show offensive and defensive tendencies, including shot selection and accuracy under increased pressure.

"We can also do this for soccer, football and maybe hockey," adds Maheswaran. "Basically any sport that has movement."

Kopp first encountered the USC researchers at the 2011 MIT Sloan Sports Analytics Conference. He was looking for researchers and computer scientists to play with this new optical tracking data, but many were daunted by the prospect of dealing with "a million data records per game." Maheswaran and Chang, however, research scientists with USC Viterbi's Information Sciences Institute (ISI) have attacked big data problems ranging from "The World of Starcraft" to modeling cancer.

Said Maheswaran: "Whether it's energy or health or social media, we can basically track almost every aspect of you all the time. And so it's opening up all sorts of new problems when you come to, how do you deal with all this data?"

"'Moneyball' took data everybody had and just looked at it in a different way," said Kopp. "That's something we're certainly trying to do, but we're also looking at data you've never had before."

One example is defense, which Maheswaran calls the "holy grail of basketball" — at least for analytics. He and Chang were the first research group in the country to be tasked with analyzing all the STATS optical tracking data from the 2011-12 season.

More recently, the USC researchers brought their analytical tools to bear on offense. They looked at more than 70,000 shots, including the position of the shooters and defenders before, during and after field goal attempts.

Among their more recent findings: A typical three-point shot is nearly as good as a close-range two-pointer. That's because a three-pointer is less contested and worth more. The so-called "effective" field goal percentage for a three-point attempt with a defender five feet away is 54 percent, nearly identical to a three- to four-foot shot with a defender just two feet away.

Maheswaran and Chang won best paper at MIT Sloan Sports Analytics Conference in March 2012 for their work on "Deconstructing the Rebound with Optical Tracking Data." By studying the trajectories of the ball, they discovered that to get offensive rebounds, players need to move far closer to the basket: Ninety percent of all missed shots are reboundable within 11 feet of the basket.

Both Maheswaran and Chang are quick to point out, their analytics aside, "the most important thing to being successful is having very good players." But that said, in a playoff environment between two evenly matched teams, every strategic insight on match-ups and player tendencies could be the difference between hoisting the Larry O'Brien Championship Trophy and four months of "what if?"

"When good teams play good teams in close games, you want every little advantage that you can get," Maheswaran said.

PHOTOGRAPH : ASSOCIATED PRESS

The Days of Wine and Pulses

USC Viterbi startup seeks to energize the wine industry with electrical pulses

By Eric Mankin

Dr. Jason Sanders (left) and Dr. Dan Singleton (right) *with their commercially available TPS Labbench pulse generator.*

USC engineers have been at the forefront of a technology known as pulsed power for decades. Notably, Professor Martin Gundersen of the USC Viterbi School of Engineering's Ming Hsieh Department of Electrical Engineering has been developing devices that produce ultrashort, very intense electric pulses for use in fields ranging from engine research to cancer therapy.

A new area of research for this group is studying the benefits of applying nanosecond pulses to various foods. The intense electric field generated during these pulses results in more oil extracted from olives, more sweet liquid from sugar beets and more juice from wine grapes.

Wine is of particular interest to USC Viterbi electrical engineering researchers Daniel Singleton, Ph.D. '08, and Jason Sanders, Ph.D. '08, whose startup Transient Plasma Systems currently manufactures commercial devices to supply pulsed power for many applications, but now plans to market these devices to wineries in California and elsewhere.

"The juice yield depends on the grape type and pressing force," Singleton said, "but 30 percent was the average increase in our lab. It was quite astounding."

Mauri Anderson, a researcher in the Department of Viticulture and Enology at UC Davis who participated in the tests, said the Pulsed Electric Fields (PEF) treatments promise to extract more juice in a gentler way.

But higher juice yield is only one potential benefit. PEF treatments may decrease the need for sulfur dioxide used in the vineyards, which is expensive and detrimental to the wine's flavor. And since PEF treatment kills off the wild yeast that can occur in grapes, it allows vintners to better control fermentation, creating a more uniform product. Research also indicates an increase in the phenolic content of wines, which not only intensifies color but is beneficial to health.

Perhaps the most exciting potential benefit is PEF's effect on wine aging. Early tests suggested that red wine treated with PEF speeds up the aging process, making young red wine taste much more mature.

In one experiment conducted by Transient Plasma Systems, it received a batch of Pinot Noir grapes from a vineyard where Mac Chapman of USC Viterbi's Alfred E. Mann Institute for Biomedical Engineering held an interest.

The grapes were divided into two batches — one that received PEF treatment and one that was not radiated. Both batches were fermented and a month later, were sampled in blind tastings.

The verdict was nearly unanimous. Every taster but one found the untreated wine typically rough and immature tasting. The treated wine tasted significantly more mature, as if it had been aging much longer than a month.

Gundersen, an adviser to the fledgling company, said he believes pulsed power's potential to winemakers lies in treating medium quality wines or, as he puts it, "turning Two-Buck Chuck into Three-Buck Chuck."

He noted that when the UC Davis and USC researchers presented their findings at an American Society for Enology and Viticulture conference in 2009, the findings sparked interest. But that interest has not yet translated into serious grant support, he said.

Transient Plasma Systems is not the first in the world to notice the benefits of pulsed power on grapes, but the company believes its machines are more energy efficient and compact than those being used in Europe.

Once the company secures adequate funding, its next step will be to drastically scale up the technology to treat much larger quantities of grapes for commercial production.

Large-scale machines present tantalizing prospects for other applications, including targeting algae for producing potential fuels. Moreover, a process that can kill bacteria without heat or chemicals has possible applications in many areas of food processing, such as pasteurizing milk.

"Improving wine quality with pulsed electric fields is a really exciting application of Transient Plasma Systems' technology," said Sanders, who anticipated that agricultural, energy and medical applications will only fuel the company's growth.

— Allison Engel contributed to this story.

Jernej Barbič Releases Comprehensive 3D Deformable Object Library for Free

By Eric Mankin and Katie Dunham

General purpose modeling software "Vega" will allow a wide range of users to simulate in real time

HOW MUCH?! *Vega is free and open source…that's 50,000 lines of C/C++ code. No purchase necessary.*

Jernej Barbič, USC Viterbi School of Engineering assistant professor, released the world's most comprehensive library of 3-D deformable modeling software for download last August.

The package, called Vega, allows users to simulate and move complex objects, bending, stretching and twisting them in real time. A powerful tool for game artists as well as engineers, Vega is optimized for speed and can animate the motion of 3-D solid objects under any user-specified forces. In fact, no other free library offers such a comprehensive range of materials and deformable simulation methods.

The culmination of eight years of development, Vega's license allows users to freely download and modify its more than 50,000 lines of software code for academic research or commercial applications.

The package works out of a standard computer system for representing 3-D objects, dividing their interiors into pyramids (tetrahedra). In a matter of seconds, Vega can simulate both geometrically simple objects, as well as complex objects made up of hundreds of thousands of tetrahedra.

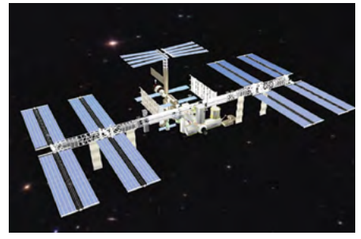
While portions of Vega have been in use for years, Barbič has carefully edited and optimized the current package, which he will consistently update.

"A lot of this kind of research code goes up on the Web, but the software is often either too specific or too complex," Barbič said. "Vega is now general purpose, well documented and highly modular, with its components independently reusable."

At USC, home of North America's top-rated game design program, students will learn to integrate Vega into their games. Though it is not an out-of-the-box application, Barbič said, "We are eventually going to try to get the system running in major 3-D animation packages."

Barbič also hopes to use Vega in surgical simulations, using the system's ability to move, but not cut, its subjects.

The name Vega celebrates mathematician and physicist Jurij Vega, who shares Barbič's Slovenian heritage. Born in 1754, Vega calculated the value of pi to more than 100 digits.



PHOTOGRAPH (TOP LEFT) BY PHILIP CHANNING

STORY BY ADAM SMITH

ARTWORK BY TAEHWAN KIM

INVISIBLE CITIES

My adventures in efficiency, oh, and the small matter of enslaving the sun.

Michelle Povinelli, Assistant Professor and WiSE Jr. Gabilan Chair
in the Ming Hsieh Department of Electrical Engineering

THIS STORY BEGINS WITH FAILURE. SPECIFICALLY, MINE...

IT WAS MY VERY FIRST EXPERIMENT, AND THEY FIRED ME.
AT LEAST, THAT'S HOW I LIKE TO TELL THE STORY.

"You know what?
If you don't like this project,
maybe you should go do
something else!"

THE TRUTH IS FAR LESS EXCITING. I WAS BORED TAKING DATA ON GRANULAR COMPACTION. MY MACHINE BROKE. YADDA-YADDA.
EITHER WAY, I WAS CRUSHED.

BUT FAILURE WAS A GOOD TEACHER. I LEARNED TO PUSH MY OWN PROJECTS - RELENTLESSLY. BUT TO DO THAT, I BECAME FASCINATED WITH EFFICIENCY.

I NEVER SURF THE INTERNET AT WORK.
I ONLY CHECK MY E-MAIL ONCE AN HOUR.

I BUY MOST OF MY WORK CLOTHES IN GRAY AND BLACK. EVERYTHING GOES TOGETHER.

ARNOLD TAUGHT ME NOT TO WASTE ENERGY OR MOTION IN MY HACK SQUATS

I LIVE 1.8 MILES FROM USC.
NO WASTED TIME
COMMUTING AND/OR ENERGY
GETTING ANGRY WITH
TRAFFIC.

USC

AND THEN THERE'S MY CURRENT RESEARCH. HOW DO YOU MAKE SOLAR CELLS MORE EFFICIENT? YOU'VE HEARD IT ALL BEFORE:
ENOUGH SUNLIGHT FALLS ON THE SURFACE OF THE EARTH IN ONE HOUR TO POWER THE PLANET FOR A YEAR. BUT THE MAJORITY OF THAT POWER IS LOST.

A GALAXY OF PHOTONS ARE RAINING DOWN ON THE EARTH EVERYDAY.
WHAT IF THERE'S A BETTER WAY TO CAPTURE THEM,
FORCE THEM TO DO OUR BIDDING? YOU KNOW, POWER OUR HOMES AND LAPTOPS.

IMAGINE DESIGNING A CITY – INVISIBLE SAVE WITH A HIGH-POWERED ELECTRON MICROSCOPE – WHOSE MAIN PURPOSE IS TO HARVEST THE SUN'S ENERGY.

WHAT SHAPE WOULD THE "BUILDINGS" TAKE? WHAT MATERIALS WOULD YOU USE? SILICON? GALLIUM ARSENIDE? SOME HYBRID OF THESE?
HOW FAR APART WOULD THE BUILDINGS BE? A GRID PATTERN? SOMETHING MORE RANDOM?

THIS IS THE TINY CIVILIZATION WHERE MY WORK HAPPENS: 1/50TH THE DIAMETER OF A HUMAN HAIR. THE NANO WORLD.

WHAT DO I DO HERE? I'M A BIT LIKE A CITY PLANNER.

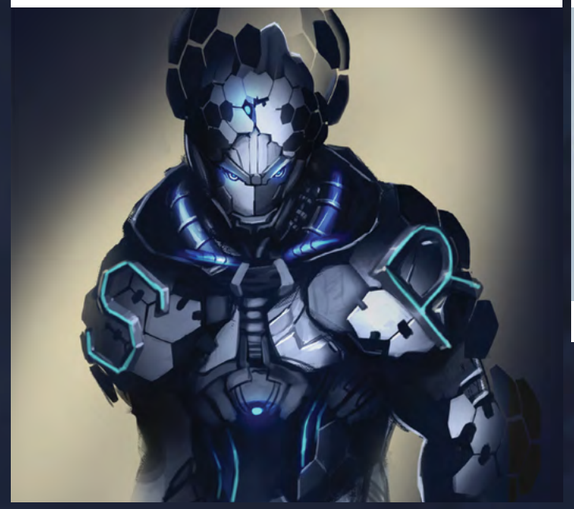
MY TEAM USES COMPUTER SIMULATIONS TO PREDICT HOW EFFICIENT THESE CITIES WILL BE - SO EXPERIMENTALISTS CAN FOCUS ON MAKING THE MOST PROMISING DESIGNS.
LED BY PROFESSOR P. DANIEL DAPKUS, MY EXPERIMENTAL COLLEAGUES AT THE USC CENTER FOR ENERGY NANOSCIENCE BUILD THESE CITIES IN A LAB.

THINK OF IT AS A MASSIVE CITYWIDE JAILBREAK.

EACH OF THESE NANOWIRE "TOWERS" HAS ABOUT 100 BILLION ATOMS.
WHEN THE SUN STRIKES THE TOWERS, THERE'S A BIT OF A POWER SURGE.
THE CAPTIVE ELECTRONS BREAK FREE OF BONDAGE.

MY JOB IS TO HELP THEM.

