USC Viterbi

SPRING 2014

ON THE 10TH YEAR ANNIVERSARY OF ANDREW AND ERNA VITERBI'S NAMING GIFT

CAN YOU BREAK OUR VITERBI CODE?

10 YEARS, 10 CLUES. A SPECIAL HIDDEN MESSAGE TO TROJAN ENGINEERS.

(SEE PAGE 5)

"IN A WAY, I FEEL THAT WE'VE GROWN UP TOGETHER."

— Andrew Viterbi (PhD EE '62) on his relationship with USC

March 2, 2004 – Surrounded by hundreds of well-wishers, Andrew and Erna Viterbi are the center of celebration following their $52 million gift to the USC Viterbi School of Engineering. On this 10th anniversary, *USC Viterbi* magazine looks ahead to the future (see page 24), envisioning eight specific visions of our world.

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ALUMNI

EDITORIAL

CHANGING THE CONVERSATION

THE LAST WORD

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DEAN'S LETTER

Viterbi: Our Proud Name

What's in a name?

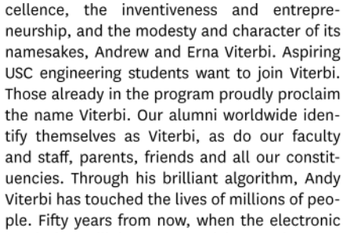
I ought to know. What with the frequent mispronunciation of my own name or the question "What does it mean in English?". I should also know, because the school I represent has carried for the past decade its own distinct name, this one of Italian, not Greek, origin. Being mathematically inclined, I could try to use a digital representation. Certainly Viterbi can be represented in digital form—but this might take the whole page, so let's simply use the letter V to denote it. (In fact, we did use V as shorthand for Viterbi for a while, until that innovation was overridden by our new branding policy!) V being the 22nd letter in the alphabet, its digital version would be 10110. Andrew Viterbi, having spent his career dealing with digital signals, would certainly appreciate this approximation!

Yet that sequence of 1's and 0's is not what's in a name. In 2004, Andy and his wife, Erna, gave their name to the USC School of Engineering. The naming of a school, one that will last in perpetuity, has profound implications and responsibilities. It is the transference of a name from two individuals and their close family to an institutional family that is exponentially larger in time, disciplines and geographic distance. It is an act of confidence and faith; an act of pride in the ability to protect and expand a legacy through the students, faculty and alumni who will be associated with the school for generations to come. It is a magical transformation of the finite Andrew and Erna Viterbi family to the greater Viterbi family of the USC Viterbi School of Engineering.

It is truly remarkable how in the very short time since its naming, what we do and what we represent now simply carry the name Viterbi. It is a name associated with the academic excellence, the inventiveness and entrepreneurship, and the modesty and character of its namesakes, Andrew and Erna Viterbi. Aspiring USC engineering students want to join Viterbi. Those already in the program proudly proclaim the name Viterbi. Our alumni worldwide identify themselves as Viterbi, as do our faculty and staff, parents, friends and all our constituencies. Through his brilliant algorithm, Andy Viterbi has touched the lives of millions of people. Fifty years from now, when the electronic revolution will be surpassed by another one (hopefully invented here at the Viterbi School!), and for a long time thereafter, Andy Viterbi's legacy will live on in perhaps a different but always empowering way: through the impact of students and faculty who have studied, worked and invented here.

So it has been our responsibility, perhaps similar to that of passing the torch of generations, to carry the academic brilliance, innovative spirit, and character of giving and magnanimity of our namesake to the school we represent. To transform, so to speak, his physical DNA into the DNA of the soul and essence of the school, thus conveying and expanding his legacy.

I think that that's what's in a name.



BREAKING NEWS

USC Faculty and Alumna Iraj Ershaghi and Geraldine Knatz Elected to the National Academy of Engineering

New academy members receive engineering's highest honor.

By Marc Ballon

USC Viterbi Professor Iraj Ershaghi, the Omar Milligan Professor of Petroleum Engineering in the Mork Family Department of Chemical Engineering and Materials Science and executive director of the Center for Interactive Smart Oilfield Technologies at USC, and Viterbi lecturer Geraldine Knatz, the former Port of Los Angeles executive director, have been elected to the National Academy of Engineering, the highest professional distinction accorded an engineer.

Ershaghi, who earned an MS at USC Viterbi in 1968 and a PhD four years later, has made innumerable contributions to the university. Under his nearly three-decade leadership, the USC Petroleum Engineering Program has become one of the most renowned in the nation. Ershaghi also helped establish the country's first and only master's in smart oilfield technology. As co-director of CiSoft, a unique partnership between USC Viterbi and the Chevron Corp., Ershaghi has played an integral role by helping to build teams of university scholars, scientists and students to undertake important research.

Knatz, a lecturer in the Sonny Astani Department of Civil and Environmental Engineering and a former member of the Viterbi School's Board of Councilors, earned a master's in environmental engineering in 1977 from USC Viterbi and a doctorate in biological sciences in 1979 from USC Dornsife. She became the Port of Los Angeles' executive director in early 2006 and held that position until recently. She and her team transformed the nation's busiest commercial port into one of the greenest. During her tenure, she transformed the port complex, spearheading the creation of more than 60 acres of public parks and adding several miles of public promenade along the waterfront.

PHOTO: STEVE COHN

Can You Break the Code?

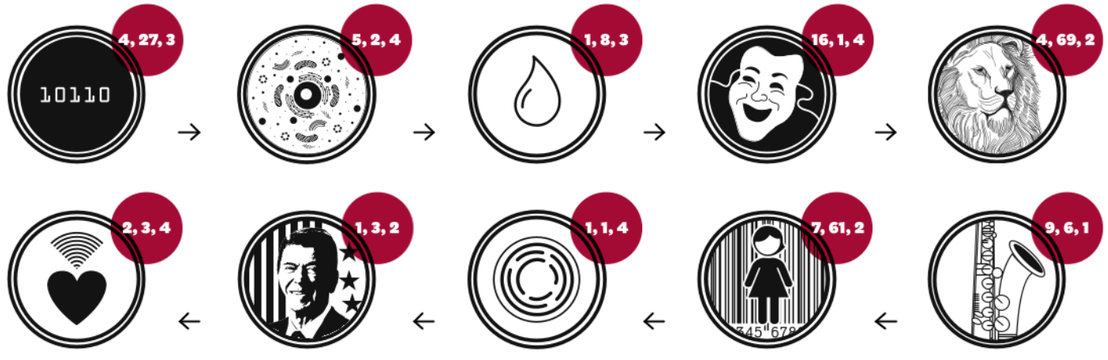
Andrew Viterbi's famous algorithm (see page 10) has been used in everything from cell phone communication to DNA analysis.

Not so well known, however, is its use in cryptography, the science of code breaking.

Just ask Professor Kevin Knight, a computer scientist at the USC Information Sciences Institute, our resident Robert Langdon, à la Dan Brown's *The Da Vinci Code*. The Viterbi Algorithm, first conceived in 1957, was later reappropriated as the nearly identical Forward-Backward Algorithm, the chief code-breaking tool for the CIA and modern intelligence agencies. Similarly, it's been used by Knight to attack ciphers ranging from secret societies in 18th century Germany to coded messages from the Zodiac killer.

On the occasion of the 10th anniversary of Andrew and Erna Viterbi's naming gift to the school, *USC Viterbi* magazine was inspired to create our own unique code. In collaboration with Professor Knight, **we have imagined a special "Viterbi Code" hidden within the pages of this magazine**, something not as sophisticated as the codes Knight tackles, but perhaps challenging on the order of a *New York Times* crossword puzzle.

So, dear readers, to get you started, here are 10 clues:



The translated code will appear in the form of a 10-character URL (www.?.com). Enter the web address online—you'll be greeted with a special video message from the namesake of our school.

To be entered for a chance to win, watch the video and answer the prompt at the video's end. **The winner will receive a free dinner with Andrew Viterbi himself.**

Good luck!

Adam Smith, Editor

www. — — — — — — — — — — .com

A Building for the Ages

The new USC Michelson Center for Convergent Bioscience will bring together engineers, scientists and other innovators to advance biomedical science and engineering.

By Marc Ballon

In the words of the late National Academy of Engineering President Chuck Vest, "We live in the most exciting era for science and engineering in human history."

Thanks to a recent multimillion-dollar gift to USC, that's never been truer.

In January, retired orthopaedic spinal surgeon and inventor Gary K. Michelson and his wife, Alya, donated $50 million to create the USC Michelson Center for Convergent Bioscience, which will bring together biologists, engineers, computer scientists and others to come up with novel medical devices and ways to detect and cure diseases.

When completed in 2017, the Michelson Center will embody USC's commitment to interdisciplinary learning and research to advance knowledge and science. It also represents a powerful collaboration between the USC Viterbi School of Engineering and the USC Dornsife College of Letters, Arts and Sciences. "The new USC Michelson Center will be a vibrant hub for innovation and will help create a major biomedical corridor in Southern California," said USC President C. L. Max Nikias.

The facility, added USC Viterbi Dean Yannis C. Yortsos, "will be the cauldron where scientists and engineers will exploit biological phenomena for useful purposes as never before."

The USC Michelson Center will stand in the southwest quadrant of the University Park Campus, home to most of the campus's engineering and science buildings. It will house 20 to 30 principal investigators, with laboratories employing hundreds of researchers and students.

Among the center's first residents will be Scott Fraser, a world leader in microscopic imaging. The Provost Professor of Biological Sciences and Biomedical Engineering joined USC in 2012 from the California Institute of Technology, where he founded the Biological Imaging Center in the Beckman Institute.

About five years ago, then-provost Nikias hatched the idea for a convergence building where innovators would work at the intersection of life sciences and engineering. Nurtured under his and Provost Elizabeth Garrett's leadership, the dream will become a reality thanks to Michelson's visionary philanthropy.

Michelson, a prolific inventor who holds more than 950 patents and pending applications throughout the world, serves as a fellow of the American Academy of Orthopaedic Surgeons. In 2008, the Paralyzed Veterans of America recognized him as that year's Distinguished Scientist for his work in treating traumatic spinal disorders.

"Ten years after its naming, USC Viterbi finds itself as one of the recipients of another tremendous gift," Dean Yortsos said. "This is a momentous occasion that will help us build a world that never was."

To support research at the USC Michelson Center, please contact Mary Ann Schwartz at 213-821-0441.

ILLUSTRATION: UNIVERSITY OF SOUTHERN CALIFORNIA

HOW TO 3-D PRINT THE USS *ENTERPRISE*

In Five Easy Steps

Associate Professor Yong Chen develops a 3-D printing process with the speed of light, boldly taking the field where no one has gone before

By Megan Hazle

Stereolithography—or "additive manufacturing," the process of building 3-D objects from digital designs by adding material in layers—has been around for more than 30 years, and several models of 3-D printers are now commercially available. The problem? Three-dimensional printing of even a small object can take several hours! The solution, according to Dr. Yong Chen? **Light.**

In celebration of the 30th anniversary of *Star Trek III: The Search for Spock*—directed by Leonard Nimoy himself—we are 3-D printing the USS *Enterprise* (NCC-1701), which Captain Kirk deliberately autodestructs to defeat the Klingons.

1

Start out by 3-D scanning the object you'd like to replicate, or create a digital model with computer aided design (CAD) or animation modeling software. The program will create a digital blueprint of the object and divide it into cross-sections so that the 3-D printer can build it layer-by-layer.

Tip: Feeling lazy or pressed for time? Many 3-D models are available for purchase or free download via sites like MakerBot's Thingiverse. This design of Star Trek's *Enterprise* was created by user sitts314.

2

Load the Standard Tessellation Language file (.STL) into Dr. Chen's proprietary Printing Support Generation Program, which automatically generates supports for the model, and choose a material for the object, such as plastic or a composite. For this project, we chose a plastic resin and used a mask projection-based 3-D printing machine to fabricate our *Enterprise* model.

3

Hit the "Print" button. In a typical 3-D printer, layers of material are deposited via a dispenser that moves around the perimeter of the hollow object, like squeezing toothpaste out of a tube. Dr. Chen's technique uses a different approach: light in the shape of each layer is projected onto the surface of a pool of plastic resin—no movement or waiting necessary! The machine "prints" each subsequent layer with a quick flash of light, which cures the material in the desired shape according to the digital blueprint.

4

Wait 15 minutes for the object to be fabricated. (Just enough time to enjoy a cup of hot Earl Grey tea!) Once the object is complete, remove it from the bucket of gooey resin, peel off the supports, and clean it off with an alcohol solution.

Watch Professor Yong Chen's video on 3-D printing multi-material objects faster at viterbi.usc.edu/3dprinting

5

Zoom around humming the Star Trek theme song and reenacting the Battle of Veridian III.

ILLUSTRATION: KATHERINE DUFFY

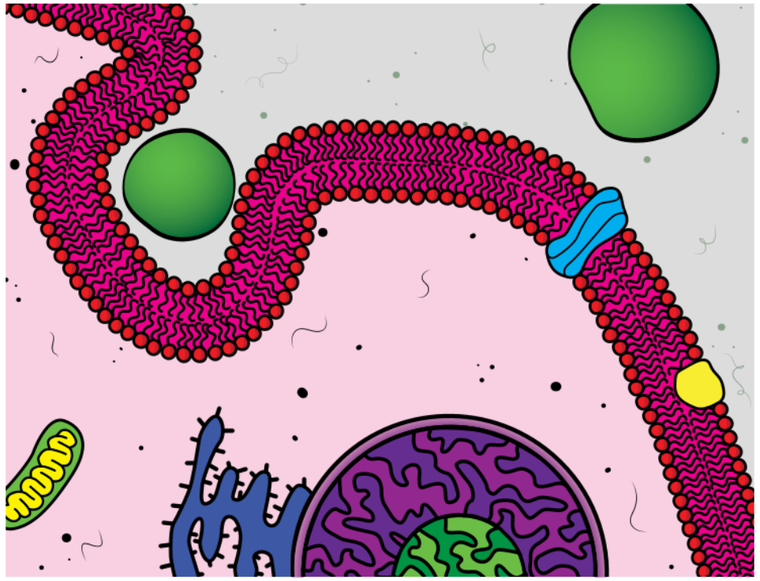
THE MEMBRANE CHALLENGE

Noah Malmstadt faces his toughest critics: Los Angeles 7th graders.

By Rosalie Murphy

Noah Malmstadt's work is, to the untrained eye, complicated. The chemical engineer, who holds a BS from Caltech and a PhD from the University of Washington, designs artificial cells. Here's what's written on his USC Viterbi profile page:

Lipid phase segregation leading to the formation of nanoscale lipid rafts is important in many cellular processes, including signaling and viral docking. Existing membrane model systems do not exhibit this nanoscale raft formation phenomenon: phase segregation in model membranes takes place on much larger scales. We are designing biomimetic systems that reproduce the nanoscale phase separation behavior observed in cells.



USC Viterbi Assistant Professor Noah Malmstadt designs artificial cells.

This fall we challenged Malmstadt to the "Membrane Challenge"—explaining his work to a seventh-grade science classroom at South Gate Middle School near Los Angeles not only so the students understood, but so they stayed interested. What follows is a transcript of his presentation. See if you can keep up:

"As an engineer, one thing I believe really strongly is that the best way to understand something is to try to build a copy of it. If you want to know how a car runs, one good way to understand it is to build your own car. I'm taking this approach to how cells function. I want to build a copy of a cell.

"The copies I'm building are a lot simpler than real cells. We're using the most basic chemicals we can get our hands on and using them to assemble things that kind of act like cells. I'm sure you're all aware that cells are the basic unit of all biological systems—our bodies are made of cells, cells have specialized functions, there are particular things in the various tissues that they act in, they're the building blocks of biology. And when I try to build copies of cells, I focus on the cell membrane. Our work really focuses on using these artificial cells to study important biological processes that affect the membrane.

"One thing we're really interested in is looking at how medicines get across the cell membrane. This is important because a medicine that can cross the cell membrane by itself, without any proteins in the membrane interfering in the process, is a medicine that you can take as a pill. Otherwise it has to be a shot. A lot of people who are designing new medicines are very interested in how medicines get across the cell membrane, and they use our artificial cell membranes to study that process.

"The other thing we study is how oxygen can damage the cell membrane. You might have heard of antioxidants. The reason antioxidants are important is because oxygen is a very damaging molecule. Oxygen makes metal rust, for instance. In the same way it can damage cell membranes. Part of what happens in heart disease is oxidation of the cell membrane. So we're developing artificial cell membranes to understand how oxygen can damage cell membranes, how it can change their mechanical properties, it can make them more stiff and change their shape. That's what we care about in my lab."

The students' follow-up questions lasted an hour, ranging from "What would you do if you weren't a professor?" (A: Probably work for a biotech company), to "What happens if the cell membrane gets blocked?" (A: Paralysis, seizure or even death. A lot of powerful toxins block the cell membrane), and "How does the cell membrane help in evolution?" (A: Some people think the key step in the development of life is the emergence of membranes).

ILLUSTRATION: GREER FRESHWATER BURTON

SURF'S UP—FOREVER

USC's Adam Fincham and surf champion Kelly Slater create the perfect wave.

Edited by Kathleen Concialdi (original story by Angus McColl)

"We are ready to do it," says USC Viterbi's Adam Fincham. "The full-size tank will be more than half a kilometer in circumference. Our partners envision a resort hotel and a community of surfing enthusiasts who will come in search of—and find—Kelly's perfect wave."

Surfers along the California coastline must wait for the perfect wave, lacking the power to produce ideal conditions on command.

Kelly Slater, 11-time world surfing champion, wants to change that, and his efforts may bring about a renaissance in surf culture. "This is the wave I've been dreaming about my whole life," reveals Slater.

Since 2007, the Kelly Slater Wave Co. has collaborated with USC Viterbi Research Professor Adam Fincham on wave generation technology. Along with other USC Viterbi professors and students, they have developed Slater's groundbreaking concepts into technology that allows a wave to run continuously around an island in a doughnut-shaped basin, wherein waves can be adjusted to suit individual preferences.

Fincham received his doctorate from USC Viterbi and then went to work researching ocean wave dynamics at the Laboratoire des Écoulements Géophysiques et Industriels (LEGI) in France. He returned to USC and later joined with USC Viterbi professors Tony Michaels, Larry Redekopp, Tony Maxworthy and Fred Browand in their quest to help Slater build the perfect continuous wave. They concluded that a doughnut-shaped tank with vertically orientated hydrofoils rotating around the perimeter would likely work. The Kelly Slater Wave Co., which Slater and Fincham co-founded with several businesspeople, built a scale model of the tank in an off-campus research facility. The design is patented and will soon be scaled up to its full dimensions, with the first of many wave parks soon to be developed.

"What we have is something totally unique," Slater has said. "I know we're going to make the best wave anyone's ever made."

PHOTO: NOE MONTES

*Not really a game. The Viterbi Algorithm is quite serious.

Let's play the

Viterbi Algorithm Game*

You must traverse this landscape using the least amount of energy. Each path bears a cost based on the difficulty of the terrain. Challenging paths have higher numbers. Easier routes have lower numbers. You don't have food and water, so you have to conserve as much energy as possible. Get through this forest!

HOW TO PLAY

1. Plan your route by considering one lettered column at a time.
2. In column A, add up the cost of each path that gets you to each of the 4 possible points in that column. Eliminate the most expensive route by crossing it out, and partially fill in the dotted line for routes that are still possible.
3. Repeat for columns B, C and D.
4. When you find the most efficient path (with the lowest number) from start to finish, go back and fully fill in the lines.
5. Bask in the Viterbi Algorithm glory.

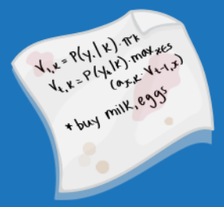
THE VITERBI ALGORITHM?

It's used for telecommunications, voice recognition and DNA sequencing, but **what is it?**

The Viterbi Algorithm provides a fast way to find the **most likely sequence** of events.

It works like a detective: it **systematically throws out unlikely paths** through a vast forest of possibilities.

It finds the **hidden, original sequence** in a garbled string of information.



And did you know that Andrew Viterbi first scribbled it on a napkin? That's pretty neato.

(Now I feel guilty for just wiping my face with them...)

Without the Viterbi Algorithm, the cost of decoding a sequence is ***exponentially*** related to its length.

With the Viterbi Algorithm, it's ***linear*** (which is way better).

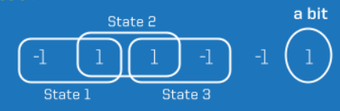
EXPONENTIAL VS. LINEAR

Sequence Length*	To Viterbi or Not to Viterbi	Possibilities to Test
10	Without Viterbi Algorithm	1,024 Ew.
	With Viterbi Algorithm	★ 40
20	Without Viterbi Algorithm	1,048,576 Ahhhhh!
	With Viterbi Algorithm	★ 80 Yay!

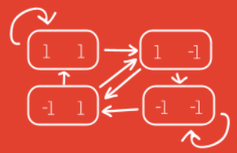
** with 2 possible values and a processing memory of 2 bits*

Hey, what's the deal with these points? Why aren't they all connected?

Each circle is a **STATE**, which actually represents 2 **BITS** of information at a time.



2 **BITS** can be in 4 possible **STATES**



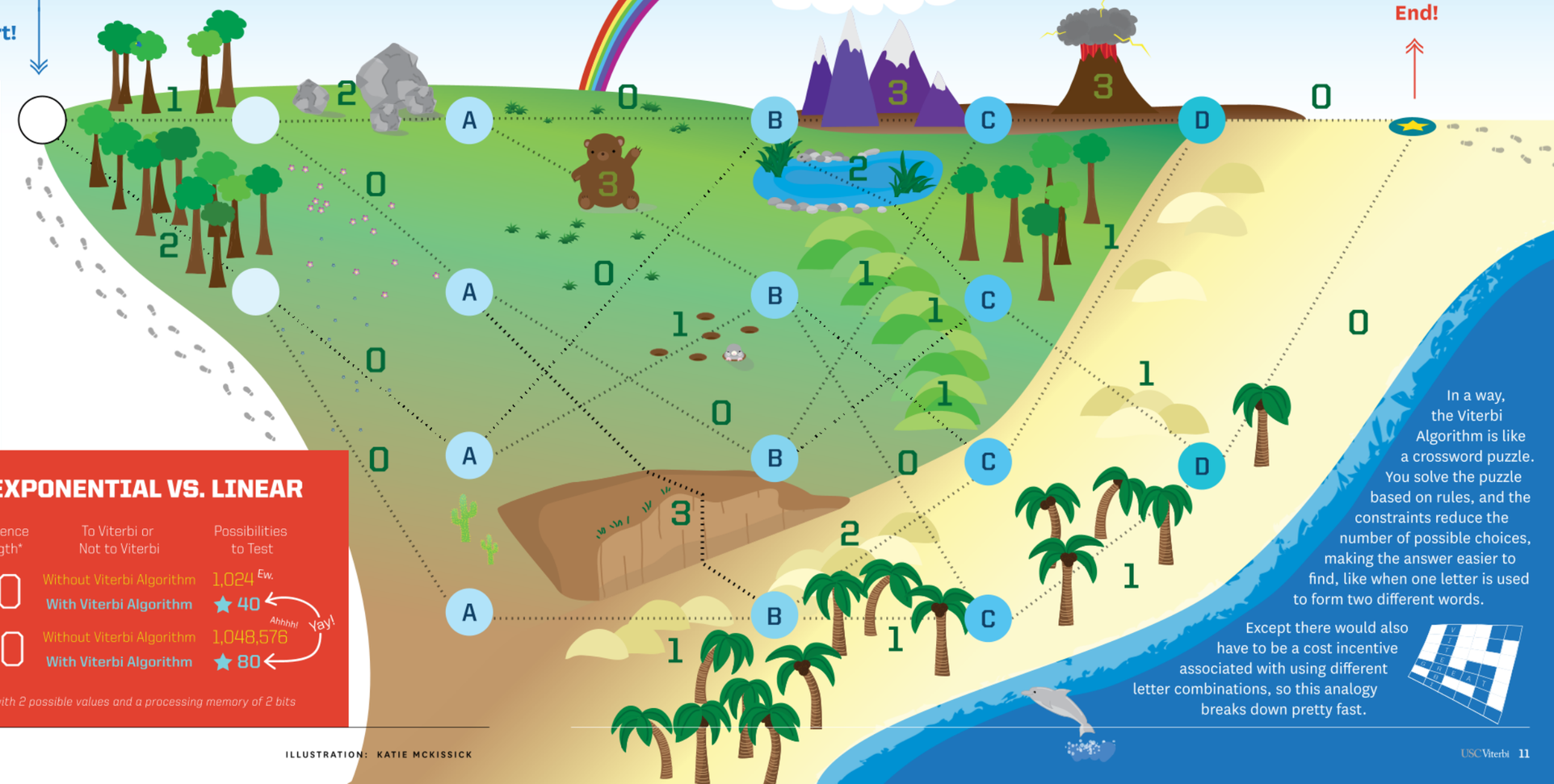
The second bit of one state will be the same as the first bit in the next state.

This limits which point you can go to next. That's why they're not all connected.

You can find the best route by adding up the numbers for each individual route possible.

There are 32 possible paths, so have fun with that.

Or you can use the **VITERBI ALGORITHM** and think in terms of paths, not points.



In a way, the Viterbi Algorithm is like a crossword puzzle. You solve the puzzle based on rules, and the constraints reduce the number of possible choices, making the answer easier to find, like when one letter is used to form two different words.

Except there would also have to be a cost incentive associated with using different letter combinations, so this analogy breaks down pretty fast.

ILLUSTRATION: KATIE MCKISSICK

Faculty Accolades

01 **Ted Berger**
Foreign Policy's Top 100 Global Thinkers

02 **Ashish Soni**
Socaltech 50

03 **Jernej Barbič**
Research Fellowship, Alfred P. Sloan Foundation

04 **John-Shi Pang**
Epstein Family Chair

05 **Burcin Becerik-Gerber**
NSF Career Award

06 **Shuo-Wei Chen**
NSF Career Award

07 **Shaddin Dughmi**
NSF Career Award

08 **Costas Synolakis**
2014 Soloviev Medal of the European Geophysical Union

09 **Cyrus Shahabi**
IEEE Fellow

10 **Ellis Meng**
2014 ASEE Engineering Research Council Curtis McGraw Award

11 **Hao Li**
Next Gen 10 by CSQ magazine

12 **James Moore**
Member of the Year Award, WTS Los Angeles

13 **John Heidemann**
IEEE Fellow

14 **Milind Tambe**
ACM Fellow

15 **Nora Ayanian**
"AI's 10 to Watch," IEEE Intelligent Systems

16 **Paul Ronney**
Associate Fellow, The American Institute of Aeronautics and Astronautics (AIAA)

17 **Ramesh Govindan**
IEEE Fellow

18 **Sheldon Ross**
INFORMS Fellow

19 **Stefan Schaal**
IEEE Fellow

20 **Yan Liu**
2013 Okawa Foundation Research Grant

Engineering Plaza: A Brand New Look Increases Use

Daniel and Phyllis Epstein and family remake the former Engineering Quad.

Last summer, the Archimedes Plaza underwent a significant transformation, thanks to a $3 million gift from Daniel J. and Phyllis Epstein and their family. And the results are not only beautiful—they have created a central space that draws crowds of students for studying, talking and relaxing with each other. The newly renamed Epstein Family Engineering Plaza features an expanded lawn, new tree plantings and a cascading waterfall fountain. A statue of Neil Armstrong now stands near the east end of the Hedco Chemical Engineering building. The plaza is equipped with electronic outlets, a laptop "bar," as well as comfortable chairs, shade umbrellas and benches.

"We are grateful to the Epstein family for their tremendous support of our mission and to this wonderful improvement in our students' experience," said Dean Yannis C. Yortsos.

Water Wonder Woman

USC VITERBI PROFESSOR AMY CHILDRESS HAS DEVELOPED AN INNOVATIVE AND SUSTAINABLE APPROACH TO WATER PROBLEMS IN SOUTHERN CALIFORNIA. HER WORK ALSO HAS GLOBAL IMPLICATIONS.