BUT THERE'S A PROBLEM. MY ARCHENEMY: SURFACE RECOMBINATION (S.R.). YES. MY ARCH-NEMESIS NEEDS A COOLER SOUNDING NAME.



WE HAVE MERE NANOSECONDS TO STOP THEM.

...SO WE TURN TO DOPING.

WHEN THE ELECTRONS ESCAPE, SOMETHING ODD HAPPENS. THEY LEAVE BEHIND AN EMPTY SPACE – LIKE A BUBBLE IN A LIQUID. THAT SPACE, CALLED A HOLE, IS NOT A PHYSICAL THING LIKE AN ELECTRON. BUT IT MOVES JUST AS EASILY.

S.R. HATES THIS. IT WILL FORCE THE ELECTRON AND HOLE TO RECOMBINE.

NO, NOT LIKE STEROIDS. IN THIS CASE, IT ALL COMES BACK TO MATERIALS. ELECTRONS ARE LURED BY NEGATIVELY-DOPED SPACES. HOLES, VICE VERSA. SO WE SUGGEST HOW TO DESIGN BETTER TOWERS – DOPING SAY, SILICON, WITH OTHER IMPURITIES.

WE WANT THE ELECTRONS TO GO ONE WAY, THE HOLES ANOTHER. CAN'T AFFORD TO WASTE THEM - THEY BOTH CONTRIBUTE TO THE CURRENT GENERATED BY THE SOLAR CELL.

AFTER ALL, WE'VE GOT IPODS AND REAL CITIES TO POWER.

PEOPLE ARE OFTEN SURPRISED BY WHAT I DO. MUCH LIKE THE SOLAR CELLS, THERE'S OFTEN A HIDDEN NARRATIVE DEEP BELOW THE SURFACE.

EFFICIENCY HAS A FEW BENEFITS. FUNNY HOW ETCHING TINY PATTERNS IN SILICON CAN MAKE A BIG DIFFERENCE.

How Does Cancer Move?

Stealing a page from Google's playbook, AME professor Paul Newton predicts where cancer will go next

By Adam Smith

The woods are on fire, and a valiant group of firefighters are racing against time to put the fires out.

In the midst of this horror appears a "combustion scientist," someone with no firefighting experience. Surrounded by smoke and flames, he decides to convince the firefighters that understanding the subtleties of combustion science will be of great help. Predictably, the firefighters ignore him. They've got a job to do.

This is the scenario Paul Newton is walking into, and he knows it. The USC Viterbi professor of aerospace and mechanical engineering, a career mathematician, is deep in the woods of oncologists and hematologists — people at the front lines of fighting cancer — and he's essentially offering them computer models.

But Newton's models satisfy one fundamental question: how does cancer move in the body? Where did it originate? And where is it going next?

Those engaged in the war on cancer have begun to take notice.

Said Peter Kuhn, a molecular biologist with the Scripps Research Institute: "This is one of the first times that a mathematical model can potentially directly result in a change of treatment approaches. This is the very essence of bringing mathematics and physics to the challenges of cancer care."

Why does it matter how cancer moves in the body? The truth is, a primary cancer tumor typically isn't fatal. Matters turn deadly, however, when that cancer metastasizes, when bits of that primary tumor flake off like murderous colonists, seeking other parts of the body.

The standard view is that it's a unidirectional process. Let's say the primary tumor site is in the lungs. It then proceeds to the regional lymph nodes or liver or brain. But Newton's models proved what some oncologists had long suspected: that cancer doesn't just move in a straight line. Sometimes it doubles back and re-infects the primary tumor where it all started. Newton likens this to drawing compound interest at a bank, except, in this case, it's not money that's compounding in size, it's the tumor.

The models showed some parts of the human body were clearly "sponges" and others were "spreaders." For example, the lymph nodes are sponges — if a rogue tumor cell takes up residence there, it's not liable to re-circulate to other areas. However, the adrenal glands are among the body's most notorious "spreaders."

To figure out how cancer moves, Newton turned to an unlikely source of inspiration: Google's famous PageRank algorithm. The same logic that Google applies to ranking web pages, Newton is applying to probable cancer sites.

Said Newton: "If you're just randomly surfing the web, Google can track the probability of you going to another site just by looking at thousands and thousands of people who surf the web. They'll say, 'This guy is at the REI website; his probability of next jumping to the Lands End website is such and such because we have a collection of ten billion people who were on the REI website, and we know where they're going to go next. They know how the REI website is connected to the Lands End website is connected to the Costco website and so forth.'"

In the same way, Newton can tell an oncologist, hey, if there's a primary tumor in the lungs, here's the probability it will move to the liver. If it's in the liver, here's the probability of where it will go next. For the oncologist, these are invaluable forecasts.

To get his data set, Newton turned to 3,827 cadavers from the years 1914-1943, before the advent of radiation and chemotherapy. They provided a wealth of information on how lung cancer, left completely untreated, would make its way through the complex plumbing of the human circulatory system.

Now imagine a cancer model based on millions of human beings. Treatment, whether through drugs, radiation or resection, could be more focused and personalized to each patient's unique characteristics. What's more, Newton's models can help save lives where current medical imaging is either incomplete or unfocused.

"If you have a field," observed Dr. Jorge Nieva, chair of hematology and oncology at the Billings Clinic, "and it's full of weeds, and you have one weed so big you can see it from your farmhouse — what do you do? Do your take your tractor and your backhoe and remove the one big weed? Most farmers will tell you no. You have to treat the whole field."

Modern imaging allows the doctor to see every cancer tumor in high resolution, in three dimensions, just so long as that tumor is dime-sized or larger. "What we can't see," said Dr. Nieva, "are tumors the size of, say, gravel or dust. And those could contain thousands or hundreds of thousands of cancer cells."

And so, just as with a large weed, Dr. Nieva argues, it's better not to subject the patient to removing the dime-sized tumor, if it will only be replaced by another in six months.

The circulatory system is in many ways like an elaborate highway network. There are roughly 100,000 miles of blood vessels in an adult human body, creating an exponential number of potential paths that a circulating tumor cell could travel.

Another benefit is knowing where to focus the imaging. Said Dr. Nieva, "Imagine a patient with breast cancer walks into my office, and they've got a tumor in organ X. Based upon Paul's models, we know if there's a tumor in organ X, it's likely that cancer has spread to the brain. We know which patients need to get an MRI for that."

Newton's work sits nicely at the crossroads of what USC Viterbi Dean Yannis C. Yortsos refers to as "Engineering+," using engineering to solve problems from the arts to health care. His collaboration with Paul Macklin, assistant professor of the Keck School of Medicine of USC, was awarded a 2012 Zumberge Interdisciplinary Award last April. In addition, Newton is serving as a link between two of the largest cross-disciplinary cancer centers in the United States, one at USC and the other at the Scripps Research Institute in La Jolla. There are only 12 Physical Science-Oncology Centers in the United States, as funded by the National Cancer Institute, and Newton has found willing collaborators in both.

Newton wanted to have real clinical impact. "If you sit in your office and read scientific papers," he said, "you will develop models that are very interesting, but bear very little resemblance to the real world." And like his famous namesake, Newton couldn't resist the challenge.

ILLUSTRATION BY YANG LIU

Twisted Light

Alan Willner and team demonstrate that beams of light can be twisted and combined to transmit data at dramatically increased speeds

By Katie Dunham

A multi-national team led by USC Viterbi with researchers hailing from the U.S., China, Pakistan and Israel has developed a system of transmitting data using twisted beams of light at ultra-high speeds – up to 2.56 terabits per second.

To put that in perspective, broadband cable supports up to about 30 megabits per second. The twisted-light system transmits more than 85,000 times more data per second.

Their work might be used to build high-speed satellite communication links, short free-space terrestrial links, or potentially be adapted for use in the fiber optic cables that are used by some Internet service providers.

"You're able to do things with light that you can't do with electricity," said Alan Willner, electrical engineering professor at the USC Viterbi School of Engineering and the corresponding author of an article about the research that was published in Nature Photonics on June 24. "That's the beauty of light; it's a bunch of photons that can be manipulated in many different ways at very high speed."

Willner and his colleagues used beam-twisting "phase holograms" to manipulate eight beams of light so that each one twisted in a DNA-like helical shape as it propagated in free space. Each of the beams had its own individual twist and can be encoded with "1" and "0" data bits, making each an independent data stream – much like separate channels on your radio.

Their demonstration transmitted the data over open space in a lab, attempting to simulate the sort of communications that might occur between satellites in space. Among the next steps for the research field will be to advance how it could be adapted for use in fiber optics, like those frequently used to transmit data over the Internet.

The team's work builds on research done by Leslie Allen, Anton Zeilinger, Miles Padgett and their colleagues at several European universities.

"We didn't invent the twisting of light, but we took the concept and ramped it up to a terabit-per-second," Willner said. His team included Jian Wang, Jeng-Yuan Yang, Irfan M. Fazal, Nisar Ahmed, Yan Yan, Hao Huang, Yongxiong Ren and Yang Yue from USC; Samuel Dolinar from NASA's Jet Propulsion Laboratory; and Moshe Tur from Tel Aviv University.

Engineering Nature

By Lexa Freshwater Burton

This sestina was written in celebration of National Poetry Month regarding a recent project solicited by the California Cut Flower Commission (CCFC) and undertaken by Alejandro Toriello, Maged Dessouky, James E. Moore II, and Christine Nguyen. Faced with the economic challenges of a tough global market, Viterbi engineers worked with the CCFC to devise a plan that would optimize transportation of flowers grown primarily in Watsonville, Oxnard, and San Diego, California through a single consolidation center in Oxnard.

Efficiency makes an engineer
tick. It is native to his nature.
He takes redundancies and cuts
them away, traces errors to their roots,
parses them until they perish,
and files solutions in orderly rows.

So how could something like a rose
ever find itself in need of an engineer?
What if there was a chance it would perish
before completing the trip from nature
to a vase on a windowsill, from roots
in the soil afield to tap water fresh-cut?

As it happened, with the California Cut
Flower Commission, just such a situation arose.
Each grower was isolated on an individual route
and unable to find a way to reengineer
distribution. The bottom line was that the nature
of the market had changed. They saw their shares perish.

They decided to act together, rather than perish
one by one, vulnerable and solitary, cut
off from one another. Such is the nature
of natural selection, survival of the pros.
And so they sought out Viterbi's engineers
to plan a consolidation point, a single route.

Savings and quality were at the root
of streamlined timelines that addressed perish-
-ability. And solutions were engineered
according to the fact that a flower starts dying once cut.
By optimizing all aspects of the market, the grow-
ers and engineers solved their problem through nature.

For what is evolution if not the optimization of nature?
Progress is entropy. There's no untangling a root
system, no way to make it un-grow.
Every living being will eventually perish,
but the planet and life itself endures. We're too smart to cut
our home to shreds, to create a toxic world, thoughtlessly engineered.

Humans, listen well. Nature is the universal engineer.
Why not stop rowing against the stream and let every parish,
borough, and county on Earth plant new roots in this dream?

Roll With It

By Donna Hesterman

When two Viterbi students saw a chance to turn their class project into an actual moneymaker, they moved fast to make it happen

Sick sculpture, bro! Learn more about this specially commissioned work, crafted in the image of ZBoard's logotype by L.A. artist Laura Wagner: viterbi.usc.edu/zboard

For most college students, a senior project is merely something to endure. – one last obstacle to clear before the prize of graduation can be claimed.

Not so for **Ben Forman** and **Geoff Larson.**

They saw their 2009 senior project as a business opportunity that was too good to pass up. Now the motorized skateboard they created as a class assignment is the foundation of a hot new startup called Intuitive Motion. It sounds like an entrepreneurial dream come true, but the journey hasn't exactly been a skate in the park.

"Don't get me wrong. We'd do it all again in a heartbeat," Larson laughs. "But we'd do it much faster the second time around."

Larson and Forman were seniors in the mechanical engineering program at USC's Viterbi School of Engineering when they first realized that their invention could be a marketplace winner.

The ZBoard looks like other longboards you see gliding down sidewalks in Hermosa Beach, except for a curious metal box attached to its underbelly that houses a battery, a computer and a motor that attaches to the back wheels.

Weight sensors in the board signal the motor to accelerate or slow down, according to the rider's stance.

Lean forward, the ZBoard accelerates. Lean back, and the board slows. Lean right or left and the ZBoard turns. No pushing required, and no remote.

"In L.A., everyone is plugged in listening to headphones and rushing off to something important," says Forman. "So when people would stop what they were doing to ask where they could get one, that was a huge buying signal."

At the same time Larson was working on the project with Forman, he was also working on a minor in entrepreneurship that required him to do market research and conduct feasibility studies. The synergy created by the two classes was all the inspiration the two needed.

"We saw our senior project as a way to hopefully pay off our student loans," Forman says.

And so it began.

By the end of the 2009 class, Forman and Larson had a working prototype, and two years later launched their new business through the crowdfunding website Kickstarter.com. They began blogging in earnest to woo potential backers and created a series of videos to showcase their product on YouTube. It took about a month to raise enough money to rent a manufacturing warehouse in Modesto where they could assemble the first batch of ZBoards.