By Anna-Catherine Brigida

Los Angeles has a shortage of drinking water. The city's western neighbor, the Pacific Ocean, could help solve this problem. But salt water needs to be purified first through the process of desalination, which can be energy-intensive, expensive and harmful to the environment.

But Amy Childress, professor in the Sonny Astani Department of Civil and Environmental Engineering, is working on a concept to make desalination more energy-efficient and environmentally friendly. Childress and her colleagues are the first researchers in the country to pilot the RO-PRO, short for Reverse Osmosis-Pressure-Retarded Osmosis water-desalination system, a process inspired by a similar system utilized in Norway by Statkraft, Europe's largest renewable energy company.

Reverse osmosis is a water purification technology whereby water passes through a membrane that separates the water into two streams—a purified stream and a concentrate stream containing salt that must be disposed of.

Childress's process has two benefits: Not only is the energy needed for reverse-osmosis desalination reduced, but so is the concentration of the brine water going into the ocean. Excess salt can create an imbalance that can threaten the sea's ecosystem.

RO-PRO offers more energy-efficient way to desalinate water than other techniques. Bloomberg reports that up to 50 percent of costs for water desalination plants are related to energy use.

Childress's research is particularly important in Southern California, which has unique water problems. Much of the region's water—up to 66 percent, according to the West Basin Municipal Water District, which provides water to 17 cities in Southern California, including Los Angeles—comes from Northern California or the Colorado River. Not only is this expensive, but it is also unsustainable. While Southern California does not currently take advantage of ocean water as a potential source of drinking water, Childress's research could help change that.

Furthermore, the Southland is currently vulnerable to suddenly losing access to its imported water in a major earthquake. Converting ocean water into potable water could help mitigate this risk and increase regional water independence.

"Seawater desalination and wastewater reclamation are highly relevant, especially in this part of the country," Childress said of her decision to return to the city where the UCLA alumna earned her doctorate. "Southern California is the epicenter of environmental decision making."

Many water agencies are looking to research such as Childress's to help expand their water portfolios. The West Basin Municipal Water District wants to reduce its imported water more than one-third by 2020.

"For us in Southern California, we have always been looking at local supply alternatives," said Shivaji Deshmukh, assistant general manager at West Basin. "We feel it is our responsibility to consider seawater desalination."

Childress's work has global implications, as water shortages affect numerous areas. In recent years, she has lectured all over the world, from Korea to Kuwait. Southern California, however, is often the testing ground for innovative new technologies.

"A lot of the innovation in water treatment has happened in Southern California because it has its own water problems," Deshmukh said. "It's very fitting and we are very excited to have Dr. Childress here."

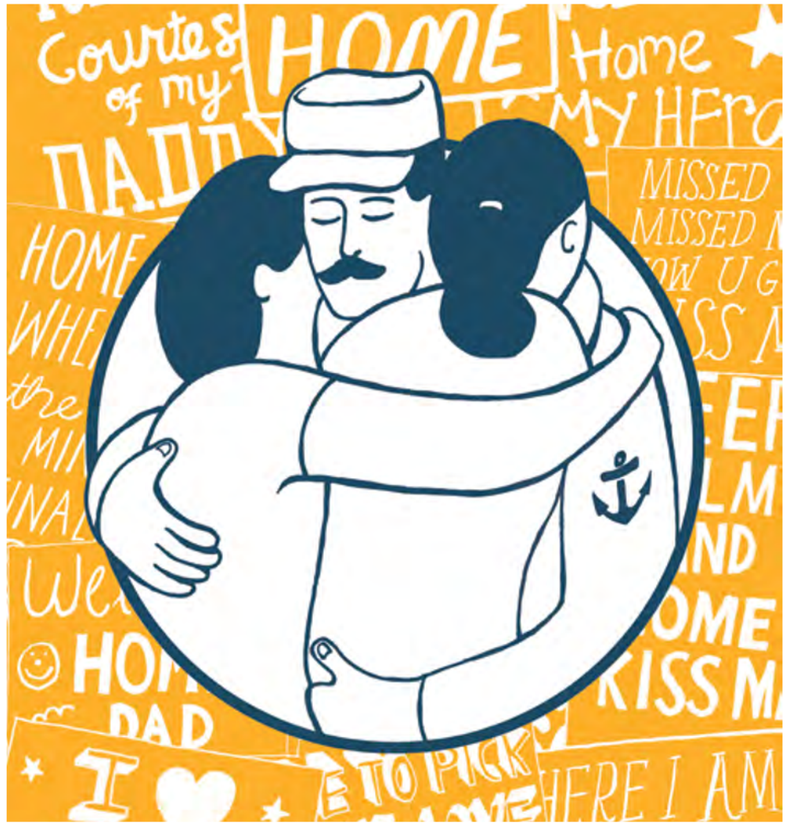
To support this or other research at USC Viterbi, please visit viterbi.usc.edu/giving/

PHOTO: NOE MONTES

VITERBI STUDENT GOES ALL OUT FOR NAVY SEALS

Maggie Hill feels for children whose parents are gone.

By David Haldane



A sign in an airport terminal changed Maggie Hill's life. It was 2009, and Hill—then a high school freshman—was passing through a baggage claim area at Dallas/Fort Worth International Airport with her sister and father when she noticed two children holding a banner reading "Welcome Home."

What happened next etched the scene into her memory like a butterfly in glass. Two uniformed military officers sprinted off the plane to embrace their joyful kids. "It made me realize how lucky I was to be with my dad," Hill recalled. "It made me think about others who aren't."

That was the inspiration for HillTeam3, a nonprofit organization she founded to help the families of fallen or deployed Navy SEALs. Hill, 19, plans to continue the group's work at USC, where she is now a freshman mechanical engineering major and Mork Family Scholar at the USC Viterbi School of Engineering. "I want to take it national," she said, "and I would love to do something here."

Hill is no stranger to the military. The daughter of a mechanical engineer who runs an aerospace company with major defense contracts, she grew up in Phoenix and spent summers at her family's beach house in Coronado, home to the Navy SEALs. She decided early to follow in her father's footsteps. "I'm 100 percent a daddy's girl," Hill explained. "Seeing the places he went, the people he met and the impact he had really impressed me."

Family tradition held that she would attend Notre Dame, which accepted her last year. An interview at USC, however, changed her perspective. "I stayed with an engineering student at Pardee Tower who was so adorable and personable that I thought, Wow, I really have to consider this," Hill said. "The people here are so normal."

What sealed the deal, though, was a letter from the university offering her a Mork Family Scholarship. Named after John Mork, a 1970 USC petroleum engineering graduate and university Trustee whose Denver-based Energy Corp. of America explores, develops and sells oil and natural gas primarily from the Appalachian Basin and Gulf Coast regions of the U.S., the scholarship provides full tuition and a living stipend.

"She was just impressive across the board in the way she presented herself," recalled Louise Yates, senior associate dean for admission and student affairs at Viterbi, who interviewed the prospective scholar. In addition to Hill's academic achievements, "we were impressed by her co-curricular activities, [which show that] she can balance her time and her interests."

So far Hill seems to be doing just that. Living in New North residential hall, she's managed to keep up with her studies as well as participate in the activities of Kappa Kappa Gamma sorority. Closest to her heart, though, is the work of HillTeam3, a moniker derived from Hill's last name and the fact that it involves three family members: herself, younger sister Lexie and father John.

Created in 2010, the nonprofit raises about $50,000 annually, mostly through organized fundraisers and on its own website, for the Naval Warfare Family Foundation, a Coronado-based organization that uses the money to support the families of fallen or deployed Navy SEALs. "I'm very proud of her," said her father, John Hill, vice president of NAMMO, a Mesa, Ariz., company that manufactures weapons for the U.S. military. "She's done everything right."

HillTeam3's biggest event, he said, is the NWFF's annual Christmas party, held in a hangar at the Naval Amphibious Base Coronado. Last year's party entertained 1,000 children and featured Santa Claus parachuting from a helicopter. Hill and her family also sponsor an annual fundraising dinner and auction, and contribute to other events year round.

The 7- and 10-year-old sons of one SEAL lieutenant, who requested anonymity, have attended many of those events during his numerous deployments, including two to Iraq. "It definitely takes the pressure off your thoughts," he said. "The weight is lifted off your mind, providing you a little extra space for the here and now, which in combat means not stepping on a bomb or getting killed in a firefight."

John McTighe, special assistant to commander naval special warfare and a retired SEAL captain himself, gives all the credit to people like Hill. "In a word, they're fabulous," he said of Maggie Hill and her family. "They recognized a need and found a way to pay back."

The next step, according to Hill, is to get her sorority involved. "I'd love to have T-shirts," she said.

ILLUSTRATION: JOSE HERNANDEZ

ENGINEERING LAUGHTER

Greg Grabarek studies biomedical engineering and comedy.

By Katie McKissick

Greg Grabarek delivers an engineering joke on stage.

At the Ground Zero café on the USC campus, Greg Grabarek, 19, wields a microphone in front of a spotlight on the small stage.

"If we go to Disneyland and you go on the rides, it's like Splash Mountain—you get it. The mountain, the splash—there's a whole theme going on. You go on the Haunted Mansion—it's a house, there's ghosts. It makes sense. If you go to Six Flags you get Ninja… What's Ninja? Am I the ninja? Am I riding on a ninja? Am I fighting a ninja on a train? What is the theme? There is no theme! What is the mythos of the ride Ninja? I don't understand."

Grabarek is a USC Viterbi biomedical engineering undergraduate student by day and a standup comedian by night. Originally from Chicago, he found inspiration in the comedy of Pete Homes, Chris Hardwick and Scott Ackerman, among others. When he came to USC, he decided to take advantage of an open mic night opportunity and began his foray into comedy.

Since then, Grabarek has appeared in three different TV shows on TrojanVision, USC's student-run TV station: *Platforum*, *Trailer Park* and *Showcase*. *Platforum* is a discussion program, and Grabarek appeared on its entertainment and current events shows. *Trailer Park* reviews movie trailers, and Showcase highlights USC-made student films.

Grabarek's appearances aren't limited to the USC campus. He has performed at open mic nights around LA, and has appeared at the Laugh Factory.

Getting started was the hardest part, he said, because it can be very intimidating, especially when you don't know how the audience will react to you and your material.

Grabarek's life in comedy does not usually cross paths with his studies as an engineering student. "I do, however, think science and engineering promote a type of critical analysis that is really helpful in comedy or writing in general," he said. "It asks you to question, 'OK, but why does this work?' or more likely, 'OK, why is this a total failure?' which is a great road toward a comedic perspective."

Although not normally a purveyor of one-liner comedy, Grabarek drew on his engineering education to write some USC Viterbi jokes definitely worthy, as he says, of a Popsicle stick.

Which mathematical plane would you need to locate the star of *Parks and Recreation*? Poehler coordinates.

My hands always hurt when I drive underground with other people in my car. The doctor says I have something called carpool tunnel.

Where do pachyderms go to study neuroscience? The hippocampus.

I'm really tired of explaining Archimedes principle to other students. Honestly, how dense can you be?

I'm not in a fraternity, but I've solved for θ and ω so many times I'd like to think I understand Greek life.

I'm working on a screenplay for a romantic comedy about an engineer who can't seem to juggle both school and her love life. It's called *Constance and Variables*.

What do you call diabetic patients who don't listen to their doctors? Insulent.

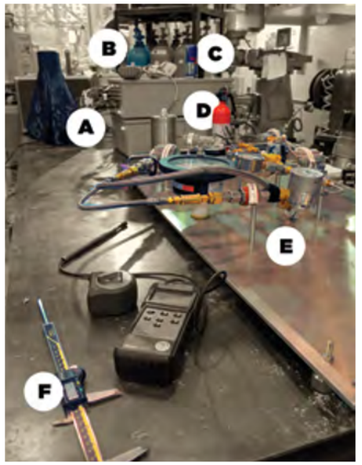
Have you heard about the new dance craze where kids gyrate in a circular motion? It's called torqueing.

PHOTO: NOE MONTES

*You can see a very special performance by **Greg Grabarek** by visiting **viterbi.usc.edu/comedy***

WHAT'S ON YOUR DESK?

USC Rocket Propulsion Laboratory operations manager Jordan Noone describes the tools of the trade.



(A) Silver Spur III: Launched in 2010, this is our second-highest-performing rocket to date. Unfortunately, after its supersonic flight to 59,000 feet, its parachute failed to deploy, and the rocket impacted the ground nose first, at almost the speed of sound. The force of the impact was so great that the rocket actually buried itself 7 feet into the dry lakebed; the fins seen here were the only visible part.

(B) Nitrogen bottles: The lifeblood of propulsion projects, used and abused to pressure, clean and suffocate anyone who used too much at once.

(C) Red Bull: During intense build periods, people sometimes work 50 or even 100 hours a week, which often requires some "wings." During the build of RPL's first space shot attempt in the fall of 2011, Traveler I, the fraternity Beta Theta Pi donated an entire pallet of Monster energy drinks that was about 6 feet tall.

(D) Fire extinguisher: Naturally, building rockets involves a lot of flammable materials, but it is usually the things you don't expect to cause a fire that can be the most dangerous—various electronics sparking or overheating and cups of liquid adhesives known as epoxies randomly catching fire. Luckily, we have never had to discharge an extinguisher in the lab.

(E) Calipers: As RPL makes incredibly high-performance vehicles, this requires extremely high-quality parts. Sizing errors on the order of 0.01 inches—much less than the thickness of even a penny—can be the difference between a successful or an unsuccessful part and therefore rocket.

SCAN THIS QR CODE
on your smartphone or visit http://goo.gl/RoEHpN to stream all of the tracks.

Playlist:

A THEME SONG OR ANTHEM FOR USC VITERBI

If USC Viterbi had a theme song, what would it be? An epic rock ballad to play in the lab? An inspiring song to give you a shot of adrenaline during an all-nighter? Or maybe a catchy club jam to revel in the glory of acing an exam? We asked current and former students for their song nominations. Read what they had to say.

► Brent Caldwell:
If I had to think of one song to be the anthem of USC Viterbi, I would say it would be **"On Top of the World"** by Imagine Dragons. *It is fun and upbeat and to me represents perseverance and working hard, yet also reminds us to slow down once in a while and appreciate our accomplishments and surroundings.*

► Lindsey Heineman:
"Take on Me" By A-ha—Loni, Lindy Liggett, Phil Mellinger, Jake gizmo Iverson. *Finishing a 404 project minutes before midnight was never so exhilarating!*

► Jay Jimenez:
The Big Bang Theory theme song *by the* Barenaked Ladies. *The song is about science on a show that has made science cool and funny. "Math, science, history, unraveling the mysteries, That all started with the Big Bang!" Plus, who doesn't love Big Bang? Bazinga!*

► Steve Escalante:
"Can't Hold Us" by Macklemore & Ryan Lewis. *The driving tempo reflects the startup's pace of innovation and the high-energy atmosphere of working for success. Themes of perseverance, hard work and limitless possibilities. "Put our hands up like the ceiling can't hold us."*
Added bonus: The @USCTMB already knows "Can't Hold Us." Available for live performances, weddings, fundraisers... #Synergy

► George Chien:
Let's bring it to the new horizon with **Einleitung of Also sprach Zarathustra**, by Richard Strauss.

COMING HOME

A strong family support system and USC outreach programs for underserved students helped Eduardo Avila realize his dream of attending USC Viterbi.

By Marc Ballon

USC long held a special place in Eduardo Avila's heart.

"When I was younger, I would walk by USC and tell my mom I wanted to go there," Avila said. "She would laugh and say if I worked hard, I could do it."

The odds appeared long. Neither of Avila's Mexican immigrant parents went to college, and he grew up in a hardscrabble neighborhood.

With a determination and grit as expansive as his intellect, Avila overcame any and all challenges to realize his dream. In fall 2013, the 18-year-old Manual Arts graduate matriculated as a student in the USC Viterbi School of Engineering.

"I'm so happy to be here," said Avila, smiling, as he sipped a coffee drink at a campus Coffee Bean teeming with students. "This is the first of many goals I want to accomplish."

His was an arduous journey. Avila graduated from high school with a nearly 4.1 GPA, despite taking several Advanced Placement classes, including calculus, history and government. To prepare for the many robotics competitions that he competed in, Avila learned three computer program languages and mentored teammates. Some weeks, he logged in about 100 hours between school, homework and preparing for robot and other engineering-related tournaments.

"In spite of the fact that he had every opportunity to fail, to throw away his talents, to get involved with drugs, to get involved with gangs, he stuck with it. Now he's at USC," said Viterbi School alumnus Michael Ortega, who mentored Avila through the USC chapter of the Society of Hispanic Professional Engineers. "I'm so proud of him."

His parents' love and support, Avila said, have given him a strong foundation for future success. A USC outreach program designed to increase the number of educationally disadvantaged students earning university degrees in science, technology, engineering and mathematics, or STEM fields, helped him to blossom intellectually.

Founded at UC Berkeley in 1970, MESA, now a national program, "motivates and prepares mostly low-income, minority students to go to college in STEM fields and later work in areas they might never have known existed," said Larry Lim, director of Pre-College Programs at the Center for Engineering Diversity at USC Viterbi.

USC's MESA, which the university launched in 1977, offers academic support, hands-on math and science competitions, and leadership training to 1,300 students at 27 area middle and high schools. As a measure of USC MESA's quality, more than 97 percent of recently participating seniors went to college, including USC, MIT, UC Berkeley and Brown University, Lim added.

Avila joined the program his freshman year at Manual Arts. Through it, he honed his leadership skills as team captain, deepened his mathematic and engineering skills, and received mentoring from professional engineers.

He also developed a love for robots.

Avila literally spent thousands of hours over the years working with his Manual Arts teammates to create algorithms and build robots that could kick a soccer ball into a goal, climb a pole and pick up objects, said John Santos, Avila's ninth-grade teacher and MESA adviser for four years.

Under Avila's leadership, Manual Arts placed eighth in the world in the Zero Robotics Competition, a prestigious tournament sponsored by NASA, DARPA and MIT.

"No matter what the situation, Eduardo would find a way to succeed," Santos said.

To ease his transition to USC, last summer Avila enrolled in Summer Bridge, a six-week program for students who might need extra assistance. Avila said he learned much during his first semester at USC Viterbi. "I'm happy," he said.

Of the 2,200 USC Viterbi School undergraduates, about 18 percent are African American, Latino or Native American, according to Traci Thomas Navarro, director of USC Viterbi's Center for Engineering Diversity. Attracting talented minorities like Avila helps fuel innovation, she said, "because you need a diverse group with different ages, ethnicities and backgrounds to approach the Grand Challenges from a unique perspective."

Avila's next goals: to earn good grades and enroll in a master's program in aerospace engineering.

"Whatever I end up doing, I want to be one of the best in my field so I can help others reach their own goals," he said.

LORD OF QUIDDITCH

Computer science student Nicky Guangorena programs and plays.

By Marc Ballon

Nicky Guangorena wields his quidditch broomstick proudly.

"You always have to account for all the possibilities and variables that are going on in the middle of a play."

Not many sports require players to have a broom between their legs at all times, but quidditch isn't your average sport.

On the USC quidditch team, players wear white jerseys with red stripes and the USC quidditch emblem. Often spotted in cardinal and gold knee socks, the team members race between two sets of lofted hoops throwing the quaffle and bludgers, the balls of the game, aiming for the hoops or opposing players.

Based on the game from the Harry Potter book series, quidditch is a full-contact, fast-moving sport that blends elements from soccer, dodge ball and basketball.

Nicky Guangorena is one of the co-captains of the USC quidditch team. A sophomore in computer science, he balances his studies and the sport he has come to love since he started playing it in high school.

Guangorena, 19, not only enjoys the physicality of the sport, but also likes the challenge of devising plays and strategies on the field, which he finds draws on his work as a computer science student.

"You always have to account for all the possibilities and variables that are going on in the middle of a play," Guangorena said. "The analytic work that I do in computer science where I have to look at a piece of code to see if there are going to be issues with it and debug it, in a sense is sort of like looking at a play and seeing how it's all going to work and whether or not somebody from the other team can mess it up by doing a single clever move or by being in the wrong place at the wrong time. So you always have to account for all these variables and try to mix it up,and keep it working. Try to keep your plays moving in the same way you have to keep your code working."

Quidditch is unique in that it is the only full-contact coed sport at USC. Guangorena, who played baseball, soccer and basketball before quidditch, likes the team atmosphere that comes from a mixed-gender sport. "It makes you respect everyone as a person, a player. They're equal. You're all doing the same sport—you're all playing the game."

While it is based on a series of adored fantasy books, quidditch has become a sport that stands on its own two legs (and broom, as it were). Players love quidditch apart from their love for Harry Potter and want it to be seen as a stand-alone sport. Since it was adopted in 2005 at Middlebury College in Vermont, it has spread to 300 universities and high schools throughout North America, Australia and Europe. The governing body, the International Quidditch Association, today hosts nine regional championships, the World Cup, International Open, Global Games and QuidCon.

The USC quidditch team was founded in 2010, and since then has competed in the World Cup in 2011 and 2013, and will again in 2014.

Quidditch Rules for Muggles

Each team has seven players on the field at one time: three chasers, two beaters, one keeper and one seeker.

The chasers handle a ball called the quaffle, which is usually a partially deflated volleyball. The chasers' goal is to throw the quaffle through one of the three elevated hoops at either end of the field.

Beaters handle bludgers, which are essentially dodge balls. Beaters try to strike the opposing team's chasers with them. When chasers are hit with a bludger, they must return to their end of the field before they are considered in play again. This is an effective way to stop them from scoring points.

The keeper is the goalie and protects the three hoops from the onslaught of the chasers.

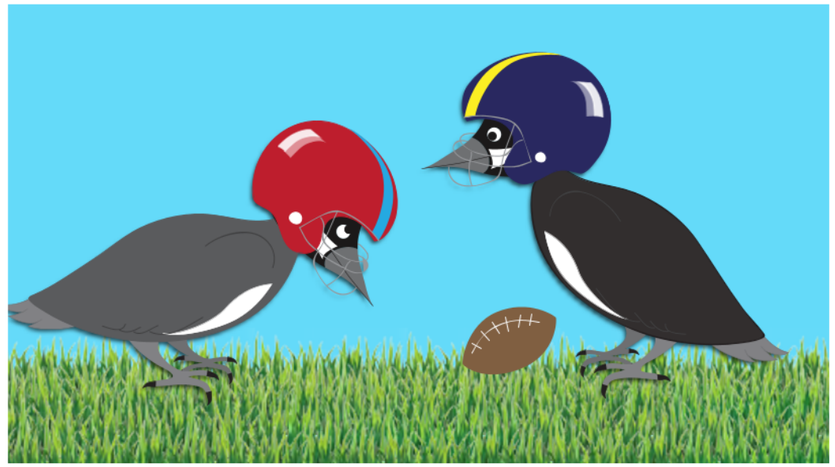
The seeker is in charge of capturing the golden snitch. In the Harry Potter world of magic, the snitch is a golden ball with delicate wings that flies quickly and unpredictably around the field. In "muggle," or magic-free, quidditch, the golden snitch is played by a person. This impartial player has a tennis ball in a sock tied to his or her waist. When a seeker retrieves that ball from the snitch, the game is over.

PHOTO: NOE MONTES

BIRD BRAINS

What the NFL can learn from woodpeckers.

By Katie McKissick



The bones of the woodpecker's skull hold valuable information about how we can design better helmets.

Andrew Luck may be among the toughest quarterbacks in the National Football League. In his rookie year alone, he was sacked 41 times, with hits as powerful as 150gs—three times the force of an F-16 barrel roll. But he's got nothing on Woody Woodpecker.

It's true: Woodpeckers can handle 10 times the force on their heads that we can. Over and over and over.

Professor Veronica Eliasson of the USC Viterbi Aerospace and Mechanical Engineering Department specializes in shock waves and is interested in how they (and other waves such as stress waves) affect the brain. "That's why we decided to look at woodpeckers," Eliasson said. "They're such remarkable animals. How do they protect themselves? How did nature make this happen?"

These woodland birds are famous for their tireless and noisy efforts to chip holes into hardy trees with jackhammer-like force. When a woodpecker pierces the side of a tree to make space for a nest, it slams its beak into the bark 20 times per second, thousands of times per day. The force this puts on its head is upwards of 1,200gs, or 1,200 times the force of gravity.

We humans can only handle about 80-160gs of force without sustaining traumatic brain injury, which can cause devastating and chronic problems like crippling headaches, loss of balance and coordination, impairment of concentration and memory, even personality changes.

Brain damage has become part of national discourse because of the wars in Iraq and Afghanistan and the number of returning soldiers with traumatic brain injuries (TBIs) as a result of bomb blasts. The effects of the concussion crisis in the NFL have also made us question the limits of our brains and what long-term damage shock waves may cause.

The average human brains weighs just 1.5kg, or 3 pounds, but within its fleshy folds lies the source of every thought, feeling and action we will ever experience. Among the billions of neurons connected by trillions of connections, or synapses, our unique personality emerges. We are our brains.

The slow process of evolution ensured that our brains have some protection from outside forces. We are equipped with the thick bones of the skull, and inside the brain cavity the brain tissue is surrounded by a bath of cerebrospinal fluid. But despite these protections, the brain is still a vulnerable lump of soft tissue that can be easily damaged by shock waves.

But what exactly is a shock wave?

A shock wave is a blast of energy that travels faster than the speed of sound, and it can occur in gases, liquids or solid substances. Shock waves carry an enormous amount of energy, and if that is transferred to our brains, it can have disastrous consequences.

How do these small, seemingly delicate birds sustain 10 times the force we can without damaging their brains? And what can we learn from them?

To study forces on a woodpecker's unique skull and brain cavity, Eliasson's research group built a model of a woodpecker mimicking the range of impact force, the acceleration and deceleration, and the impact time of a real woodpecker. By attaching it to a motorized arm, they approximated the experience of a woodpecker chipping away at a tree trunk. With this they measured the pressures and strains the brain cavity of the bird is actually being exposed to.

But that's just half of the problem. We also need to know how much force brain cells can absorb without dying and how networks of brain cells handle the stress.

For this, the researchers partnered with neuroscientist Dr. Parijat Sengupta at Washington State University. Sengupta prepared a thin film of neuronal networks made of mouse brain cells for the project. The researchers exposed these networks to various strengths of impacts and a varied number of impacts to see where the threshold lies for neural stress and damage.

Helmet technology has been relatively stagnant for the past 30 years. The newest helmet made by Riddell, the most popular helmet maker in American football, is called the "360." Describing its design, Riddell's website explains that "with previous helmet models paying special attention to addressing side impacts, a crucial design challenge emerged: find new ways to manage energy to the head from frontal impacts. Not only did the data align with this challenge, the team evaluated several helmets returned to Riddell for reconditioning and research that demonstrated significant wear and tear to the front of the helmet and facemask. Tapping this data, evaluating used helmets firsthand and relying on their knowledge from years around the sport, the 360 was born."

We may have exhausted the insights we can gain from examining current helmets and updating the same basic design. We need to incorporate inspiration from one of the most time-tested designers out there: nature.

With information about brain cells' susceptibility to repeated impact damage combined with knowledge of how stress waves propagate around and through the woodpecker's skull, we can better understand how nature has built an effective structure to protect its brain. With this insight, we can design better helmets that can keep soldiers' and football players' brains as protected as a woodpecker's.

To support this or other research at USC Viterbi, please visit viterbi.usc.edu/giving

ILLUSTRATION: GREER FRESHWATER BURTON

SAVE THE ANIMALS

PAWS, an "intelligently" randomized scheduling system, holds the promise to frustrate poachers in Uganda and elsewhere.

By Marc Ballon

At Queen Elizabeth National Park in Uganda, only 79 rangers patrol the massive park's 1,900 square kilometers, or one ranger for about every 24 kilometers.

At Queen Elizabeth National Park in Uganda, poachers win more often than not, to the detriment of local animal populations.