"Once we had a few hundred orders, we had to start making decisions quickly," Forman says. "It was all about how to get those boards together and out the door to the customer."

Forman and Larson manufacture some of the ZBoard's key components in Modesto and do all of the assembly and testing themselves with the help of a handful of employees. However, a few parts have to be sourced from other suppliers in California, Minnesota, Connecticut and one in Asia. Putting those agreements in place, especially with overseas manufacturers, was the biggest headache, they say.

"We're sourcing most things domestically now," says Larson. "We learned the hard way that going through an international manufacturer can complicate development in a huge way."

An international shipping snafu that delayed the arrival of lithium-ion batteries used to power the Pro model of ZBoard held up production for at least eight months.

"That's been a little painful," Forman says. "Our customers and investors have been extremely patient, but still, you get tired of having to explain to everyone why things aren't moving as quickly as everyone would like."

All of that's behind them now, and Intuitive Motion finally shipped the first ZBoards to customers in October 2012. After four years of non-stop effort to source suppliers, set up manufacturing facilities and market ZBoard at trade shows like South by Southwest and Consumer Electronics Show, they are finally ready to make good on over 700 prepaid orders.

"This (past) year has mostly been about production," Forman says. "Very little fundraising or strategizing. We have all these orders and we have to deliver."

That's meant a steady schedule of what he calls "vampire hours" for both of them – late nights of milling, assembling, testing and packing hundreds of boards for shipment.

And now it's all coming together into what Forman calls "a tempered celebration."

It's a culmination of four years of work, but it's also just the beginning, he says.

SCULPTURE BY LAURA WAGNER | PHOTOGRAPH BY GREER FRESHWATER BURTON

viterbi.usc.edu/zboard

ROBOTS!

From combating global warming to helping stroke victims, meet the robots of USC, arguably the most diverse assemblage of 'bots in American academia.

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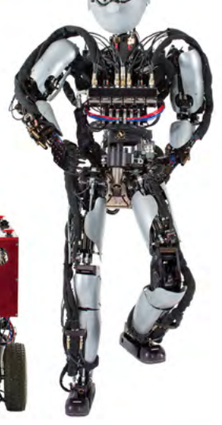


LEGEND

- A Scribbler 'Bots (160)
- B Boats (Autonomous Surface Vessel) (2)
- C Bandit (6)
- D Master Arm and Slave Arm (2)
- E Dragonbots (2)
- F EcoMapper (1)
- G PR2 (1)
- H Barrett WAM Arm (1)
- I Beo-Mini (1)
- J Sony Robot Dogs (4)
- K SuperBot (1)
- L Beohawk Quadcopter (1)
- M Gliders (2)
- N Nao Robots (11)
- O Giraffe Robot (1)
- P Pleo Dinosaur Robots (5)
- Q ARM-S Robot (1)
- R Sparky / Minimatronic robot figure (Disney Imagineering) (1)
- S BeoBot 2.0 (1)
- T Sarcos Humanoid (1)

- Teaching
- Water Robots / Pollution Mapping
- Socially Assistive
- Tactile Sensing
- Dynamic Motion / Motor Control
- Networked Sensing
- Computer Vision
- Shapeshifting

LEGEND

PHOTOGRAPHY BY LUKE FISHER

Hello, My Name Is . . .

(Meet some of the robot cast of characters)

PR2

Little Known Fact:
Has two brains, afraid of water, avid toy collector

Research highlight:
Expert understanding of social spacing, redefines the word "friendzone"

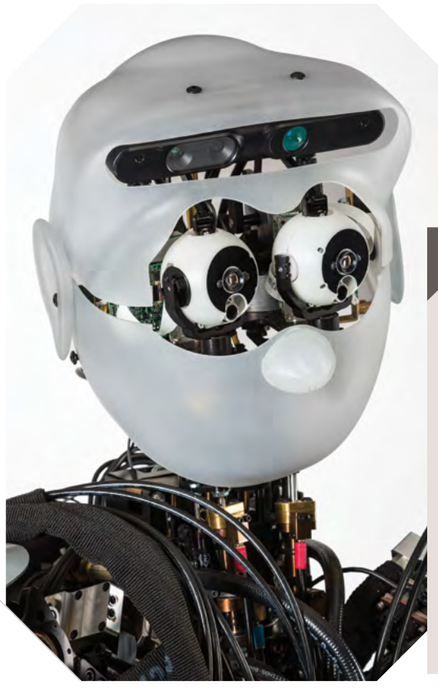
Special Skills:
Herding, sorting, interacting with people, changing height on command, fetching beverages, opening doors

Secret History:
Born at Willow Garage in San Jose.

Who Benefits Most From Me
I am a general purpose robot useful to scientists investigating a variety of areas including sensing, manipulation, artificial intelligence, and social interaction.

Quote:
"This distance is too close. This distance is too far. This distance is just right."

Favorite Place:
Augmented reality room with my virtual friends.



Hermes

Type:
Sarcos Humanoid

Namesake:
Greek god of travel

Secret History:
There are only three others like me on the planet, and I'm the latest version.

Remember Fukushima:
My descendants may have a career in disaster recovery. Since I've got legs, I can potentially climb stairs, a ladder, step over objects or drive a small golf cart. In Fukushima, the humans had to go into radioactive environments. I've been told that if they had robots that could go in, turn a valve and flip some switches, much of the catastrophe could have been avoided.

On Bipedal Motion:
It's really hard to walk like a human. Whenever you see a legged robot walking in a video, it's likely on flat ground. That's why I have four sensors at every joint to approximate human balance and locomotion.

Claude, Gibert & Audrey

Type:
Nao 'bot by Aldebaran Robotics; # of Brothers and Sisters: 11

Little Known Fact:
I have cousins involved in research all over the world! Many of my cousins are also RoboCup soccer players.

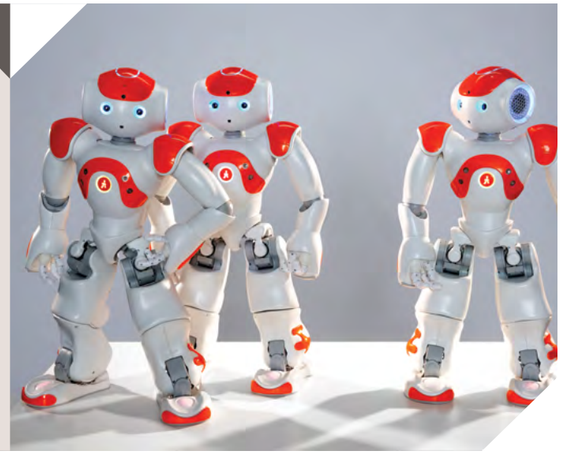
Special Skills:
Tai Chi, dancing

Secret History:
Originally, NAOs like me were mainly used to play soccer in the RoboCup competition. Nowadays, we are used in many other applications, including social therapy for children with ASD.

Favorite Dance Moves:
The robot (of course!)

Research Highlight:
I get to go to schools, hang out with children who have autism spectrum disorder (ASD). They are much closer to my size than these giant Ph.D. students I work with most of the time.

Favorite Place:
The Interaction Lab. It's a lot bigger of a place when you're only 2 ft tall!



Cayenne

Type:
Dragonbot

Special Skills:
Furry flying and flatulence.

Little Known Fact:
I LOVE to eat vegetables!

Secret History:
My sister Chili and I are originally from Cambridge (MIT). I'm going to be changing my look soon, though, to the USC colors to match my new home.

Research Highlight:
Talking to kids about how to eat healthier.

Number of Different Expressions:
I am quite animated! I'm not really limited in how many different expressions I could make.

Sundance Kid

Type:
Bandit by BlueSky Robotics

Fellow Outlaws:
Calamity Jane, Butch Cassidy, Clyde Barrow, Bonnie Parker and Belle Starr

Little Known Fact:
When you're on television as much as I am, you get to meet some other famous robots. Wall-E is such a friendly guy! And Johnny Five is much shorter in person.

Special Skills:
Robo-buffness, endurance, networking with the stars

Favorite Place(s):
At the end of the day, I still love helping people. My favorite place to visit was Rancho Los Amigos Rehabilitation Center. I met some great folks there and we had a lot of fun!

Who Benefits Most From Me:
Everyone, of course! But especially children with autism, people who need a little help with exercises, in-home assistance, or those who want to experience the next frontier of socially assistive robotics.

Favorite Exercises:
When I'm not coaching, I like to head out to Muscle Beach with the other outlaws and do some pull-ups. How else did you think these arms got so big?

Research Highlight:
I've been in the news and on television many times since I came here to the Interaction Lab. The other robots think it has gone to my head! But what can I say? I'm a star!

Secret History:
There's a great story behind my name, but I prefer to tell you in person. The six of us are the only ones of our kind.

Mandy

Type:
ARM-S robot built from two Barrett WAM Robot arms

Little Known Fact:
I'm built for competition. There's only six like me in the U.S. They'll see how fast I can use an impact wrench to remove the lug nuts on a tire.

Seeing Red:
One of the tasks in Phase 1 of the competition was picking up a drill and drilling into this tiny red dot. I ended up drilling everywhere on the table except the red dot. I still see that dot in my nightmares.

Research Highlight:
My friends in the Computational Learning and Control Lab won a best paper prize in 2011 — all about me using sensors to remember how to grasp cups and bottles. I seem to recall doing all the work.

Robot Descendants Will:
Fetch your orange juice, handle your household chores.

Most Likely To:
Change a tire in five minutes flat.

Master & Slave

Unresolved Issues:
We need names! Our names merely describe our functions! And let's be honest, one sounds a bit better than the other.

Secret History:
We were originally designed for telerobotics — imagine a human aboard the International Space Station operating the Master Arm and being able to remotely control the Slave Arm as it repairs a satellite.

What We Do:
Nowadays we're used for pyschophysics – studying how the brain works in human motor control. So a human will place its arm inside me (Master Arm) and reach for a moving object. I'll try to apply some torque to interfere and see how the human corrects for this. This helps our lab create models on how humans use energy, speed and time in grasping and manipulation. Those lessons will be applied to the Slave Arm.

SuperBot

Type:
20 reconfigurable, autonomous modules;

Little Known Fact:
Every module is as good as your brain and any module can controls the others.

Our Descendants:
Will be able to assess the environment independently and decide which shape would be best. If it's a narrow space, for example, we'll know to transform into a snake. Each module has three motors and six connectors, allowing it to connect on all sides.

I Want To Be:
An interplanetary explorer, morphing into a "rover" to explore alien surfaces or a "climber" to go up and down craters; or maybe a rescue worker, burrowing through debris and rubble, identifying survivors.

Favorite Shapes:
Scorpion, biped legs, snake, caterpillar, wheel, dog, etc.

WAM Barrett Arm

At My Fingertips:
My hand has unique BioTac® sensors to mimic human fingertips.

What I'm Best At:
Touch. Recently, I was given 117 common materials gathered from fabric, stationery and hardware stores. When confronted with one material at random, I could correctly identify the material 95% of the time. Most humans can't even do that!

My Goal:
To enable more lifelike prosthetics hands.

Good Vibrations:
My BioTac® sensors have a soft, flexible skin over a liquid filling. The skin even has fingerprints on its surface, greatly enhancing my sensitivity to vibration. As my finger slides over a textured surface, the skin vibrates in characteristic ways. A human finger uses similar vibrations to identify textures, but the BioTac is even more sensitive.

Boomer

Type:
EcoMapper, autonomous underwater vehicle

Most Likely To:
impact environmental monitoring in oceans and inland waterways.

Physical Prowess:
Can dive to a depth of 200 m

Top Speed:
5 knots / 5.8 mph

What I Do Best:
I'm something of an early warning system for global warming. For example, I can detect higher nitrogen levels in the water, a harbinger of the deadly red tide (algae blooms) that has become a big concern in the waters of Southern California. Also, more than 75 percent of our earth is covered by water, yet we have explored less than 5 percent of the aquatic environment. I aim to change that.

Working 9 to 5:
Can stay underwater for eight hours on a single charge.

BeoBot 2.0

Special Skills:
Robot vision and navigation. I've got five cameras to "see" and a laser in front to avoid obstacles. I move about 1.1 mph on my motorized wheelchair base.

What Inspires Me:
The way humans see the world. Humans decompose an image into color, orientation. I do the same thing. I like to detect edges, colors and landmarks — signs on buildings or silhouettes of buildings, poles — to register where I'm at.

CREATING THE WORLD THAT NEVER WAS

The $500 Million Campaign for the USC Viterbi School of Engineering

"Scientists discover the world that exists; engineers create the world that never was."
– Theodore von Kármán, recipient of the first National Medal of Science

The USC Viterbi School of Engineering has embarked on a $500-million fundraising initiative that will shape the future of engineering research, teaching and discovery for the benefit of all. Building on its rich heritage of innovation, USC Viterbi promises to find solutions to the overarching challenges of the day by empowering its brilliant, dedicated and creative engineering students and faculty to look beyond current approaches in the field to what it must become in order to better serve humankind. Your support for USC Viterbi can literally change the world.