Because of limited resources, only 79 wildlife rangers patrol the park's more than 1,900 square kilometers, or one ranger for about every 24 kilometers. Compounding matters, some neighboring villagers inform poachers of rangers' comings and goings, making it easier for the bad guys to pierce the already porous security network.

The result: the slaughter of cape buffalo, waterbuck, warthogs and giant forest hogs, which are served up locally and exported illegally as "bush meat." Additionally, poachers target lions, leopards and hyenas for their skins and teeth and to eliminate potential threats to livestock. They kill elephants for their ivory.

USC Viterbi computer scientist Milind Tambe and his team—including collaborators Andrew Lemieux, a criminology researcher who works closely with the Ugandan national park, and USC Viterbi PhD students Rong Yang and Benjamin Ford—hope to put an end to the carnage. Tambe, a renowned expert in creating randomized patrol schedules to thwart terrorism and other crimes, has leveraged that knowledge to build a new security system to protect against poaching.

"The ecosystem is thrown out of balance by poaching, and there are unintended, unforeseen and adverse consequences as a result," Tambe said. "I think we can make a contribution in the fight against it."

The Protection Assistant for Wildlife Security, or PAWS, will create "intelligently" randomized schedules for ranger patrols, using complex algorithms. Randomization optimizes the use of limited security patrols by making it impossible for would-be poachers to determine when a particular area will be protected. Intelligent randomization, a core of PAWS and Tambe's other security systems, means that software programs ensure that rangers will make more visits to areas most targeted by poachers.

Since 2007, Tambe and his team have rolled out intelligently randomized scheduling systems used by the U.S. Coast Guard, the Transportation Security Administration and the Federal Air Marshal Service to protect American ports, airports and airplanes.

Tambe's research is rooted in mathematical game theory, which tries to predict how conflict might play out between adversaries. According to the Bayesian Stackelberg game theory, the offense (in this instance, the poachers) observes the defense (park rangers) to identify and exploit any possible security weaknesses. PAWS' rigorous game-theoretic modeling and algorithms stymie the bad guys by creating randomized schedules with no discernible patrol patterns.

Information gleaned from studying past crimes and from apprehended poachers will help create better algorithms for models, resulting in ever more effective patrols, Tambe said. He expects Queen Elizabeth National Park officials to test PAWS this spring.

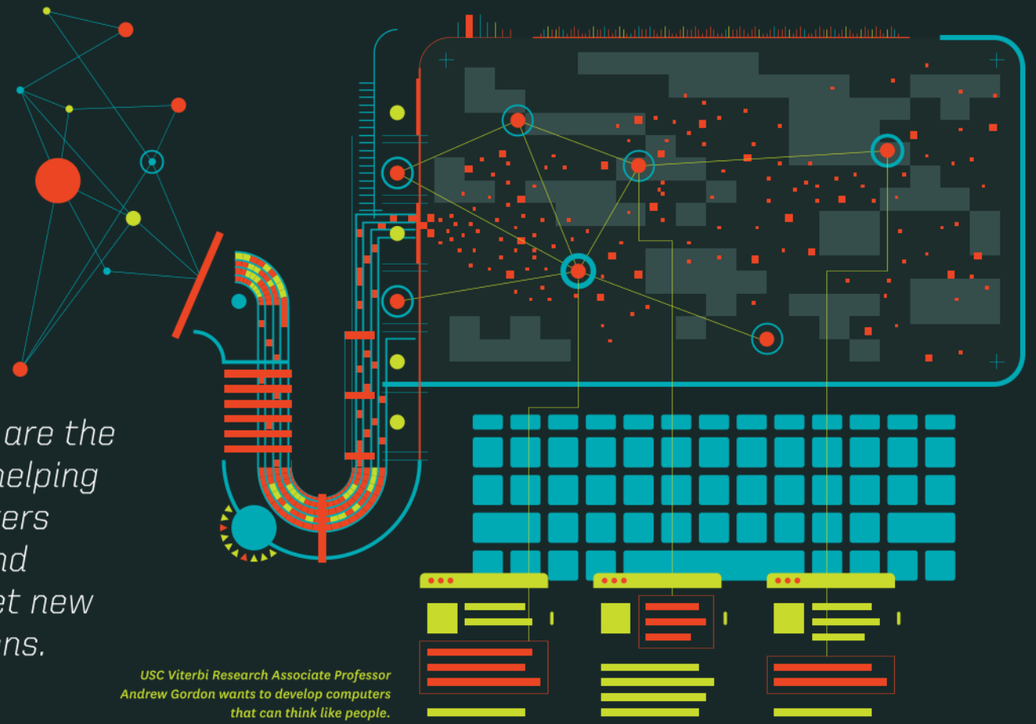
PAWS has attracted widespread interest. Mahendra Shrestha, head of the Tiger Conservation Partnership program at the Smithsonian Conservation Biology Institute in Washington, D.C., has met with Tambe and his team to discuss the system's benefits.

"There is definitely a good potential to join forces with PAWS for better tiger conservation and for their recovery in the wild," said Shrestha, noting that poachers have wiped out more than 97 percent of the world's tiger population over the past century. "I see a great possibility to use the expertise of Dr. Milind Tambe and his team at USC."

ILLUSTRATION: DAVID MEYERS

DRIVEN BY THE EXPERIENCE

By Orli Belman



Stories are the key to helping computers think and interpret new situations.

USC Viterbi Research Associate Professor Andrew Gordon wants to develop computers that can think like people.

Computer scientist Andrew Gordon counts jazz legend Charlie Parker among his greatest inspirations. Gordon, a USC Viterbi research associate professor, is a serious student of improvisational jazz, but Parker's influence also permeates Gordon's advances in artificial intelligence research.

"When you listen to Charlie Parker play a saxophone solo for the first time, it sounds like an explosion of raw invention," said Gordon, who leads the Narrative Group at USC's Institute for Creative Technologies. "After analyzing dozens of his improvisational solos, however, I realized his brilliance came from creative reuse. Nearly everything he played was stitched together from something he or someone else played previously."

In other words, Charlie Parker's greatness was grounded in experiences.

Gordon's goal is for computers also to learn from experiences—experiences people share when they narrate and interpret the events of their lives. Driven by a desire to develop machines that can think like people, he is identifying, collecting and studying stories in order to give computers knowledge they can apply in new situations.

His narrative research intersects with many of the multidisciplinary topics explored at the 15-year-old ICT, a research center established at USC by the U.S. Army to advance the state of the art in simulation and training. Story is a common thread throughout the institute, which specializes in the creation, study and use of believable characters and scenarios.

"Soldiers swap war stories for a reason," said Gordon, whose current work is funded by the Army, Navy and Defense Advanced Research Projects Agency, also known as DARPA. "They help people explain why things happened and predict what will happen next. They serve to pass on knowledge of things that people didn't go through themselves."

USC, home to the world-famous School of Cinematic Arts, is a natural fit for someone interested in narrative. What is unusual is to find this focus in a department of computer science, where Gordon's research ranges from basic science analyzing the structure of stories to the development of training video games that incorporate real-world lessons. He has turned the Internet into a living laboratory by collecting and analyzing millions of personal accounts posted on blogs. He even developed a documentary about the bloggers he studied.

Gordon's overarching challenge is to understand the processes that produce stories and program computers with the same interpretive powers.

Take the following phrases: The birth of your child. The foreclosure of your home. The crashing of your Porsche.

"These experiences will have enormous significance in your life, evident in the stories you tell, but for today's computers they are only syntactically similar noun phrases," Gordon said.

In essence, Gordon, who earned his doctorate in computer science at Northwestern University, is trying to pass along the mental algorithms that make people creative. It is here where Gordon's other lifelong pursuit, mastering improvisational jazz, has come in handy.

Though Gordon can't duplicate Parker's ability to draw upon a rich database of musical solutions (yet), he has given computers a vast library of source material to pull from in the form of other people's stories.

He developed a pipeline for the automatic collection of tens of millions of personal stories from streams of online blogs. This database led Gordon's former PhD student Reid Swanson to develop an interactive storytelling system called Say Anything, in which a human and a computer take turns adding new sentences to a story.

"The human's contributions are limited by their own ingenuity, but the creative contributions of the computer come from the enormous body of source material in the nonfiction narratives posted to blogs," Gordon explained. "It is an improvisational storytelling program, inspired by Charlie Parker."

Gordon has learned that jazz improvisation requires the ability to seemingly automate the production of sounds on an instrument before any emotion can be layered in. A musician must master the basics so that he doesn't have to think about the sounds he is going to make. It is a concept that Gordon brings to his latest interactive storytelling project, which aims to automatically generate narratives by interpreting the movements of geometric shapes.

"In this project, we train our software to recognize action verbs by giving them tens of thousands of examples," he said. "We're teaching these programs to effortlessly recognize actions like jumping, pursuing and hobbling, so that they can spend more of their computational effort thinking about the deeper-level intentions, motivations and emotions of the characters that they are observing."

According to Gordon, for many listeners jazz improvisation seems unconstrained. In reality, jazz is quite structured, and the genre has a rich catalog of reoccurring structural idioms.

"I used to wonder how it was possible for great players to memorize around one thousand jazz standards, each with dozens of different chords," Gordon said. "Now I hear each song as a collection of a handful of idioms, stitched together using one or two defining ideas."

Gordon relates this revelation to his collaboration with USC's Brain and Creativity Institute exploring the neurobiology of narrative framing, a project that aims to compare the structural differences in the ways that narratives are told and received across different cultures.

"Each language and culture has their own ways of describing past events, providing background information, introducing concepts, justifying behavior and making points," Gordon explained. "The aim is to enable more effective storytelling across cultures by adhering to the structural conventions of specific audiences."

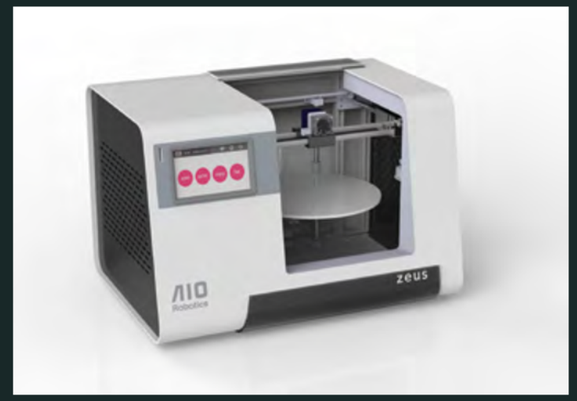
No matter the language or the skill level, one thing Gordon says both jazz improvisation and storytelling have in common is that each is most effective when something personal is being shared. It is likely Charlie Parker would agree. When Parker's friends once asked him why he liked country music, he said, "The stories, man. Listen to the stories!"

If Andrew Gordon has his way, future computer systems will be able to do just that.

A "GAME-CHANGING" 3-D PRINTER

Zeus, the world's first all-in-one 3-D printer and the creation of two USC Viterbi PhD students, promises to upend the market.

By Marc Ballon



AIO Robotics, a company launched out of the USC Viterbi Startup Garage, offers the world's first all-in-one 3-D printer.

A Los Angeles-based jewelry designer creates what he thinks is the perfect engagement ring. He takes his wax prototype to the local post office and overnights it to his company's chief designer in New York.

The next day, his boss calls to give feedback. She likes the ring but thinks he should add a couple of small hearts. He agrees and goes back to work. The following day, he again overnights a new prototype. This time, the chief designer approves.

The entire process takes three days, including two trips to the post office and shipping costs. Might there be a better way?

Now, thanks to AIO Robotics, there is. The company, led by two USC Viterbi School of Engineering PhD students and launched out of the USC Viterbi Startup Garage, has begun production on the world's first all-in-one 3-D printer that prints, scans, copies and faxes. So hot is Zeus, as the device is named, that it surpassed its $100,000 Kickstarter fundraising goal in just 24 hours.

"We offer the easiest to use 3-D printer on the market," AIO Robotics CEO Jens Windau said. "All you have to do is push the copy or fax button."

Imagine if in the above example the LA jewelry designer and his New York-based supervisor both had Zeus 3-D copiers. As soon as the designer finished the first prototype, he could have placed it in Zeus and pushed the fax button, which would scan the object and send data over the Internet. Fifteen minutes later, his boss's machine would have printed an exact replica by extruding plastic through the Zeus's printer nozzle. After a quick consultation, the designer could have quickly produced a new ring with hearts and faxed it again.

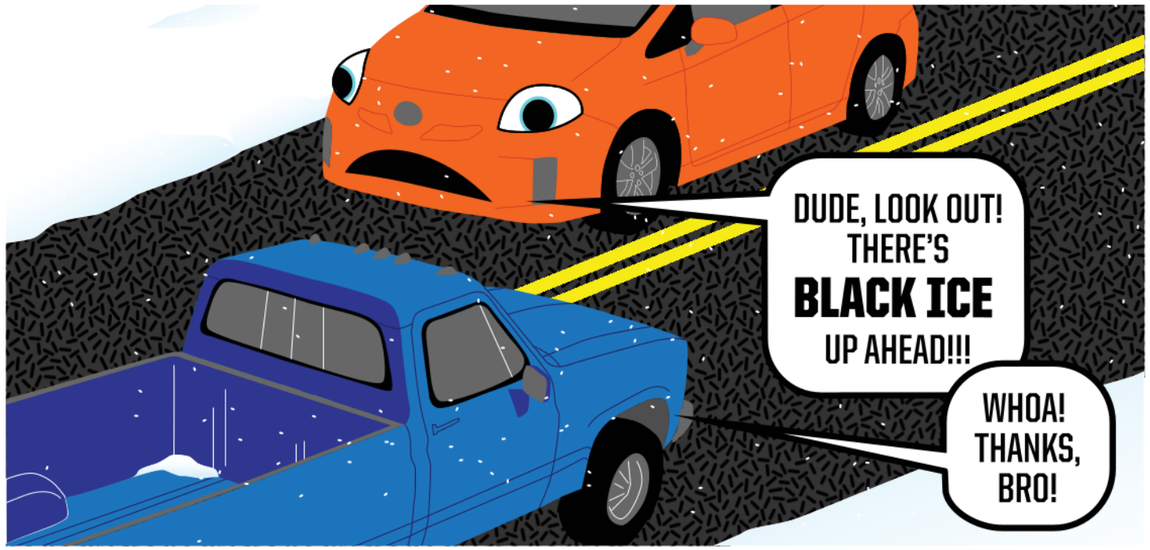
No trips to the post office. No delays. No hassles. Perhaps that's why Forbes.com has called Zeus a possible "game changer."

ILLUSTRATION: ERIC FROMMELT

"Bonjour, My Name Is Peugeot!"

By Marc Ballon

Electrical engineer Bhaskar Krishnamachari's research could make it possible for vehicles to "talk" to each other to improve safety.



On a four-lane highway outside Minneapolis, cars going 55 mph slip and slide over a hidden ice patch. Vehicles drift dangerously into adjacent lanes. Twenty-five minutes later, a car swerves into oncoming traffic, badly injuring four people and closing the highway for hours. Authorities report similar accidents in Cleveland, Milwaukee and Detroit.

Thousands of miles away, a steady rain pummels Southern California. The heavy precipitation, combined with poor road maintenance, results in a massive pothole on a busy stretch of Olympic Boulevard. A few automobiles are thrown out of alignment. An hour later, a speeding Porsche runs over the huge crater, jumping the sidewalk and slamming into a tree. The driver lives but suffers serious internal injuries. Traffic comes to a standstill.

The above scenarios are all too common. However, USC Viterbi faculty member Bhaskar Krishnamachari hopes to make them a thing of the past. The 35-year-old associate professor of electrical engineering has spent nearly a decade working on algorithms and software to make it possible for cars to "talk" to one another by sending messages through an ad hoc wireless network.

Cars talking to each other? Yes, and they have important things to say. Krishnamachari imagines vehicles one day alerting one another of impending dangers such as potholes and icy roads to prevent accidents, injuries and the accompanying traffic jams.

"I see this as a kind of early warning," said Krishnamachari, who the *MIT Technology Review* named in 2011 as one of the world's 35 top innovators under the age of 35 for his work on next-generation wireless networks. "If I know what's coming up ahead of me, I can be prepared for that and slow down, take evasive action and, if I know about the problem a few intersections ahead, even take a different route."

Added Shahram Ghandeharizadeh, a USC Viterbi associate professor in computer science and an early project collaborator: "This is all about information, having information at the right time at the right place. This information can save lives."

As envisioned by Krishnamachari, sensors in vehicles would alert internal computers of potential trouble. The computers would then process the information about potholes, icy roads and the like, which would be shared with nearby vehicles over radio waves.

Drivers heading toward the dangers would receive a warning, perhaps a light on the dashboard or a vocal prompt. The advance notice would allow commuters to avoid problems ahead. To prevent drivers from being inundated with messages, Krishnamachari has designed algorithms that would aggregate warnings to limit the number commuters receive. Other algorithms could determine how long and where such alerts would be disseminated.

And temporary peer-to-peer networks, he added, won't burden the already stretched existing cellular networks.

In addition to their safety implications, Krishnamachari's temporary network of clustered cars has entertainment value—literally. With vehicle-to-vehicle communication, a car could use the network to download a movie or video game for passengers and then share it with nearby automobiles.

Krishnamachari began his talking-car research in 2004 in a collaboration with Ghandeharizadeh. Krishnamachari later partnered with Fan Bai, a researcher at General Motors who earned his PhD at USC Viterbi's Ming Hsieh Department of Electrical Engineering. GM has supported the pair's research since 2008. Bai and Krishnamachari also jointly received a National Science Foundation grant titled "Information Centric Networking on Wheels (ICNoW)—Architecture and Protocols."

"I believe Bhaskar's academic work is pioneering and contributes much to the research community in the vehicle-to-vehicle networking field," Bai said.

The U.S. Department of Transportation and several car manufacturers are currently conducting similar research on vehicle-to-vehicle communication.

So when might a Peugeot say "bonjour" or an Audi utter "guten tag?" Krishnamachari believes the technology might not appear in cars on a large scale for at least another decade. But it's coming.

ILLUSTRATION: GREER FRESHWATER BURTON

MILESTONES IN QUANTUM COMPUTING

By Megan Hazle

USC Viterbi faculty are working to develop our understanding of quantum computing, bringing us closer to a practical quantum machine, the next giant leap in computing. Beyond the silicon-based computers that we rely on today, quantum processors will use atoms and molecules to store memory, and will have the potential to perform tasks exponentially faster than existing classical computing systems.

This timeline shows how we got here.

MAY 1981

Physicist Richard Feynman proposes the first basic model for a quantum computer during his keynote address at MIT's First Conference on Physics and Computation. His model simulates a true quantum mechanical system on a conventional computer.

JULY 1985

David Deutsch, a British physicist at the University of Oxford, formulates the description for the first universal quantum computer, also known as a quantum Turing machine.

NOV 1994

Peter Shor, currently a professor of applied mathematics at MIT, devises an algorithm that solves two major problems in number theory—factoring and discrete logs—by enabling a quantum computer to quickly factor large integers.

MAY 1996

Lov Grover of Bell Labs invents the quantum database search algorithm, which allows a computer to quickly search through an unsorted database to find an item.

DEC 2001

A team from IBM Almaden Research Center reports the successful implementation of the simplest instance of Shor's algorithm in a nuclear magnetic resonance (NMR) quantum computer, using nuclei to store quantum information. This work demonstrates experimental and theoretical techniques for precise control and modeling of complex quantum computers.

SEP 2006

Researchers from USC Viterbi's Ming Hsieh Department of Electrical Engineering demonstrate how entanglement can be used in quantum error correction, or protecting information from errors due to quantum noise. Their "entanglement-assisted quantum codes" act as catalytic codes, enabling quantum communication with only a small amount of initial entanglement.

RESEARCH TEAM:
USC Viterbi EE: Todd Brun; Igor Devetak; Min-Hsiu Hsieh

JULY 2007

The USC Center for Quantum Information Science and Technology (CQIST) is formally established as a multi-school organized research unit within USC Viterbi and the USC Dornsife College of Letters, Arts and Sciences. Its director is USC Viterbi Professor Daniel Lidar. Seeking to promote interaction between theoreticians and experimentalists, USC CQIST hosts the First International Conference on Quantum Error Correction later that year.

OCT 2011

The USC-Lockheed Martin Quantum Computing Center (QCC), which works on algorithm development and solving fundamental physics problems, is formally established at USC Viterbi's Information Sciences Institute (ISI). The center houses a D-Wave One 128-qubit "Rainier" processor, the world's first specialized quantum optimizer.

APRIL 2012

A multinational team that includes scientists from USC builds a quantum processor in a diamond that prevents decoherence and allows the quantum particles to perform a basic test (in this case, searching a simple dataset) at full efficiency.

RESEARCH TEAM:
USC Viterbi: Daniel Lidar; Zhihui Wang (post doc)
Delft University of Technology (Netherlands)
Iowa State University
University of California, Santa Barbara

MARCH 2013

The 512-qubit D-Wave Two "Vesuvius" processor is turned on at the USC ISI.

APRIL 2013

A team of researchers including USC Viterbi Professor Ben Reichardt devises a method to test whether a claimed quantum computer is truly quantum and advances the field toward the goal of quantum cryptography.

RESEARCH TEAM:
USC Viterbi EE: Ben Reichardt
Knight Capital Group Inc.: Falk Unger
UC Berkeley Computer Science Division: Umesh Vazirani

MAY 2013

Google, NASA and the Universities Space Research Association (USRA) found the Quantum Artificial Intelligence Laboratory (QuAIL), which assesses the potential of quantum computers to perform calculations that are difficult or impossible using conventional computers. QuAIL installs a D-Wave "Vesuvius" processor—a 512-qubit machine—in the lab and announces that the system will be functional by fall 2013.

JUNE 2013

A team of USC researchers present results suggesting that programmable quantum devices implement quantum annealing—a general strategy for solving difficult optimization problems with the aid of quantum adiabatic evolution—which can outperform classical thermalization-based algorithms.

USC ISI: Sergio Boixo; Federico Spedalieri
USC CQIST: Tameem Albash; Nicholas Chancellor; Daniel Lidar

2020-2025

(Future - theoretical milestones)

Researchers develop quantum computers that scale up to have enough processing power to solve certain problems faster than classical systems, performing calculations that used to take years in mere fractions of a second.

Quantum computing systems are used by the scientific community, commercial companies and government agencies to perform extremely complex predictive analyses in areas such as logistics, investment, cybersecurity, surveillance, drug discovery and software validation.

EIGHT VISIONS OF TOMORROW: LIFE IN THE FUTURE

Text by Adam Smith, Marc Ballon, Katie McKissick, Megan Hazle and Stephanie Shimada. Illustrations by Tim Szabo.

Ten years ago, USC faculty, staff, students and alumni watched as a 50-foot cardinal banner announced to the world a new name on campus. At the time, Andrew and Erna Viterbi's $52 million gift was the largest naming gift ever given to an engineering school.

"The gift by the Viterbis," observed then-USC President Steven B. Sample, himself an engineer, "will be a powerful catalyst for bold research and innovation, and will forever associate USC's engineering school with one of the most illustrious names in the history of engineering."

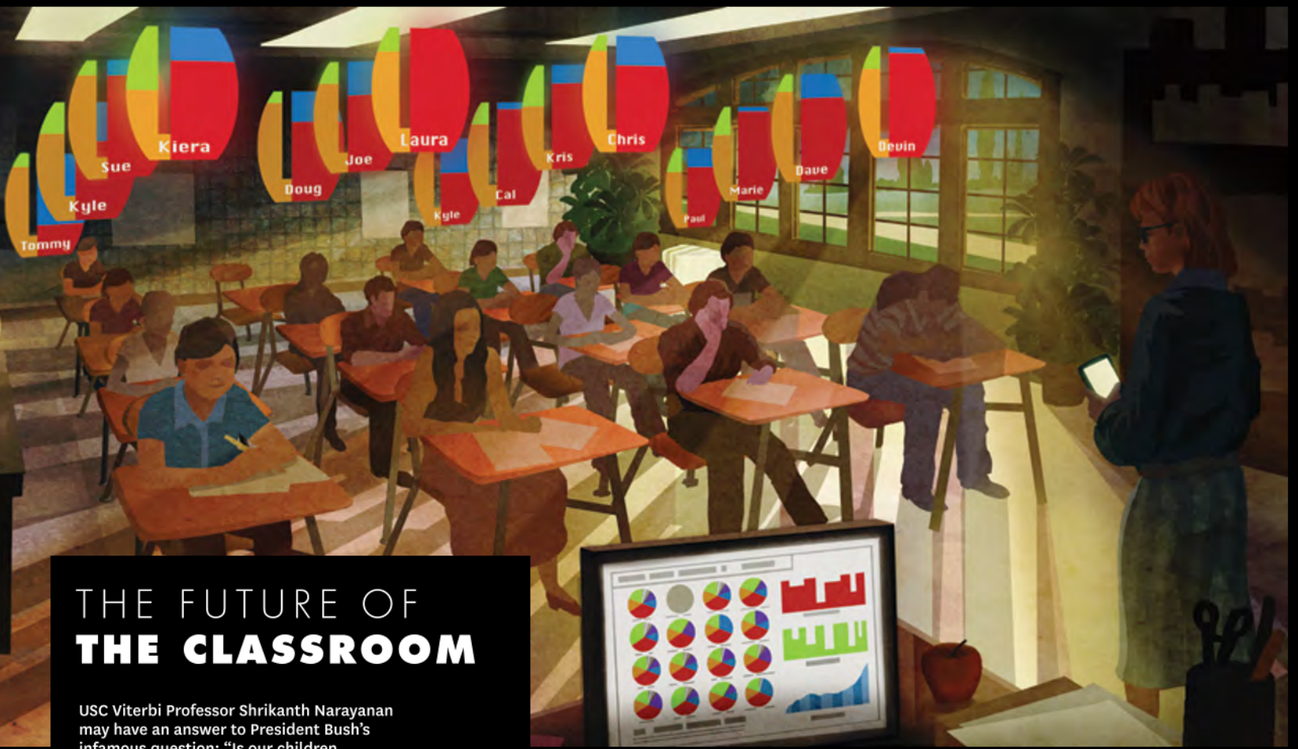
From solar homes to personalized robots, these eight visions serve merely as a taste of that bold research and innovation, glimpses of "a world that never was."

THE FUTURE OF TRANSPORTATION

It's 7:15 a.m. on April 5, 2076. You need to get across town to drop your daughter off at hologram school and get to work at the Ministry of Truth. Do you set off in your personal flying vehicle with voice-activated locks and antigravity chairs? Definitely not. The future of transportation holds many more options. In this future, owning your own vehicle will be obsolete, as there will be no need for a dedicated vehicle in your hover driveway when you can instantly and effortlessly summon a driverless transport vehicle and set off. Along your route, other commuters join you based on their location and destination.

USC Viterbi Professor Maged Dessouky is at the forefront of transportation technology. With funding from the U.S. Department of Transportation, he is finding ways to optimize ridesharing algorithms and shares his valuable research with the next wave of transportation companies such as Carma (formerly Avego) and Sidecar at USC Viterbi-hosted conferences.

While today we choose among driving alone, carpooling, taking the metro, walking or biking, commuters of the future will have the luxury of choosing among various automated transportation modes. Driverless cars and computer programs that optimize complex ridesharing networks will make personal vehicles, traffic jams, energy waste and automobile accidents relics of the past, nothing but a story that commuters tell each other as they socialize, nap and read while they are whisked from place to place. *—KM*



THE FUTURE OF **THE CLASSROOM**

USC Viterbi Professor Shrikanth Narayanan may have an answer to President Bush's infamous question: "Is our children learning?" For him, the classroom of the future is more than just universal iPads. It's about quantifying human behavior through a new field called behavioral informatics.

Consider this future scene: Sensors and cameras are ubiquitous. All the students are wearing physiological sensors of some kind, relaying immediate feedback to the teacher through a handheld tablet or other device. Information like, "Johnny is retaining 54 percent of the reading lesson. Heart rate: 90 beats per minute. Fatigue rating: 9 out of 10. Blood sugar: 65 mg."