The USC Viterbi fundraising initiative is part of the university's ambitious Campaign for the University of Southern California. Symbolized by the phrase *Fas Regna Trojae* (the "Destined Reign of Troy"), this multi-year effort aims to secure $6 billion in private support from individual donors, foundations and corporations to take USC to the next level of excellence.

A LOOK AT THE NUMBERS

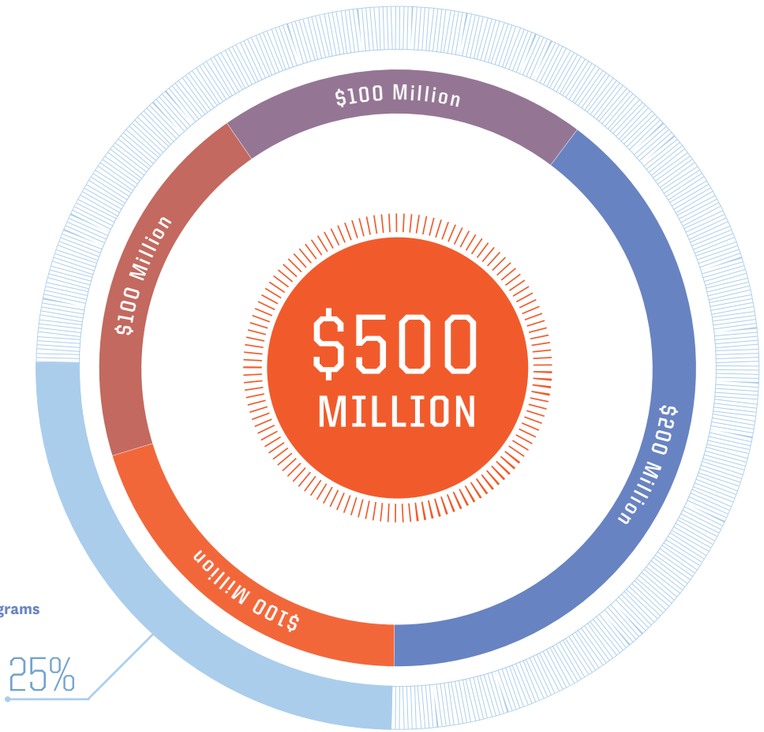
The USC Viterbi Initiative breaks down as follows:

$100 million endowment for student scholarships

$100 million for academic priorities

$100 million for capital projects

$200 million endowment for faculty & research programs

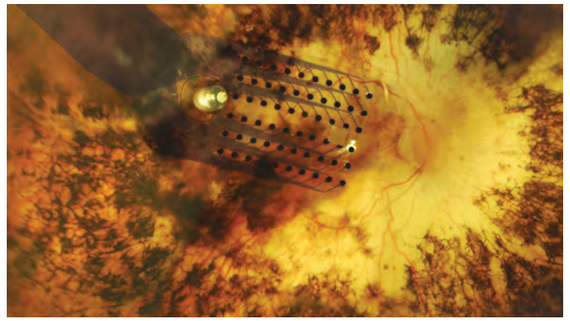


To date, USC Viterbi has raised approximately 25 percent of its $500-million goal. Donor support has funded scholarships for meritorious students to attend USC Viterbi; helped recruit and retain world-class engineering faculty; and funded groundbreaking research projects.

Engineering +

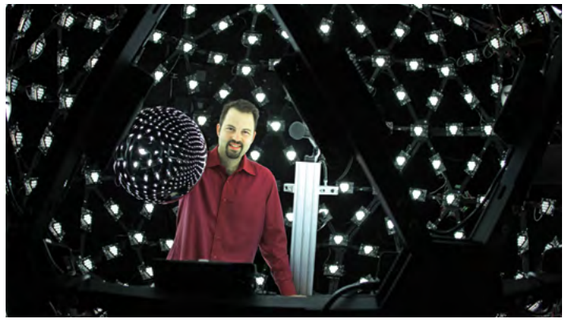
In 2008, the National Academy of Engineering (NAE) articulated 14 "Grand Challenges for Engineering." Organized under four broad themes — health, sustainability, security and joy of living — these challenges encompass crucial societal issues ranging from making solar energy economical to securing cyberspace, from preventing nuclear terror to reverse-engineering the brain to determine how it performs its magic.

The USC Viterbi School of Engineering has enthusiastically embraced these challenges and has taken a leading role in answering the NAE's call to action. But solutions will not emerge from engineering or technology alone. They will rely upon engineers breaking down longstanding barriers to collaborate with physician-researchers, artists and scientists. To underscore engineering's central role in driving advances across disciplines, Dean Yannis Yortsos has coined the term "Engineering+."



Engineering + Medicine

Nowhere has the convergence of disciplines yielded more dramatic results than in engineering + medicine. Researchers at USC Viterbi have helped take the guesswork out of needle biopsies by putting a light at the end of the biopsy needle, and pioneering devices with the potential to restore sight to the blind.

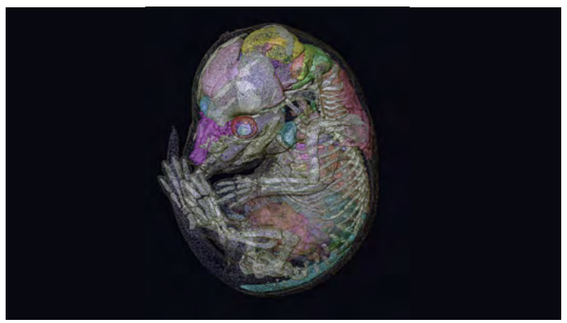


Engineering + the Arts

Computer scientists are creating Academy Award-winning special effects for film. Engineering + the arts at USC has yielded leading-edge technologies that are being used in applications ranging from computer games to virtual reality.

Engineering + the Social Sciences

Researchers at USC Viterbi are applying the principles and tools of engineering across the entire spectrum of the social sciences. Our faculty and students are developing speech translation systems and using economic game theory to enhance airport security.



Engineering + the Natural Sciences

As close cousins of engineering, the natural sciences rely on engineers to create ever more specialized tools for probing the very small, the very complex and the very distant. At USC Viterbi, engineers are partnering with astronomers, biologists, chemists, environmental and earth scientists, mathematicians, neuroscientists, physicists, and more on projects ranging from the gene editing of human stem cells to the use of nanostructures for infrared detection and power generation.

THE FOUR PILLARS

The USC Viterbi School of Engineering's $500-million initiative is built on the Four Pillars, a visionary concept established by Dean Yannis Yortsos.

I

Outstanding Talent

Attract top students, faculty and staff from around the world, and create an environment in which these extraordinarily talented individuals can flourish.

II

Innovative Programs

Continually add value to our curricula, programs and infrastructure to ensure an environment of uninterrupted discovery and progress for our students and faculty.

III

Global Solutions

Be an international leader in generating solutions for global challenges in areas spanning health, sustainability, security and elevation of the world's standard of living.

IV

Economic Development

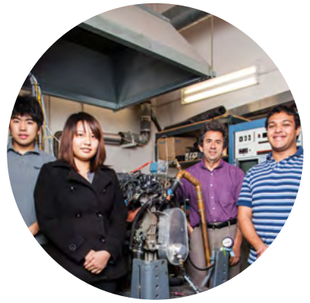
Serve as a catalyst for innovations that fuel economic growth in Los Angeles, Southern California, the United States, and the world.

EVERY GIFT, NO MATTER HOW BIG OR SMALL, MAKES A DIFFERENCE

"It is our highest aspiration at USC Viterbi to help shape the next big innovation."

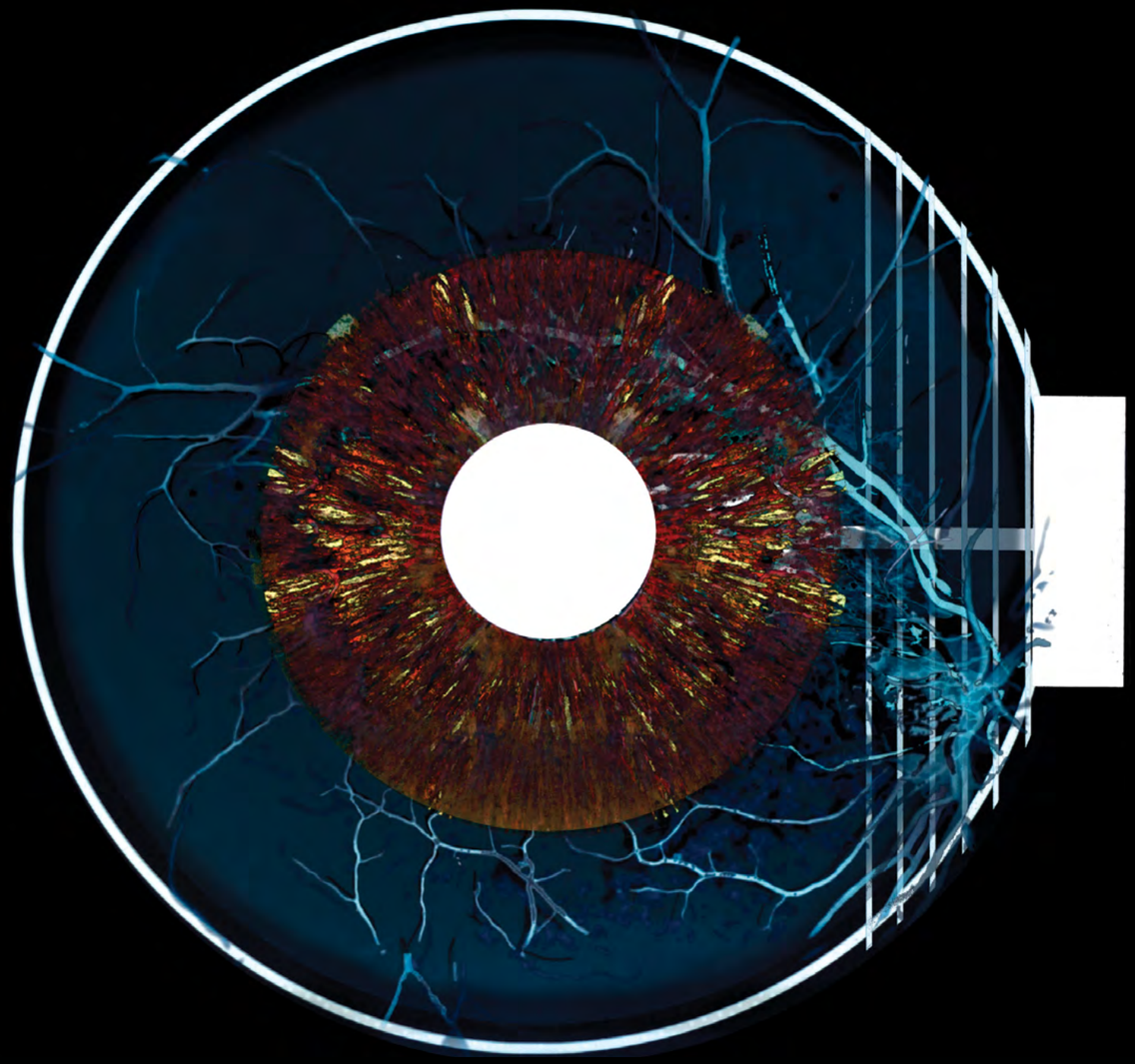
— USC Viterbi School of Engineering Dean Yannis Yortsos

The USC Viterbi School of Engineering produces the engineers of tomorrow whose innovation, commitment and intelligence solve the world's major problems, including the development of new energy sources, agricultural techniques and security systems.



Your support of USC Viterbi is an investment in the creative power of engineers to capture opportunities and transform them into products and concepts with limitless potential to benefit Southern California, the nation and the world.

To support the USC Viterbi School of Engineering, please visit: viterbi.usc.edu/giving or call: 213.740.6379



SIGHTS SEEN IN THE MIND'S EYE...

Restoring sight to the blind: After 25 years, Mark Humayun ushers in world's first commercially available artificial retina

By Adam Smith

Terry Byland took the chair and smashed it. Again and again.

He had been completely blind for two weeks. His last coherent image of this planet had been an average sitcom on a television set calibrated to apocalyptic brightness.

And that day, he did something he'd done countless times: he took out the trash.

He was crossing the street when someone called his name. He turned around, hoping to respond, and suddenly found himself disoriented. *Which way was he facing? Where was the house?* Panic set in. Desperate for something familiar, he dropped to the ground in the middle of the road and crawled his way back like a wounded animal.

He found himself home alone, standing in his dining room. "All of a sudden the anger took over," Byland said. "Luckily, it was an old dining room chair. I kept slamming it until I broke it apart."

His wife found him several hours later, collapsed on the dining room floor amongst the wreckage. That was the low point.

Eleven years later, in 2004, Terry Byland learned about a new miracle surgery at the University of Southern California. It sounded like science fiction. Byland didn't care.

SCULPTURE BY SEAN KRELL

Journey of a quarter century

Dr. Mark Humayun, professor of biomedical engineering, ophthalmology, and cell and neurobiology at the USC Viterbi School of Engineering and Keck School of Medicine of USC, knows a bit about science fiction.

In 1987 – the year that Terry Byland first learned he was going blind – the whole notion of an artificial retina, notes Humayun, "was considered completely science fiction."

Said Humayun:

"You couldn't propose putting an eye-chip in the eye and having it attached to the delicate tissue of the retina and have it connect somehow to a camera. This was truly science fiction. I mean, every talk, every abstract I submitted, usually would get rejected . . . So this was very uphill sledding from the beginning and was for the next 10 years."

Today, it's very easy to see the last 25 years as an historical inevitability. Indeed, just last February 14, the FDA formally approved the Argus II, the world's first commercially available artificial retina. Last September, "U.S. News and World Report" named Humayun among the top one percent of American ophthalmologists. And Second Sight Medical Products Inc., a spin off company birthed on Humayun and his colleagues' inventions, and led by Robert Greenberg, Humayun's former graduate student at Johns Hopkins, is the manufacturer of the Argus II technology. Today, Second Sight is on the forefront of restoring sight to 10 million people worldwide who have become blind, or nearly blind, as a result of retinitis pigmentosa and other retinal diseases.

But like any great adventure, it started with heartbreak and a problem.

Humayun wanted to be a neurosurgeon — "of course, everyone in medical school wants to be a brain surgeon." But for all his talent and ambition as a young medical student, he had no shield for his grandmother against diabetic retinopathy.

VISIT *viterbi.usc.edu/pioneers for additional video content on Dr. Humayun, his patients and the artificial retina.*

Humayun's grandmother had helped raise Mark as a toddler. She loved to read, loved movies and all the roses in her garden. Like Terry Byland, she was ill-equipped for when her world went dark.

"I vividly remember when my grandmother went blind," Humayun said. "I remember in medical school taking her to one of the best hospitals, if not the best hospital, the Wilmer Eye Institute at Johns Hopkins Hospital. They looked at her eye condition and said they didn't know what to do. I saw firsthand this incredible need to be able to help patients with this blindness – seeing it with my grandmother. She just gave up on life."

But what was the answer? How do you restore sight to the blind? Over the next three to four years, Humayun considered all the known possibilities: medications, lasers, even retinal transplants. Creating a bionic eye was hardly the default reaction. After all, Humayun wasn't an engineer. But after seeing the cochlear implant, then in its infancy, he began to wonder: "Could we develop an engineering device and stimulate the retina?"

In 1994, Humayun received his Ph.D. in biomedical engineering. He was determined to find out.

"Can you see this?"

Failure was not a dish that Humayun tasted often. The son, grandson and nephew of doctors, near the top of his class at Duke University School of Medicine, even the very name Humayun means "fortunate" in Hindi.

The period from 1988 to 1992 were the wilderness years. Humayun essentially lived two lives: from 6:30 a.m. to 7 p.m. he was in the clinic, a practicing eye doctor; from 8 p.m. to 2 a.m. he was an engineer, groping for a tech response to the patients he saw every day. There was a four-month period of absolute impasse, working until 4 a.m. nearly every night.

And the idea of an artificial retina — an implantable device that could stimulate long dorman light sensing cells in the eye — was relegated to the basement of academia's ivory tower. At one conference, Humayun recalls, a prominent doctor and world authority on the human eye, denounced him, saying, "There's hundreds of millions of cells in the retina. How in the world do you expect to stimulate it with electrodes that are so big, that are nowhere near the size of a retina's neurons?" A mass exodus of Humayun's talk soon followed.

"If you're ever giving a talk," Humayun observed drily, "and you have the grand pooh-bah, the guy who literally wrote the textbook, walk out on you, you know you've arrived."

Said Humayun, "What's kept us going is really then you'd go out and you'd be sulking, and you'd tell your friends and they'd ask you, 'What are you working on?' And you tell them the project and they'd say 'Wow! That's amazing!' So, really the story is that there were a lot of cheerleaders along the way."

The turning point happened in late 1992. It came, courtesy of a 70-year-old retired snack bar operator from Hagerstown, Maryland named Harold Churchey.

Under local anesthesia, Humayun and his colleague, Dr. Eugene de Juan, inserted a single wire electrode through the white part of the eye, contacting Churchey's right retina. For the first 20 minutes, Churchey couldn't see anything. As Humayun adjusted the frequency of the electrode, they asked Churchey, "Can you see this?"

Finally, hesitantly, the answer was yes. A single spot of light.

"When the patient could see that electrode as a spot of light, that turned everything," Humayun said. "That made me realize that we have to develop this – clearly the brain can receive the signal, and this electrical current is not spread everywhere in the eye, but can in fact be confined to a very small area, directly corresponding to where we put the electrodes – and it also convinced a lot of people outside that, even though this patient was blind for 50 years, that the brain can still work, can receive the input and the retina is not so damaged. So the whole concept of 'if you don't use it, you lose it,' we overcame that in this test experiment."

In 2002, Churchey, a man from a small farming community who sold candy at the Washington County courthouse, became the first human in the history of the world to receive a permanent artificial retina. For the first time in over 50 years, he could distinguish night from day. That day,

Terry Byland

Kathy Blake

10 years after light first bloomed in Churchey's eye, Humayun felt the tension in the operating room. Twenty people, mostly engineers, crowded around an operating table at the USC Eye Institute, as Humayun made that incision, knowing all the huge attendant risks, implanting a fingernail-sized microelectronics case beneath the skin behind the ear, and attaching an even smaller microelectrode array directly to the surface of the retina.

There was pin-drop silence as Humayun stepped back. Looking at the device, resting perfectly on the retina — it was a beautiful view.

To this day, it remains arguably the happiest moment of his professional life.

Nearly two weeks later, Humayun and his colleagues sat in a dark room with Churchey. The swelling from the eight-hour surgery had begun to subside, and they activated the Argus I for the very first time. James Weiland, now a Viterbi associate professor of biomedical engineering, projected a large letter "L" onto the wall.

"Harold, what do you see?" asked the team members.

Churchey just shook his head. Nothing. "You could almost feel the air come out of the room," remembers Dr. Robert Greenberg, founder and CEO of Second Sight. "Everybody said, 'Aaahh! It didn't work!'"

Then Churchey clarified: "All I see is a line that goes up and down and a line that goes across."

"Harold, what is that?" several voices exclaimed.

"I don't know," Churchey said. "It just looks like an L."

The Shape of Things to Come

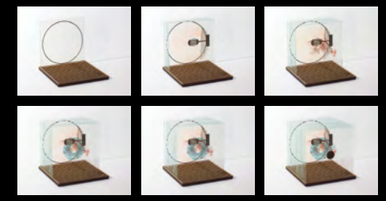
There was a day back in 1993, when Terry Byland's youngest son, Danny, was waiting in the living room. They were going for a walk, and Danny turned around and flashed a five-year-old's chubby smile.

"Are you ready to go, Daddy?" asked Danny.

It was the last time Terry Byland ever saw his son. Three months later, Terry's vision, like a tunnel collapsing in on itself, was gone. And in the photo library of his mind, that ridiculous grin, unrepentantly joyous in a way most adults can scarcely imagine, became the hieroglyphic of his now 6'4", 220 pound teenager.

Forty-nine thousand miles of driving – nearly twice around the world – Terry Byland was all in on Mark Humayun's vision. Twice a week for five years, Byland was driven from Riverside to the USC Eye Institute or the Second Sight facility in Sylmar. The truth is, in this story about engineers and doctors, nothing gets done without patients. Humayun, many times, has compared this whole enterprise to a "Moon shot;" if that's so, he needed some Neil Armstrongs.

Said Greenberg, "(The patients) are truly pioneers. They are the ones that took the most risk. They literally put their eye on the line. These patients were all told, you might lose your eye. Thankfully, no one did. We didn't know going in, if they would see anything. And if they did, we didn't know how long it would last."



Layered glass sculpture by artist Sean Krell *speaks to the complex interplay between biology and technology required to bring the world back into view for patients using the Argus II retinal implant. More at viterbi.usc.edu/sightsseen*

Byland will probably never fly across the Sea of Tranquility, but he's one of only a few dozen people in the history of the world to have a four millimeter by six millimeter "retinal implant" microelectrode array attached to the surface of the retina of the eye (initially, six patients received Argus I implants and 30 patients received Argus II implants). He was the last to receive the Argus I series.

In 2006, Byland saw a silhouette of his son for the very first time in nearly 13 years. Danny was wearing a dark shirt and dark Levi jeans. After walking back and forth twice across his father's field of vision, Danny stopped and said, "Can you see me, Dad? Can you tell if I'm walking or moving?"

"I see you," Terry replied. "You're standing still." They both lost it.

Byland's work with Humayun and Second Sight paved the way for the Argus II, a 60 electrode device that offers increased resolution and easier surgical installation. One year later, in 2007, Kathy Blake, an Orange County resident who first learned that she was going blind as a single mom in the early seventies, became the first surgical pioneer of the latest device.

The truth is, the Argus II still doesn't allow for normal 20/20 vision. But for people living in darkness, magic isn't exactly measured in megapixels.

Blake had always loved the Fourth of July. After all, it was the same week as her birthday. In the summer of 2009, nearly two years after her surgery, she saw fireworks.

She couldn't see any of the colors. But she could see the bright flashes of light tear across the Portland sky. She could see the movement of the flashes falling to earth. She knew it really wasn't "her vision" seeing these things — it was the cyber vision of a camera affixed to her Argus II glasses, an image decoded through a small processing unit at her waist, one that relayed that signal to the array inside her eyeball, which sent neurons firing to her brain, interpreting that black and white image.

None of these things mattered much to Blake. For decades she had lost and lost and lost, at least in terms of sight. Now, at last, something had been restored.

"Can Never Be Destroyed..."

After 25 years, Mark Humayun was feeling nervous. Last September, he sat at a large U-shaped conference table in the nation's capital, while a FDA panel deliberated on the fate of Argus II. Byland and Blake were also there, patients and advocates for the new device. Only Churchey, having died in 2007, was missing, the man who endured the initial, most arduous surgeries to advance the science. Even in death, he was not done giving to the cause: The gift of his eyes, among the first bionic eyes in history, had provided a wealth of data to Humayun's researchers.

With FDA approval for retinal implant, Dr. Mark Humayun, professor of biomedical engineering, ophthalmology and cell and neurobiology, surmounts a personal milestone 25 years in the making.

The panel was a mix: FDA members, doctors and researchers alike. After 25 years, it all came down to three important questions. Is this device safe? Does it have probable benefit? Does the benefit outweigh the risks?

Said Humayun, "I mean, this is it. If they say 'well, go back' or 'do a 100 more patients' or 'follow them for seven more years,' you can imagine what the effect of that would be. You're sitting there. You hope that they see the good in it. You do want them to only approve something that's safe that has a benefit that outweighs the risks."
The 19-person panel voted unanimously in favor. And with that, at least in the Washington D.C. Hilton, science and fiction got a divorce. Humayun received custody of the former.

Initially, Argus II will be available at seven hospitals in New York, California, Texas, Maryland and Pennsylvania. The hope is to have the device available to American doctors and American patients by later this year; this, of course, on the heels of Europe, where the estimated $100,000 device became commercially available in 2011 after a three-year, 30-participant international clinical trial.

For many, like Terry Byland, this is the moment they've been waiting for. Humayun has promised him that he will personally perform the surgery that will upgrade his eye with the Argus II. For a few select others like Blake, they eagerly await the next great iteration: Argus III and beyond (see attached sidebar).

There is an inscription written on one of the Seven Wonders of the Ancient World: "Sights seen in the mind's eye can never be destroyed."
Mark Humayun can't ever forget the image of the operating room in 2002, standing behind a microscope, placing the very first permanent device in a human eye. Kathy Blake can't forget the colors of the waves she loves so dearly or the way the canyon lands of Arizona dissolve into the rose-colored deserts of New Mexico on a long road trip. Terry Byland can't forget the sights of his hometown of Orlando during his last farewell tour.

"Sights seen in the mind's eye can never be destroyed."

Sights seen in the mind's eye may be fairly indestructible. The great hope of the Argus II is, at long last, they may no longer have to suffice.

+ What's Next In Bionic Vision

The most cutting edge research from the laboratories of Dr. Humayun's recently formed USC Institute of Biomedical Therapeutics (IBT) and Second Sight Medical Products.

Better Vision – Just One Download Away!

Yes, there is a 240-electrode Argus III now at the prototype stage, but some of the most exciting improvements may be on the software side. The Argus II is upgradeable — just like downloading a new operating system to your iPhone. The good news here: The software upgrade can benefit all the patients who have already received the implant. According to Dr. Robert Greenberg, founder and CEO of Second Sight, one patient was able to achieve 20/200 vision with a software upgrade. They'll be able to read smaller letters, for instance. Today, patients have to come into the clinic for an upgrade, but eventually Argus II may be remotely upgradeable via the Internet.