But Narayanan's vision goes further. With cameras positioned on the teachers and teaching assistants as well, he wants to provide a more complete picture. Where are their eyes focused? How effective is their particular teaching style?

Narayanan's SAIL (Signal Analysis and Interpretation Laboratory), which uses video, audio and sensor data to analyze everything from autism to couples therapy, has studied literacy and reading in children since 2004. The feedback, he notes, is "about supporting, not supplanting." —*AS*

THE FUTURE OF **ROBOTS**

Good news, everyone! (Well, maybe just for those who believe the zombie apocalypse will pre-empt the Rise of the Machines.) USC Viterbi Assistant Professor Nora Ayanian is developing technologies that will allow us to easily command and control robots to perform household chores, construction and other jobs.

Are your robot workers loading that train car incorrectly? Did your robot chef forget to put mayo on your sandwich? If the answer is yes—but you don't have an advanced degree in computer programming or mechanical engineering—Ayanian is here to help.

Her progress in developing an iPad app that will allow regular people to communicate simple instructions for complex tasks to a large group of robots also guarantees that your robot army won't accidentally invade the wrong solar system.

Keep your quest for universe domination (or a baloney sandwich) on track with the swipe of a finger! —*MH*

THE FUTURE OF **MOVIES**

The year is 2023. Inside a theater, the lights dim. James Dean, in all his youthful glory, appears on screen. Moments later, he embraces a beautiful blond. It's Marilyn Monroe! Behind her is Heath Ledger, wearing Armani and looking dapper. For the next 90 minutes, the stunned audience watches the screen legends star shine in a new movie decades after their deaths.

A dream? No, the future, said Paul Debevec, the Academy Award-winning associate director of graphics research at the USC Institute for Creative Technologies.

He should know. Debevec and his research team's photorealistic digital faces, which seem lifelike in any lighting condition, have appeared in blockbusters such as *Avatar* and *The Curious Case of Benjamin Button*. The challenge in resurrecting the dead: using computer vision algorithms to extract from old movie footage thousands of 3-D images of the late actors' faces. "We'll be able to re-create their appearance and probably even their mannerisms," he said, "but we can only guess the approach they would take to a given role or scene." —*MB*

THE FUTURE OF **SOLAR HOMES**

Sunrise on a small suburban community. Every roof is outfitted with a highly efficient, 3-by-5 meter photovoltaic panel, drinking in the sun's rays. A dashboard display inside the home tells the tale: 80 percent of the home's power comes from an integrated solar system; 20 percent comes from the grid; 45 percent solar conversion efficiency; 6 cents per kw/hr. That's roughly one-third the cost and three times more efficient than what's currently available.

In addition, that solar power is being output in unique ways: paper-thin panels of OLED lighting instead of wallpaper and directional task lighting made from highly efficient LEDs. Interactive lighting and video walls that are instantly responsive to the occupants' mood and preferences.

Led by P. Daniel Dapkus, the USC Center for Energy Nanoscience's team of engineers and scientists has already made key breakthroughs in this arena: new nanostructure designs that should yield greater efficiencies in solar cells and LEDs. —*AS*

THE FUTURE OF **SPACE COLONIES**

You wake up early and enjoy coffee alone with the morning news. It's just another average day at the Europa Space Colony. You gaze out the crystal lattice window and watch Saturn's rings stretch across the horizon. Outside is a crisp -200 degrees Celsius, with radiation levels that would cause death within hours. But inside the biostructure, the system is kept at a constant 21 degrees Celsius, and the colonists are protected from the constant flow of solar radiation. It's home.

How could we possibly build a sustainable structure in this harsh environment? The future of space exploration and colonization will make use of yet unknown materials, engineered for optimal levels of strength, conductivity, heat resistance and radiation buffering.

Professor Andrea Hodge of the USC Viterbi Department of Aerospace and Mechanical Engineering is designing materials that might just end up in the space colony of the future. These new structures will be built from smart materials designed from the nanoscale up to allow for safer and easier space travel. The harsh physical realities of space, complete with radiation and temperatures that fluctuate between subzero and metal-melting, will be met with materials that can change properties to adapt to changing environments, protecting passengers and crew from danger zones outside our body's limits.

Hodge is also developing materials to shield satellites from meteorite fragments. These materials must be strong enough to withstand the onslaught of space debris yet light enough to be efficiently launched into orbit. To meet this challenge, Hodge looks to nature for inspiration. The best biological materials, designed over eons for optimal performance (for qualities like strength, flexibility and efficiency), give her clues about possible elements and their arrangements that will yield the desired material qualities she's looking for—whether it's for today's satellites or tomorrow's space colonies. *—KM*

THE FUTURE OF **BUILDINGS**

The members of the communications startup Chat.com waste the most energy in their 500-person office building. Ted blasts the heater. Bob never turns off the lights. Sally runs her computer 24/7.

The building knows all this. Sensors throughout it capture temperature, lighting and other data, which are then filtered through algorithms. The building decides to act. It sends avatars to the energy abusers' computers and smartphones, encouraging them shut off the lights, lower the thermostat and collectively reduce energy consumption by 25 percent. The building texts weekly conservation reminders and updates, offering gift cards for meeting the ambitious goal. The result: Chat.com's energy usage drops 30 percent.

The future is now. Technology created by Burcin Becerik-Gerber, a USC Viterbi assistant professor of civil and environmental engineering, and her team can capture, analyze and compare building occupants' energy consumption. As part of their research, they conduct experiments in several USC buildings. Becerik-Gerber and her team are currently working with colleagues from psychology to personalize the link between buildings and their occupants. "All the pieces are in place," she said. *—MB*

THE FUTURE OF **MUSEUMS**

The traditional museum will soon be a remnant of the past. In 2023, the museum will be a digital portal into past, present and future connections, accessible from the comfort of your home.

Launch the virtual museum on your iPad, and your tour guide, Vincent Van Gogh, instantly appears. Your first stop: stargazing in an immersive, 3-D version of *The Starry Night*, with Richard Wagner's *Parsifal* serenading in the background.

Knowing your penchant for music, the app suggests you explore the connection between Van Gogh and your favorite band, the Beatles. You click "yes" and are whisked into a historical journey through linkages between the two artists, including Emil Nolde, a German painter who had an influence on Van Gogh, and Van Gogh as an idol of John Lennon's. The path concludes with a comprehensive glimpse into the Beatles' world—past concert and interview clips flood the screen.

In collaboration with the Smithsonian American Art Collaborative, Craig Knoblock and Pedro Alejandro Szekely of the USC Information Sciences Institute are revolutionizing museums and developing a comprehensive, connected world of data. The engineers are currently transforming artwork into digital Linked Open Data (LOD) and developing an app that will allow users to embark on self-curated tours or explore pathways and connections between different subjects and disciplines. *—SS*

FIGHTING MODERN SLAVERY

Technologies under development by USC computer scientists could help in the fight against underage sex trafficking in the United States.

By Marc Ballon

This story deals with mature themes and disturbing subject matter. Reader discretion is advised.

They are the lost ones, living as modern-day slaves bought, sold and brutalized for sex.

In the United States they number in the thousands, tens of thousands or more, nobody really knows for sure. They are children, mostly girls, and their pimps sometimes brand them with tattoos to show "ownership." Robbed of their dignity, security, hopes and dreams, America's trafficked children often end up as addicts, prisoners or corpses. Trapped in a vicious cycle, some grow up to become abusers themselves.

Previously, men wishing to exploit trafficked children would hunt for victims in underground newspapers or cruise for them in gritty back alleys. It took work. The communications revolution, though, has made finding children for illicit purposes easier than ever.

The Internet has become the No. 1 platform for hustlers, traffickers and customers, or "johns," to buy and sell women and children for sex, according to the Washington, D.C.-based Polaris Project, a leading anti-trafficking organization. Traffickers recruit underage victims through social media sites, luring them with promises of love, affection or modeling jobs. Pimps exploit these young girls through such mainstream sites as Backpage and possibly even Twitter.

"Globalization and technology allow traffickers ... to operate in a way that they never used to be able to," Luis CdeBaca, U.S. Ambassador-at-Large in the Office to Monitor and Combat Trafficking in Persons, said in 2011.

"Globalization and technology allow traffickers ... to operate in a way that they never used to be able to."

On the other hand, online trafficking provides the anti-trafficking community with an unprecedented opportunity to observe, track and monitor the exploitation of youth. The same technological tools that make it possible for traffickers to communicate with more people and over a greater distance than ever before can also be used to disrupt the illicit trade, said Mark Latonero, research director of the USC Annenberg Center on Communication Leadership and Policy.

"I think these tools will be of tremendous value to law enforcement."

An interdisciplinary faculty team at the USC Annenberg School for Communication and Journalism and the Information Sciences Institute of USC's Viterbi School of Engineering is at the forefront of research to employ technology to combat youth sex traffickers and to help find and free victims. Since 2011, researchers have collaborated on a project to develop software and other tools, including Big Data, to help law enforcement investigate suspected cases of online trafficking activity, particularly those involving underage youth. USC researchers have worked with the U.S. Department of Justice, the Department of State, and federal, state and local law enforcement agencies, among others.

"I think it's a great idea that could potentially save lives."

"It is gratifying to know the Annenberg and Viterbi schools are playing a role in helping victims and survivors of trafficking," said Latonero, co-principal investigator of the project. "If we can help just one victim, then it's worth it, but it also has the potential to make a huge difference in one of our society's greatest human rights issues."

The various technologies are at different stages of development. However, USC researchers believe anti-trafficking agencies could begin deploying one or more of them within a year.

"I think these tools will be of tremendous value to law enforcement," said Lt. Andre Dawson of the Los Angeles Police Department, who has attended presentations about the USC team's innovative work and heads the LAPD's Human Trafficking Unit.

Leveraging natural language processing technologies, information retrieval and machine learning, Andrew Philpot of USC Viterbi's Information Sciences Institute is building tools that enable law enforcement to filter and sort through massive amounts of data quickly to find suspected underage sex trafficking victims and their enslavers. At the simplest level, proprietary algorithms scan in a matter of minutes thousands of online sex advertisements and look for telltale evidence of child exploitation. By contrast, the same exercise would take law enforcement searching with an iPad, computer or another device hours, if not days.

"We want to be able to go to the Web and standardize, digitize, systemize, sort and store lots and lots of information every day to help identify those young people advertising sexual services," said Eduard Hovy, co-principal investigator and longtime ISI faculty, currently on leave at Carnegie Mellon University. He added that feedback from law enforcement would allow computers to "learn" through basic artificial intelligence techniques.

Team researchers have gathered and analyzed millions of sex ads. Hovy estimates that algorithms currently under development could eliminate more than 97 percent of them, including businesses such as massage parlors and spas with real addresses, because they lack obvious or subtle signs of sex trafficking.

What are some of those signs? Sex traffickers sometimes post online ads of minors using coded language. They might describe them as "young looking" or as a "cute girl," USC Viterbi's Philpot said. They might also decorate ads with girlish symbols such as hearts. Computational linguistics algorithms under development by Philpot and Hovy could soon crunch data from online ads to ferret out such information.

Such software could also extract facial images from online ads. Algorithms identify potentially underage girls by the roundness of their faces and other features. Flagged photos are sent to an outside firm for further processing, Philpot said. In the future, young-looking faces might be matched to a national missing persons registry, allowing law enforcement to identify underage runaway victims.

Additionally, advanced software could map the movements of suspected underage victims through the phone numbers included in online ads. Because traffickers sometimes shuttle children among several cities to keep them disoriented and to avoid detection, they often run similar ads with the same phone number over a large geographic area, Philpot said. Such information could assist in the identification and apprehension of traffickers and their victims.

Advocate Tina Frundt applauds the USC team's efforts. The founder of Courtney's House, a Washington, D.C.-based provider of services to sex-trafficked children and their parents, knows better than most the horrors of underage sex slavery.

At 9, her foster parents forced her into prostitution. Adopted by loving parents three years later, she soon met an older man who groomed her for months before taking her to Cleveland from her Chicago home. Frundt's "soul mate" turned out to be a vicious thug and a hustler. In the course of 24 hours, she was raped twice, sent into the streets, and viciously beaten when she failed to meet her nightly $500 quota.

Frundt eventually escaped and tried to pull herself out of that life, but fell back into prostitution. She finally left it behind at age 25. "You just get sick and tired of being sick and tired," she said.

Frundt, who is familiar with the USC trafficking project, has high hopes for the technologies under development.

"I think it's a great idea that could potentially save lives," she said.