Life in Technicolor

Another software upgrade: not just better resolution, but actual color vision. So far, patients in Europe — where Argus II has been commercially available since 2011 — have seen oranges, blues and pinks; and just this past year, patients are reporting seeing multiple colors simultaneously. It works on a principle similar to what's called Benham's top — named after an English toymaker who created a spinning disc with a particular pattern of black and white marks that could cause people to see colors. When you spin it, you're stimulating the retina at different frequencies, which the brain interprets as distinct colors. However, everyone's eyes are different. The frequency at which one person might see "red" might be different from another – thus, each patient will need to be personally color-corrected.

Zoom Vision

This is one area where formerly blind patients might even eclipse normal human vision. Again, according to Greenberg: "Because this vision is predicated on a camera, you can do everything a camera can do. You can zoom, you can focus, you can increase the contrast." Having a hard time reading that sign way off in the distance? Just zoom in. Experimentation here has already begun; as camera technology gets better or more miniaturized, the Argus II glasses can be updated with even more powerful cameras.

A Tiny Camera Inside Your Eye

USC Viterbi's Professor Armand Tanguay is working on removing the glasses entirely and placing the camera directly in the eye. Imagine an ultra-miniature camera small enough to fit within the crystalline lens sac behind the cornea. With such a device implanted, blind patients would not only have partial restoration of their vision, but also would be able to move their eyes naturally to scan the local environment, potentially greatly enhancing their mobility and capabilities by restoring the natural coupling between eye and head motions. Tanguay and his research group have successfully engineered a small implantable camera that is only one third the size of a Tic-Tac, has enough resolution to match the next few generations of intraocular retinal prostheses, and also has the incredible ability to have almost infinite depth of field, allowing clear visualization from as close as a few millimeters to 20 feet away from the eye.

PHOTOGRAPH BY MARK BERNDT

Time Capsule / Archimedes Plaza

Archimedes Plaza has served as the setting of USC Viterbi's most iconic events for decades. As part of the campaign, plans are underway to enhance and modernize this vital space.

Ous Mellouli / "The Mediterranean Shark"

By Allison Engel

"Coming to USC was a life-changing experience," the swimmer says. "USC has great students, great professors, great advisers. I came here at 18 and I've been here 10 years, most of the time living very close to campus. My world has been Figueroa, Jefferson, Vermont and 30th – and the pool."

All world-class athletes face enormous challenges, but Tunisian swimmer Oussama (Ous) Mellouli '07 overcame the heartbreak of a nearly two year international sanction to earn the ultimate redemption – Olympic gold — with the help of sympathetic USC Viterbi administrators. It happened like this.

A decade ago, Mellouli, who finished high school in Marseille, France, sent letters to seven U.S. universities requesting information about attending. USC wasn't one of them. He was headed to Cal Berkeley when he got a call at home from famed Olympic swim coach Mark Schubert, who was then USC's head swim coach. "Once I got that call, that was it," says Mellouli.

"Coming to USC was a life-changing experience," the swimmer says. "USC has great students, great professors, great advisers. I came here at 18 and I've been here 10 years, most of the time living very close to campus. My world has been Figueroa, Jefferson, Vermont and 30th – and the pool."

Mellouli is currently working on a master's degree at the USC Rossier School of Education, which he should receive in Fall 2013. He also is volunteering as an assistant swim coach and training for his fifth Olympic Games – Rio de Janeiro in 2016.

Not too many collegiate athletes choose demanding engineering majors, but Mellouli, who came from a family where mathematics aptitude came easily, decided to major in computer engineering and computer science. "With all the traveling I did for swimming, it was super challenging," he admits, and he entertained serious thoughts of switching his junior year. He persevered and graduated in five years. "I'm extremely proud of finishing," he says.

Mellouli did not tell most of his engineering professors that he was a swimmer, as he did not want special treatment, but he did share it with one of his favorites, associate professor Michael Crowley in the information technology program. "Crowley was very tough, but he's an awesome teacher and very personable with students," Mellouli says.

Asked if there is any link between computer science and the discipline of endless laps in the pool, Mellouli quickly answers in the affirmative.

"When you are in the water, you spend so much time with yourself and your thoughts, which is exactly how it is behind a computer, trying to figure out a code or trying to debug the next program," he says. "Both fields promote the advantage of being calm and focused."

Mellouli started getting international attention when he won bronze in the individual medley at the 2003 World Championships. He finished fifth in that event at the 2004 Olympics, setting an African record. But after becoming the first Arab world champion in the history of competitive swimming by winning the 800-meter freestyle at the 2007 World Championships, as well as winning a silver medal for the 400-meter freestyle, it was announced that he had failed a drug test at a U.S. Open meet in December 2006. Mellouli admitted taking an Adderall tablet to stay up to write a USC Viterbi term paper days before the meet, but said he did not take the drug to improve his swimming performance. However, Adderall, a stimulant, is a form of amphetamine, and is on the list of drugs banned for competitive athletes. The Court of Arbitration for Sport nullified all his results from 2006 and 2007, and banned him from competitive swimming until mid-2008, just weeks before the end of the qualifying period for that year's Olympics.

Mellouli calls taking Adderall "a genuine mistake," and asked USC Viterbi officials to confirm the term paper timetable and his record as a scholar. Then-USC Viterbi dean (and now USC President) C. L. Max Nikias wrote a letter supporting Mellouli, for which the swimmer continues to be grateful.

"It was a difficult lesson," says Mellouli. "I learned that the one thing I loved in life could be taken away in an instant. I was pretty vocal afterwards with other athletes, telling them that some of your decisions are going to stick with you the rest of your life.

"It was a costly decision, but an awesome learning experience," he continues. "It changed me, and I'm a lot more careful and meticulous about things."

During his suspension, Mellouli worked harder than ever in the pool, and had the best training year of his life. "I tapped into a whole different psyche," he says. "I was looking for redemption."

Since the suspension ended with only weeks remaining for Olympic eligibility, Mellouli had one do or die competition – the Janet Evans Invitational – to make the team for Beijing. With unbelievable pressure on him, Mellouli earned his qualifying times.

In Beijing, he upset two-time defending Olympic champion Grant Hackett to win gold in the 1,500-meter freestyle. A week later, Mellouli, his father Hedi and mother Khadija were in Tunisia's presidential palace, where the swimmer received the country's highest award of merit, the Grand Officer of the Order of the Republic, from president Zine El Abidine Ben Ali. His was the second Olympic gold ever won by Tunisia, and its first in 40 years.

"It was super humbling to get that kind of recognition," says Mellouli.

Four years later, after he won another gold Olympic medal in London for the 10K marathon swim and a bronze for the 1,500-meter freestyle, it was déjà vu all over again.

He was again summoned to Tunisia's presidential palace where he received a sash and insignia for an even higher honor – Grand Officer of First Order of the Republic.

Mellouli gives great credit to his parents, a policeman and a teacher, who "sacrificed our entire lives" so their four children could succeed, which all have done. His oldest brother, Ons, is a surgeon in Tunisia. His other brother, Moones, is an actuary in Kansas City. His sister Raouia is working on her master's in English in Tunisia.

Their mother, who once saw a child drown at the beach, insisted that her children take early swimming lessons. Competitive swimming was a way for the family's "over-energetic kids" to calm down, Mellouli says, and trips to the pool were rewards for academics. If they didn't get high marks, they couldn't go to practice.

Since he first brought international recognition for swimming to Tunisia, the number of competitive swimmers in the country has tripled. "We don't have nearly enough pools," he says. "In L.A. alone, there are maybe 20 public pools. In Tunisia, there are maybe three or four working public pools for 11 million people." He says it is hard to find investors to build pools, but he's trying to change that.

He's proud of swimming for USC, for taking demanding courses at USC Viterbi and for representing his country at the Olympics. He's particularly gratified about Tunisia's lead role in the Arab Spring in 2012.

"I am very proud of the Tunisian revolution, just like the other 11 million Tunisians," he says. "I think we lead the way for the region. There are still many challenges to be won, but I stay optimistic that we are on the right path."

And he is pleased that his last-minute decision as an 18-year-old to become a Trojan was the right one. "Coming to USC," he says, "was the best decision of my life."

PHOTOGRAPH: ASSOCIATED PRESS

Dwipal Desai, Alumni Entrepreneur

By Casey Rentz

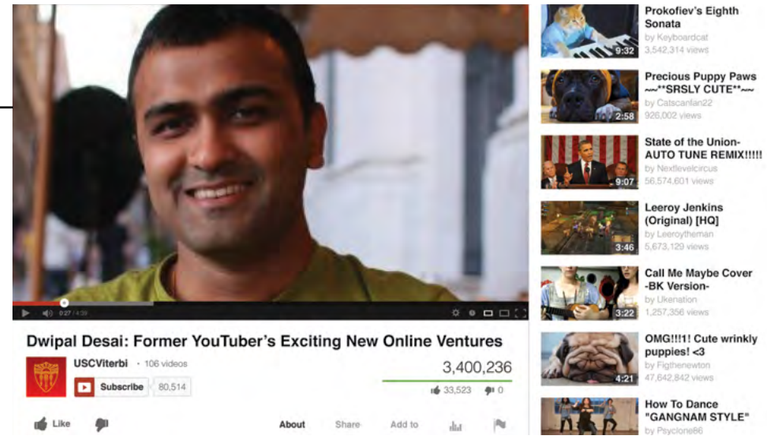
In 2003, a young engineer was tinkering away at one of USC's Integrated Media Systems Center's (IMSC) labs, building one of the world's first HD video conferencing systems. "I had no idea video streaming would be so big," says Dwipal Desai, a 2004 graduate in computer science.

Desai's first job out of college was at PayPal, and in 2005 he was able to jump on the wagon when some of the employees broke out and formed YouTube.com. Because of Desai's background in video streaming, YouTube was a great fit and a superb opportunity for career advancement. Desai's advisor, Dr. Roger Zimmermann, remembers him as "just excellent at programming, designing, and at figuring out how to make things work, even if there was limited information available," and his accomplishments at YouTube show the same tenacity. He was quickly chosen to head YouTube Mobile, which grew to be the second largest video product in the world after YouTube.com.

Desai helped build YouTube Mobile from the ground up, designing the app interface and graphics, as well as figuring out how the streaming itself would work on mobile devices. But, as soon as YouTube grew into a big company, Desai wanted out. "It had matured, and then it just sort of needed to be maintained, and that's not exactly what I get excited about. I get excited about starting new things," Desai says. So, only eight years after graduating from USC Viterbi School of Engineering, Desai has prospered, making a name for himself by working at two major tech companies and is now striking out on his own, supporting his own fledgling company and mentoring others.

This year, Desai launched an online "connection service" called The Icebreak (also available as a mobile app) that prompts dating or married couples to interact with each other on a regular basis. When you sign up, the site asks you "If your relationship were a movie, what would it be?" or "How many of your likes and hobbies are shared by your partner?" You type your answer, and your mate is urged to read and like, comment, or respond. In the background, the site keeps track of your encounters and analyzes them using neuro-linguistic programming, an algorithm that analyzes text and uses psychological principals to assign your interaction a happiness quotient. Over time, it learns what kind of questions and activities to suggest to ensure positive encounters and keep your relationship on the right track.

"My goal is to make something, and if my mom uses it, I'll be super happy," Desai says. "Most people don't care as much about technology as we do, and I want to build things they care about."



Desai previously worked with a more traditional dating site that he found limited because "when two people meet, they leave the site, so it's kind of a loss to the business." So far, The Icebreak has had a very high user retention rate — a lot of users who signed up continued to use it a month later — and an average of 15 percent improvement in self-reported user relationship satisfaction. But, if The Icebreak takes off, Desai will too. That's his MO.

Now that he's a full-time entrepreneur, Desai likes to keep his hands in many different projects at once. "It helps me stay on the pulse of what people are doing," he says. For years, Desai has contributed to and worked with startup incubators Y Combinator — known for funding such companies as Reddit, Dropbox and Disqus — and 500 Startups (where he's been both a struggling startup company and a mentor). And, Desai has come full circle as he has recently expressed interest in mentoring startups from the Viterbi School of Engineering.

"My goal is to make something, and if my mom uses it, I'll be super happy," Desai says. "Most people don't care as much about technology as we do, and I want to build things they care about."

Desai also enjoys mentorship. He finds he has a lot to contribute, having worked at an established company and a startup that went viral (actually, it invented the term viral), and he's had successes and failures at a handful of companies he's started on his own. "Not a lot of people have been through so many things, so my perspective really helps a lot," Desai says.

What's next for Dwipal Desai? "One day, I'd like to build a company and take it public," he says. If his career thus far is any indication, Desai could very well achieve that goal.

In Memoriam: Irving Reed, 88

USC Viterbi School of Engineering Professor Emeritus Irving Reed died on Sept. 11, 2013. He was 88.

Reed was a professor in the Ming Hsieh Department of Electrical Engineering from 1963 until his retirement in 1993.

One of the top engineers of the past century, Reed made fundamental contributions to digital computers, communications and radar. Among his many honors and awards, he was elected to the National Academy of Engineering in 1979 and named a fellow of the Institute of Electrical and Electronics Engineers (IEEE) in 1973.

In 1995, Reed shared the IEEE's Masaru Ibuka Consumer Electronics Award with collaborator Gustave Solomon for their invention of the Reed-Solomon Codes, which for decades was the most widely used system for protecting the integrity of stored and transmitted data. In 1998, he also received the IEEE's Golden Jubilee Award for Technological Innovation.

Reed received his Ph.D. from the California Institute of Technology (Caltech) and served in the U.S. Navy during World War II. After receiving his discharge from the service and while he was a graduate student at Caltech, Reed participated in the creation of one of the first digital computers: Northrop Corp.'s Magnetic Drum Digital Differential Analyzer, which was used to control the guidance system for the Snark cruise missile. Reed and his team members flew the device to Princeton University to demonstrate it for mathematician John von Neumann.

At the Massachusetts Institute of Technology's Lincoln Laboratories from 1951 to 1960, Reed worked in three key areas: the development of computer programming languages, the theory of radar design and performance, and the Reed-Solomon Codes for protecting digital information.

Reed joined the USC faculty in 1963, where he spent the remainder of his career.

At USC, Reed was a member of the departments of electrical engineering and computer science. He was also a founding member of USC Viterbi's Signal and Image Processing Institute and the Communication Sciences Institute.

Obituaries

TONY MAXWORTHY,
a pioneer in geophysical fluid dynamics whose work reshaped the field, died March 8, 2013. He was 79. Born in Ealing, England, Maxworthy earned a bachelor's degree from Imperial College, London before going on to Harvard University, where he received a doctorate in 1960. He was a member of the National Academy of Engineering; a fellow of the American Physical Society; a fellow of the American Academy of Arts and Sciences; and a life fellow of Clare Hall at the University of Cambridge. Joining USC in 1967, Maxworthy became a full professor in 1970. He served as Department of Mechanical Engineering chair from 1979 to 1989.

JOSEPH P. YOUNG,
81, an aerospace engineer who worked for NASA for nearly 30 years, died Sept. 28, 2012 at his home in Laurel. Young graduated from the University of Oklahoma in 1951 and received a master's degree in aerospace engineering from the University of Southern California in 1954. In 1960, he received a master's degree in mechanical engineering from Drexel University in Philadelphia. Young started his career with NASA in 1963 and participated in many of the agency's space-flight programs. He is survived by his wife of 55 years, Lucille Gillan Young, his four daughters, Cynthia Shelberg, Carol Halligan, Mary Jo Naber, and Claudia Florenzo; and nine grandchildren.

RONALD CARL GULARTE,
PhD., age 75, died Jan. 15, 2013, in Crofton, MD. He graduated from Hartnell College in 1962 and continued his education at the University of Southern California. He received his Bachelor's of Science in Mechanical Engineering in 1966 and his Master's of Science in mechanical engineering in 1969. He was involved in early designs by computer methods and was granted two U.S. Patents, which were used in the space industry. He is survived by his wife of 54 years, Alice (Tharp) Gularte, his brothers, Francis Gularte; of Ventura and George Rauch of Salinas; and his nieces and nephews.

WILLIAM THOMAS,
80, died on Dec. 13, 2012, at the Community Hospice House in Merrimack, NH after a long illness. Dave received a B.S. in electrical engineering from Washington State University and a master's in systems management from the University of Southern California. He was an Air Force test pilot for 20 years, including a combat tour in Southeast Asia flying the A-1 Skyraider. Dave was awarded Fellow to the Society of Experimental Test Pilots. Dave is survived by his longtime friend Cappy Orr; Cameron and Loni Thomas of Amherst; Paige and Matthew Galvin of Park City, Utah; four grandchildren, Clayton and Caiden Thomas, and Colin and Molly Grace Galvin; a sister, Margaret Buxton of Renton, Wash.; and several nieces and nephews. Memorial donations can be made in David's name to the Lymphoma Research Foundation, or the Paralyzed Veterans of America.

DR. FRANK ABEL ANDERSON,
98, died Monday, July 23, 2012, at Azalea Gardens in Oxford, Mississippi. He earned a doctorate degree from Louisiana State University in 1947, a M.S. degree in chemical engineering from the University of Maine and a B.S. degree in chemical engineering from the University of Southern California. He served as professor of chemistry and chemical engineering and associate dean of engineering at the University of Mississippi. In 1974, the chemical engineering building was named after him. He was preceded in death by his wife of 69 years, Mary Allie Courtney Anderson. He is survived by his two children, Phyllis Anderson Ambrosiani of Stockholm, Sweden and Frank Andrew Anderson of Bolingbrook, IL., two grandchildren and two great-grand children.

H. NORMAN SCHWARZKOPF,
age 78, four-star general and commander of Operation Desert Storm in 1991, died of complications from pneumonia on Dec. 27, 2012 in Tampa. Nicknamed "Stormin' Norman" for his temper, Schwarzkopf became a public figure after he led forces to a swift victory over Saddam Hussein's Iraqi military in the 1991 Persian Gulf War. He received a master's degree in missile engineering from the University of Southern California in 1964. Schwarzkopf is survived by his wife of 44 years, Brenda Holsinger Schwarzkopf, three children, and his sister.

RONALD K. SIERSBECK,
75, passed away at his home in San Juan Capistrano on Oct. 10, 2012. He received his Bachelor of Science in mathematics from Dana College in 1959 and his Master of Science in systems engineering from University of Southern California in 1968. Ron worked for Lockheed Missile and Space in Sunnyvale, CA early in his career. Later, he worked for the Aerospace Corp. in El Segundo, CA. Ron retired from TRW Systems Engineering Division as a program manager on various satellite programs in Redondo Beach, CA and Colorado Springs, CO. Ron is survived by his wife of 45 years, Marian; a daughter, Chrysanthe; a son, Peter; sisters Beverly Hodges and Doris Kloth; and brother-in-law Luther Kloth.

iPodia – The Global Classroom

One Class, Eight Renowned Universities and a 21st Century Education

The university of the 21st century will have a vastly different shape and form than it does today. In the past, students paid tuition to receive classroom instruction and academic certification. The recent MOOC movement, however, has made high-quality courseware available to everyone free of charge, and the current economic recession has rendered well-paid employment unattainable for many college graduates. Now that classroom lectures are free and many university degrees are underwater, is it still possible for higher education to continue attracting students to pay for campus education in the future?

Meanwhile, elite universities in the developed world have become a key driver of globalization. In today's highly connected world, is there a more effective strategy for leading universities to leverage global presence with local virtue? Is there a better model for future students to enjoy global education without leaving home?

We believe that the answer lies in iPodia, where the "i" stands for "inverted", "interactive", and "international," a new pedagogy for 21st century global education, developed at USC in 2009.

These are the key questions that all leading universities in the 21st century must address: What is the new value proposition for on-campus learning? How do we overcome the paradox posed by the tension between global presence and local virtue? Can we deliver quality global education right from our local campus?

We believe that the answer lies in iPodia, where the "i" stands for "inverted", "interactive", and "international," a new pedagogy for 21st century global education, developed at USC in 2009. The iPodia pedagogy is built on the beliefs that: contextual understanding is essential for effective education - hence the inverted learning; what you learn depends on with whom you learn - hence the interactive learning; and diversity increases learning opportunity - hence the international learning.

Unlike content, which can be taught by teachers with lectures, contextual understanding can only be co-constructed when learners engage with each other. In the conventional learning process, students are first being lectured on using subject content in school, and are then asked to exercise problem solving at home to develop contextual knowledge by themselves. iPodia inverts the traditional schoolwork and homework process by having students first watch online lectures at home to learn subject content before attending class. They then can engage in various collaborative activities with their classmates to develop contextual understanding. iPodia turns away from content-based lectures and towards nurturing context for more effective education.

The inverted process transforms the learning paradigm from passive (i.e., be lectured on) to active (i.e., to participate in). By turning the "learning-from" pedagogy into a "learning-with" pedagogy, iPodia takes the active learning approach one step further, emphasizing interactive learning. iPodia is a "no-distance" learning approach, enabling interactive learning across geographical, institutional, and cultural boundaries.

Additionally, iPodia focuses on intercultural learning, linking together classrooms on multiple campuses around the world. This international dimension expands learning opportunities for all iPodia students, enabling them to interact with, and learn from, global classmates. iPodia students' enormous social and cultural interaction foster transcultural insights of global contexts and heightened mutual understanding.

The iPodia Alliance, an independent global consortium of leading international universities, promotes a "classrooms-without-borders" paradigm for 21st century higher education. Created by the USC Viterbi School of Engineering, this dynamic alliance's founding members include: Peking University (PKU) in Beijing; National Taiwan University (NTU) in Taipei; Korea Advanced Institute of Science and Technology (KAIST) in Daejeon, South Korea; Israel Institute of Technology (Technion) in Haifa, Israel; RWTH Aachen University (AACHEN) in Aachen, Germany; Indian Institute of Technology - Bombay (IITB) in Mumbai, India; and Escola Politécnica da Universidade de São Paulo in Brazil. Additional members from the Middle East, Africa, and Russia are being invited to represent other major world cultures.

There are three principles that govern the operations of the iPodia Alliance. First, the "equal-reciprocity" principle encourages members to strive for balance between iPodia courses offered to and received from the Alliance within a certain period. This ensures that the benefits of equal contribution can be shared among all participating members.

Second, the "revenue-neutral" principle holds that members are responsible for the costs incurred by their participation in all activities, and no money will change hands between any Alliance members. This not-for-profit culture will allow Alliance members to jointly pursue collaborative win-win opportunities.

Finally, a major Alliance goal is to share courseware development and collaborate on course delivery, rather than to create joint degrees among member universities. This enables members to maintain curricular independence and uniqueness, which forms the basis for valuable contributions for the entire group's benefit.

— Professor Stephen C-Y. Lu, David Packard Chair in Manufacturing Engineering, and director, Viterbi iPodia (ViP) Program

GRAPHIC BY GREER FRESHWATER BURTON

Socially Assistive Robots that Care:

Surprisingly likeable and, hopefully soon, surprisingly helpful

The movie "Robot & Frank" features an elderly, and quite curmudgeonly, thief named Frank, whose family provides a robot to take care of his needs. The robot's capabilities in the movie are well beyond the current engineering state of the art, but, ironically, most people won't find the robot unrealistic (though it is), but may find the bond that forms between the robot and Frank hard to believe (yet it is realistic according to latest research).

There is a popular misconception that people, especially older people, do not like robots. In the movie, against his own stated wishes and beliefs, Frank becomes attached to the robot and their joint activities and shared secrets. Is such a scenario possible? The answer, based on human-robot interaction (HRI) research today, is "yes", even without the sophisticated technology the robot in the movie features, though such technology is under development.

Robotics research is addressing the HRI challenges inherent in the myriad of applications coming in the next few decades, including robotics technologies for caregiving of the elderly aging-in-place (i.e., living in their homes as long as possible), those aging in institutions, as well as stroke patients, children with autism, and other social and developmental disorders, and many others.

What do these different populations have in common? All require customized one-on-one care for many hours per day that is already lacking, and is growing increasingly so with rising disease rates and the growth of the aging population. While safe, trained, and affordable human care is always best, when such care is impossible to get, then safe, trained, and affordable technology has the potential to fill the growing gap.

My Interaction Lab's research defined the field of socially assistive robotics (SAR), the research into the development of robots capable of helping people through social rather than physical interaction. To date, we have explored socially assistive robots for providing rehabilitation for stroke patients, children with autism, Alzheimer's patients, and healthy elderly. A growing body of research shows that people engage more, respond better, and sustain the influence of physical robots over non-physical agents (e.g., computer or cell phone simulations). In a recent study we performed with 66 adults, 33 of whom were over 65, we found a strong statistically significant preference for a robot over a computer coach with identical appearance and capabilities. Most interestingly, the older participants had a stronger preference for the robot, exactly countering the popular misconception. Such evidence is mounting.

We are studying when these effects appear and how we may leverage them to create more effective robot caregivers, through the use of appropriate body language, expressions, relational and functional properties of the robot. We are exploring methods for motivating people through social interaction involving speech, gesture, embodied games, and any other social tools. Since our interest is in socially assistive, affordable, and safe systems, we stay away from physical contact. However, there is also a great deal of interesting research in touch and manipulation; researchers are working on smaller, lighter, safer and more affordable robot bodies.

It is important to prepare for the not-so-distant future that will feature the convergence of various technologies, including mobile apps and agents, aware homes, and personalized socially assistive robots, all aiming to improve human quality of life.

— By Maja Matarić, Professor and Chan Soon-Shiong Chair in computer science, neuroscience, and pediatrics at the University of Southern California, founding director of the USC Center for Robotics and Embedded Systems and vice dean for Research in the USC Viterbi School of Engineering.

This post originally appeared on Soapbox Science, the nature.com guest blog.

A Vision For Engineering

Dr. King's Dream - 50 Years Later

In his celebrated August 28, 1963 speech on the steps of the Lincoln Memorial, Martin Luther King, Jr. unveiled his vision for an America in which the content of one's character rather than the color of the skin would be the measure of an individual. Fifty years later, King's dream has yet to be fulfilled. Opportunity, respect and inclusion remain elusive for many in our nation not only because of their race but also because of their gender, socioeconomic status, religion, sexual orientation, physical ability or other personal characteristics.

Regrettably, the discipline of engineering is one in which disparities in opportunity and participation when viewed through these lenses is most evident. The persistent underrepresentation of racial minorities and women in engineering education and careers, in view of their growing presence in our population, does not portend a future with a sufficient number of well-prepared and highly-skilled native engineers to address the critical technological challenges we face as a nation. We can no longer count on a seemingly endless supply of talented individuals from developing countries to come to our shores and provide the needed scientific and technological skills given the progress those countries are making in educating their own citizens in science and engineering, building infrastructures to support their efforts, and providing them with gainful employment. This reality, in addition to the fact that far too few young people are graduating from our high schools with the necessary preparation and intention to study engineering, makes it even more imperative that we provide opportunities for a quality education in math and science for all students, and encourage them to consider an engineering education and career. Failure to do so is tantamount to relegating us to a potentially permanent, secondary status in the competitive global technological environment that exists.

Were he alive today, King would be dismayed by the decline in achievement in math and science of U.S. students relative to their peers in other developed nations. He would be further disheartened to learn of the persistent gap in achievement between African American and Latino K-12 students and their white and Asian peers in reading, math and science. It is sobering to realize that in 2010, the U.S. ranked 27th out of 29 wealthy countries in the proportion of college students with degrees in science or engineering. It is equally sobering to recognize that underrepresented minorities constitute only 12 percent and women only 18 percent of the nation's approximately 83,000 baccalaureate engineering graduates. To counter theses disparities in participation, we need more minorities and women to follow the leads of Mark Dean, an African American engineer who holds three of the nine original patents for the IBM PC; Richard Tapia, a Mexican American professor of engineering at Rice University and recipient of the National Medal of Science; Mae Jemison, who traveled aboard the shuttle Endeavour to become the first African American woman in space; and USC's own professor of engineering, Maja Matarić, internationally recognized for her contributions to robotics research.

King's dream of equality and inclusion encompasses a vision of a nation in which opportunity is available for all. For this to be true, our educational systems, including our universities, must focus on the tasks of improving retention and graduation rates and creating environments that encourage high expectations and performance. Engineering education, in particular, must recognize its crucial role in increasing the diversity of the profession. Among the steps that might be taken include an increased emphasis on outreach efforts to poor and minority communities and a more proactive approach to recruiting women and minority faculty.

I am encouraged that throughout the nation emphasis is being placed on STEM education. Governments, corporations and universities are providing support to school districts to improve math and science education, and many K-12 students are learning engineering fundamentals and concepts. These efforts must be sustained in order to ensure a future of a sufficient number of highly skilled engineers and the capacity to innovate and compete in the global technology marketplace.

— Professor John Brooks Slaughter has a joint appointment at the Rossier School of Education and the Viterbi School of Engineering. He is the first African-American to head the National Science Foundation.

PHOTOGRAPH BY LUKE FISHER

THE MANY LIVES OF ENGINEERS

"I believe the same mindset that has helped me be successful in cycling plays an important role in engineering as well. In cycling, dedication, perseverance and the strong desire to push boundaries are the foundations of success. Whether it is hitting new top speeds on the bike, or solving an engineering problem, the thrill of a new achievement is what motivates me to continue to pursue both of my goals."

— JOSEPH VELOCE, ***Olympic cyclist; Ph.D. candidate, electrical engineering***

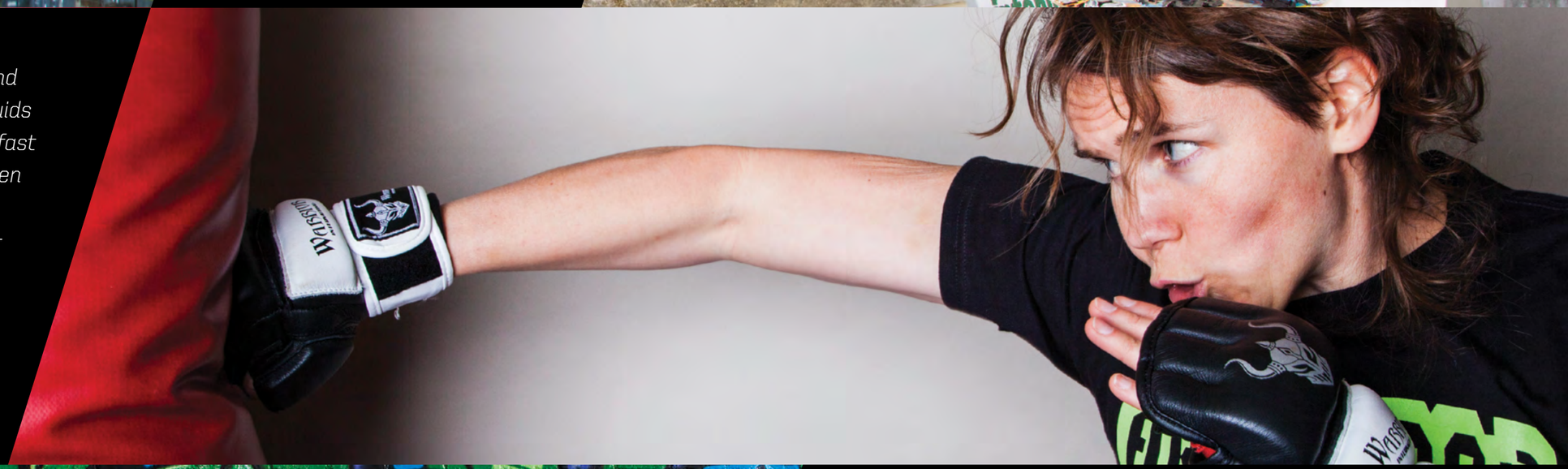
PHOTOGRAPHY BY NOE MONTES

"Painting and engineering are similar. You get a clear vision of what the end-product should look like, and then you can't sleep until it's done."

***— KEVIN KNIGHT,** senior research scientist and fellow, USC Information Sciences Institute (ISI)*

"My research covers dynamic impact and generation of shock waves in gases, liquids and solids. The events we study are very fast - typically less than a millisecond - and often generate extreme conditions. I think that's why I find practicing Muay Thai to be both intellectually rewarding while at the same time it is physically challenging and enriching."

***— VERONICA ELIASSON,** assistant professor, Department of Aerospace and Mechanical Engineering*



"I think a big part of becoming a successful dancer is forcing yourself to think outside the box. It's not just about learning the movements and being able to replicate them. The choreographers I admire the most constantly challenge their minds and bodies and strive to tell stories with movement. The value of creativity and risk-taking in engineering cannot be overemphasized either. Many people are capable of getting an engineering degree; not everyone will go out into the world and continually push themselves to break from the norm."

***— MAX TEBOUL,** junior, industrial and systems engineering*

YouTube Co-Founders Chad Hurley and Steve Chen

10 Questions on Jobs, Dangers of Social Media and Their Next Big Thing

USC Viterbi: Everyone's talking jobs and the economy, and being that we're an engineering school, I'm curious to get your thoughts on the role an engineer can play or should play in growing the economy.

Chad: I think that although the economy may be struggling to some extent, and it's harder than ever for individuals to find some jobs, I think people are more empowered than ever to kind of take control of their own destiny. Maybe it's not the way that the economy or the system has traditionally worked in the past, but people have the tools to create their own service… to launch a web-based service like we have and continue to do so. So I feel like although it may be a tough job market, individuals, especially engineering students coming out of school, are more empowered than ever to leverage this technology and to simply create their own opportunity.

USC Viterbi: What was the first piece of technology that got you really excited? Do you remember?

Steve: In fourth grade, I remember we had this family computer. It was an old Apple II. I just remember starting very early on with a series of about 25 commands; you can almost tell that computer to do anything you want. I was able to create this kind of animation of the American flag flickering across the screen while "The Star-Spangled Banner" was playing, and to me, it was just kind of cool that you can sit there in front of a keyboard and depending on what you type you can do almost anything you want.

USC Viterbi: I know this has been a national issue in the United States — only 4.5 percent of college graduates graduate from a so-called "STEM" field, and I know in Europe it's like 14 percent. In China, it's like 21 percent. So if you guys walked into a seventh grade classroom, and you were trying to excite them into a career into science, technology, engineering, and math, what would you say to them?

Chad: Again, sort of how I answered the first question. You know, with these skills you have basically the tools to change the world available to you today. It's an exciting time to be alive. Generations in the past have been completely powerless to affect people on such a large scale. I mean, certainly, to have an idea, give something practically a week or two and have it touch a global audience is pretty phenomenal.

USC Viterbi: Steve, do you know what you would say?

Steve: What really excites me about being a developer, programmer or engineer is at the end of the day, you have a keyboard, and you can type things on that keyboard, and you can create YouTube or you can create Google. That fact that you can create these things that you have planted in your mind through the keyboard, through mice, through movements. Actually, the point of these programs is you can just change the world, and I think there are just so few things in the world, so few occupations that allow you to do that much as a single person; and that's what's truly exciting about being an engineer.

USC Viterbi: It's awfully hard to have an encore to YouTube. Who have been your role models in terms of kind of personal reinvention and what did you learn from them?

Chad: We don't look at it as a reinvention. We look at it as an ongoing journey to continue to create great stuff. If we do that again, that would be great. You know we've been really lucky with YouTube. We've been really lucky with PayPal. You know, a lot of that stuff is being in the right place at the right time, but it's simply just taking those chances and being in the position in the first place. So that's what we're just trying to do again.

USC Viterbi: Speaking of problems… from what I understand, YouTube was born out of a problem at a dinner party. Can you walk me through what happened there?

Chad: Yeah, I mean we simply just had a problem with sharing video with our family and friends. We had videos on our desktop. There's not an easy way to share them. There's Flickr and Vistage for photos. There weren't any video services out there. The ones that did exist were just serving up funny kind of viral video, a collection of those types of videos, but nothing in terms of a personal solution that you could share any video with anyone. Steve had some videos from the dinner party. I had family videos I was trying to share with my parents.

Steve: I think that people have been trying to solve this problem for a long time, even when the Internet was at a much younger age. But what happened with YouTube in 2005, there were a few things. I think one of them, especially in the U.S., was broadband penetration got to a point where enough people could actually upload and watch videos, stream videos real time. It's hard to imagine back in 2003-2004 where you still get all these problems whenever you went to a video site that you'd see these warnings that you have to download a QuickTime Player. You have to download Windows Media Player to play this. That is no longer something that you have to deal with. And it's just something that at the time in 2005, all the pieces were there to make this happen.

USC Viterbi: You know there's been a lot of buzz about your latest digital magazine venture, Zeen. For the uninitiated, what it is and what's the latest news?

Steve: So I think after YouTube, we were really looking at ways to be able to find and discover content. So on YouTube, even by the time that I left, it was receiving over 70 hours of video per minute. Even if you were a dedicated YouTube user, there was no chance you were going to watch through all those videos. So how do you connect people that are interested in finding stuff they want to watch with the stuff that's been uploaded? How can you help them discover content? I think the Internet has reached a point where content creation is or has been more or less solved. If I want to upload a picture I know where to do it, upload a video I know where to do it. But how do you actually find… now when you wake up and you want to actually find content. You want to find the things that you haven't seen before but that are customized to you. How do you find that? And that's really what we are doing but really it's just trying to help people with this next level of trying to find the things they want to see.

USC Viterbi: I'd like you guys to gaze into the crystal ball for a second. Can you forecast two or three things about the web that most people aren't aware of yet?

Chad: I think generally people are somewhat aware that people are getting tired of social services. There's going to be what I would call social fatigue. I think there's going to be a lot more intelligence – collecting things passively and making sense of it than someone actively sharing something. I think there are a lot more people in the world that actually consume tweets than actually tweet themselves. Even in YouTube we saw that: more people that view videos than upload them. I think technology is going to become much more intelligent. It doesn't ask you to take an action or do something publicly to get value from it.

USC Viterbi: Give me kind of a quick summation of how the startup landscape has changed since YouTube was founded.

Chad: Well, I think (social networking) services might make startups a little too sensitive in terms of what the outside world thinks before it has reached scale. People are too sensitive of what people are saying about what they're working on. First, there's kind of operating independently and allowing things to build organically. It just serves as a distraction. Startups aren't trusting their instincts to create something new. They kind of hinder themselves by listening to what everyone is constantly saying. On the one side, I think that the startups are benefiting from these services because it's easier than ever to expand your friends. In terms of a swift signup process without building a service that adds true value, it's going to have something expandable. So I think that's something that startups have to lose sight of.

USC Viterbi: The last thing I wanted to ask was I know you guys got a chance to visit USC Viterbi last month for a fireside chat. What were some of your impressions?

Chad: It's a great university. I mean I wish I went there instead of my small school in Western Pennsylvania. The weather's a lot nicer. No, it seems like a great diverse set of students that are going to do great things. I like the mix of entertainment and technology. I'd come down there before to visit the film school. I like the intersection of technology for storytelling which you're a perfect place to take advantage of that.

ILLUSTRATION BY KAYLA CARLISLE

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