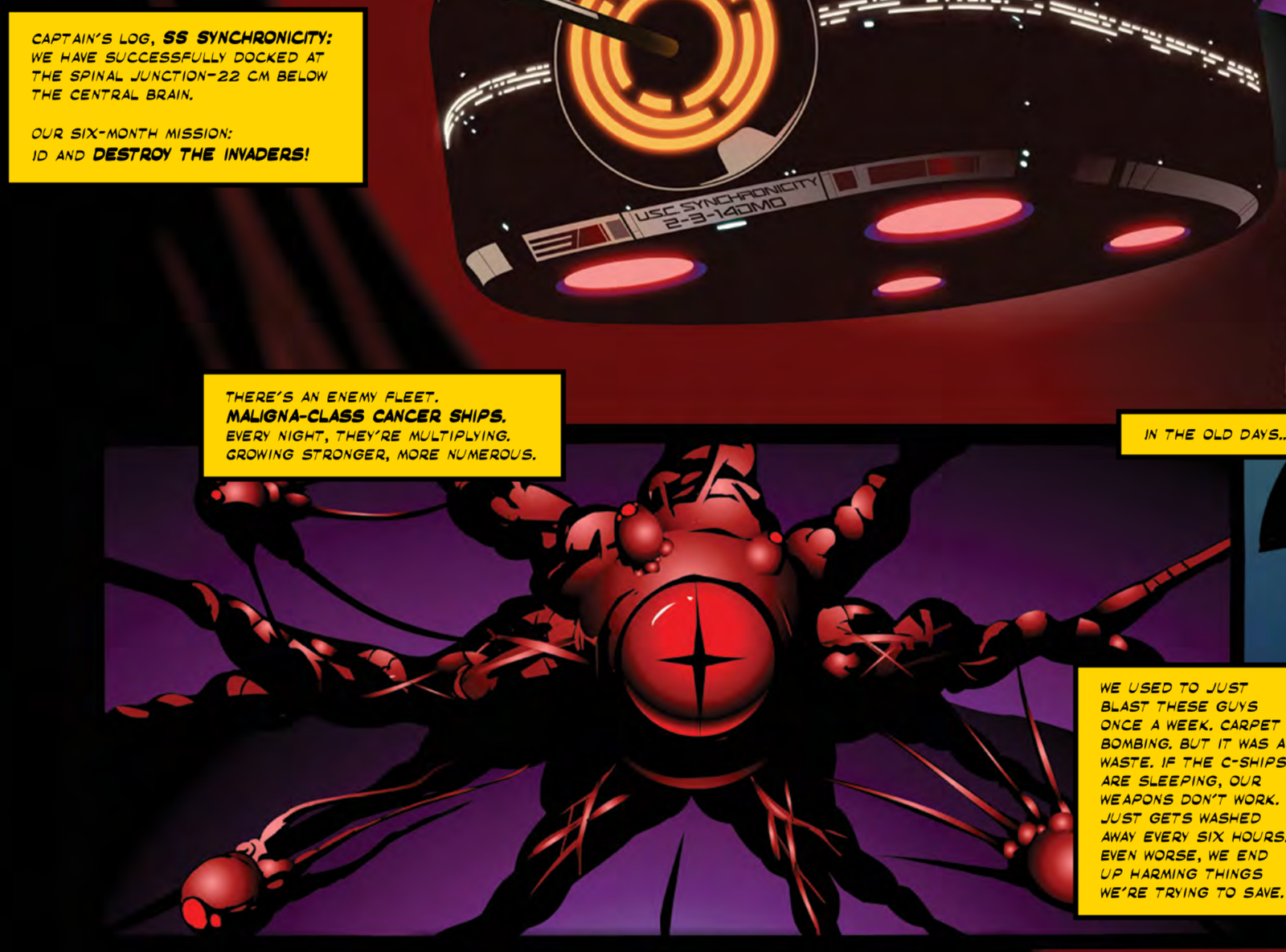
To support this or other research at USC Viterbi, please visit viterbi.usc.edu/giving/

ILLUSTRATION: PETER BOLLINGER

"THE MISSION"

ELLIS MENG, PROFESSOR OF BIOMEDICAL ENGINEERING

STORY BY ADAM SMITH
ART BY SAHARAT TANTIVARANYOO



REPORT.

00:00:41

RF INDUCTION POWER HOLDING STEADY. NOT TOO MUCH ON SENSORS - JUST A COUPLE PROTEINS.

WAIT.

I'VE GOT A SIGNAL.

THEY'RE ASLEEP.

HOLD YOUR FIRE.

WE'LL WAIT.

OUR WEAPONS ARE DESIGNED TO TARGET CELLS THAT MULTIPLY QUICKLY, LIKE CANCER CELLS. BUT THAT CAN ALSO MEAN...

HAIR CELLS

SKIN CELLS

RED BLOOD CELLS

MANY OF THE HEALTHY CELLS WE WANT TO PROTECT.

TIME. LOCATION. AMOUNT. IT'S MISSION CRITICAL.

EEEEEEEEEEEEEEEE

WARNING

THEY'RE WAKING UP

STAND BY

60 MICRO-LITER BURST ON MY COMMAND!


FIRE!


IT'S A LONELY JOB. ONE SHIP VERSUS TENS OF THOUSANDS.
00:00:00
01:59:23
TWO MORE HOURS, AND IT'S BATTLE STATIONS ALL OVER AGAIN.
BUT IT'S SO WORTH IT.

THE REAL RONALD REAGAN

A discussion with alumnus and former Ronald Reagan campaign manager Thomas C. Reed.

Thomas C. Reed has had a bird's-eye view of American defense and foreign policy for more than a half century. The former Secretary of the Air Force under Presidents Gerald Ford and Jimmy Carter, Reed holds a master's in electrical engineering from USC Viterbi, and began his career working on thermonuclear weapons at the Lawrence Livermore National Laboratory. He later served as the Northern California campaign chairman for Ronald Reagan's successful 1966 gubernatorial campaign and co-chair of his 1970 reelection campaign. He was also campaign director for Reagan's ill-fated 1968 presidential run. In 1982 Reed joined Reagan in Washington, D.C., serving as Special Assistant to the President for National Security Policy. The author of three books, Reed is currently working on a tome about Reagan's 1968 presidential campaign. He spoke recently to ***Managing Editor Marc Ballon*** *in a wide-ranging discussion.*

Former Ronald Reagan campaign manager Thomas C. Reed with the late president.

What was Reagan's strategy for ending the Cold War?

Reagan peered over his glasses to me one morning in the Oval Office. And he says, "Tom, we've got a problem." And the tone was like, "We've got a problem. The air conditioner won't work." I said, "What's the problem?" "Tom, the Soviet Union is the problem." He commissioned [NSC Advisor William] Clark and me to put together a plan on how we could prevail in the Cold War. He entrusted me to pull together the guys from State and Defense on how we were going to end the Cold War. We did that, and there was a presidential memorandum that was signed in May 1982—National Security Decision Directive 32.

We defined victory not as burning down Berlin or tanks in Red Square but as "forcing the Soviet government to seek the consent of the governed." That's Thomas Jefferson. Once they started having elections, we thought things would change. And sure enough they did. The plan was we're going to push on five fronts. Economic—yeah, we'll sell you wheat, but pay for it in cash. Well, that was really a blow. The Poles were borrowing money to fill their shelves with food to keep the people off the street. In international affairs, we decided to turn Afghanistan into Russia's Vietnam. We decided to push on technology and uncork everything from B-1 bombers to Star Wars, where the Soviets couldn't compete. The Voice of America—we're going to talk to the people behind the Iron Curtain. That's what the "Evil Empire" speech was all about. That really inspired the younger generation in '83 and '84 behind the Iron Curtain.

We pushed on all those fronts, so that if the Russians want something, yes, that's wonderful, but we asked when's your next election. Pretty soon [Boris] Yeltsin is mayor of Moscow. Pretty soon Yeltsin is president of Russia. Pretty soon there are elections in the Ukraine. Then, in December of 1991, you have all these guys meeting in Belarus deciding to end the Soviet Union. So our plan played on our strengths. We're going to push, but we aren't going to do military confrontation or occupy the capital. The point was to make the Soviets seek a legitimate government.

Tell me about Ronald Reagan the politician.

What people don't understand is that he had one of the most unique minds in politics that ever came along—fast and retentive in a way you can't believe. His mind worked not twice as fast but 10 times as fast as us mortals. You would see this over and over again if you knew him. Let's say he was at a press conference and he got a question. Click, the light goes on. He would sort out all the cards in his mind, putting the humorous kicker at the end. Finally, after 15 endless seconds, out would come this performance you couldn't believe, over and over again.

Ronald Reagan had a reputation as being congenial but a bit aloof.

When I came to Washington and joined the NSC staff in 1982, I hadn't seen Reagan in more than 10 years. It was really strange. I went to a meeting with Bill [Clark] to meet the president. It was as if I had just gone out for coffee for a few minutes. Reagan looked at me: "How's the wife? How's the kids?" He had a very retentive mind. So now I was part of the new NSC. So there I am with the very unique posture of knowing Ronald Reagan better than anyone in town. Therefore, I know how to read him, and he trusts me. He has no friends, folks he simply hangs out with. [Former Reagan Press Secretary] Lyn Nofziger said, "He'd make a perfect hermit." He has a lot of compartmented associates. He has a minister. Bill Clark was his horse-riding friend. He trusted me to run his political campaigns, absolutely with his life. And his wife, who was his lover, protector but not friend—even she says that in her memoirs.

What was Reagan's political philosophy on domestic issues?

He had a well-thought-through belief system. The government is the problem. Given the chance, the city councils and the planning boards and the feds will all screw it up. And freedom equaled getting the government off people's backs. Reagan had thought it through.

How do you respond to critics who say Reagan didn't win the Cold War, but rather Soviet internal politics, including Mikhail Gorbachev's ascension to power, ended it?

The short answer is bunk. But the longer answer is that Reagan had sense enough to wait for the right guy. He understood that he wasn't going to make any deal with [Leonid] Brezhnev. With [Yuri] Andropov, Reagan developed a writing relationship. Andropov was a strong communist and wanted to win, but he understood he didn't have a strong hand. They were beginning to communicate with handwritten letters [when Andropov died in 1984]. [Konstantin] Chernenko was just a body. Reagan understood that. He didn't have any summits until there was a guy he could talk to, and he just waited. He understood that sooner or later the process is going to percolate somebody to the top. Really, though, it took two sides. Reagan said he was going to win, and he waited until there was a guy on the other side of the table who realized he couldn't win. That was Gorbachev, who lived in the real world. The Soviet system was falling apart, but if we hadn't pushed on it, who knows?

Thomas C. Reed (center) with former presidents, Dwight D. Eisenhower and Ronald Reagan

What inspired you to write a book about Reagan's 1968 presidential run?

In 1968, I suggested that Reagan run for president. He agreed, did it, and I ran it. Being a USC-bred engineer, I'm a pack rat. I had all these files about 1968. I have cans full of 16-millimeter film from TV appearances. I have all these schedules. I've got the vote count. As I wrote in *At the Abyss: An Insider's History of the Cold War*, you just don't wake up one day and say, "Gee, it's Thursday. I think I'll run for president." You've got to learn how to do it. He didn't win in '76 because he didn't pay attention to all the lessons. He got it right in 1980. What he learned in '68 is that running for president isn't like running for governor of California—you don't just do it over the television and the airwaves, of which he was master. No, you've got to get nominated. You've got to work the machinery and work with delegates and delegation chairmen. You've got to sit there one-on-one in coffee shops, in windowless trailers. You've got to listen, find out what this guy wants, and convince him you can win and can help him. Reagan learned that you had to have a good speechwriter. In California, you can give a rah-rah speech, but in the national arena you really can't rely on just that. And you need to know what you're talking about. You can screw up, just a little, and have it blow up. In 1976, Reagan didn't have a really good speechwriter, which is one of the reasons why he lost. He had great ones in 1980.

What role do you think engineers and other technologists played in ending the Cold War?

I'm biased, being an engineer. It took will to prevail. But technology is basically where it was fought, rather than on the battlefield. We built Trident submarines. We built the B-1 [bomber]. We authorized the deployment of the MX missile. We proceeded with Star Wars. We built the F-117 Stealth aircraft that you can't see. We did all that stuff. Reagan really understood the Soviets couldn't play in that game, especially with Star Wars. It's interesting to talk to the Soviets as I did for my book *At the Abyss: An Insider's History of the Cold War.* They realized they couldn't compete and told their government that.

PHOTOS COURTESY OF TOM REED

Is Brad Pitt's Phone at Risk?

How a USC Viterbi alumnus keeps our mobile devices safe.

By Katie McKissick

Lookout runs on iPhone and Android smartphones to help keep them secure.

The scene at the 2005 Academy Awards: Hollywood royalty parades down the red carpet in front of a sea of camera flashes and handheld microphones, with reporters asking, "Who are you wearing?" and "Who do you think will win for Best Actress? Reese Witherspoon or Judi Dench?"

Across the street, three USC students armed with a high-powered Bluetooth antenna are scanning all the mobile phones within range to find those vulnerable to being hacked. Their mission: to show that even powerful celebrities' phones had a bug that allowed unauthorized Bluetooth devices to access them.

Kevin Mahaffey (BS EE '07), John Hering and James Burgess performed this stunt not to actually hack into Brad Pitt's or other celebrities' phones, but to help keep that from happening.

When they discovered their first security gap in a Nokia 6310i phone that allowed for unauthorized Bluetooth access, as responsible security researchers they disclosed the bug to Nokia. But to their surprise, Nokia declined to fix the security flaw, claiming that Bluetooth only had a range of 100 meters so the problem was not worth fixing.

But the trio had already dispelled that myth a year earlier when they went to the Santa Monica Pier with a device called the Blue Sniper, a powerful Bluetooth antenna gun. With this, they demonstrated that they could hack into a cellphone from just over a mile away.

There is a bargain in security research between vendors and researchers: If a researcher reports an issue to a vendor and the vendor fixes it, the security researcher does not disclose the vulnerability to the public. However, as Mahaffey explained, "If you do not fix your vulnerability, the researchers get to give a talk at DEF CON, the world's largest hacker conference."

And DEF CON is an interesting venue for researchers concerned with mobile security. At this hacker conference, no one dares use the Wi-Fi, as "DEF CON has the most hostile wireless network on the planet," Mahaffey said. This means the leading minds in computer programming and hacking switch gears entirely and take notes with pencil and paper.

In 2007—before the release of the iPhone and the successive wave of smartphones—Mahaffey, Hering and Burgess started Lookout, a mobile security company, in downtown Los Angeles, and began making software to keep cellphones safe. Lookout was ahead of its time. "The rest of the software world was building Facebook apps. We were this weird company doing cybersecurity in Los Angeles," Mahaffey, Lookout's chief technology officer, said.

But things sure have changed. Lookout went from filling an unknown niche in 2007 to serving 45 million users worldwide today.

Lookout works on iPhones, Android devices and Kindles. It keeps these handheld devices secure by scanning apps to make sure they're safe to download, blocking malicious websites and protecting them from destructive software. If your device is lost or stolen, Lookout enables you to locate it on a map and send instructions for the device to make a loud sound, which will better allow you to locate it. If the phone or tablet cannot be recovered, Lookout can lock the device or wipe your personal data from it remotely.

Looking ahead, Mahaffey acknowledges the possibility of a world where we are increasingly connected to our devices and each other via unsecure networks that can be hacked with disastrous consequences. But he wants to help keep that from happening.

"The alternative is a world where all of this technology can be used to make the world more efficient, to help education, to help bring people out of poverty, to help bring access to completely new technologies and products that never could have been built before. And our goal is to make sure that as the world gets more connected, it gets more secure instead of less secure," he said.

Mahaffey's love of computer programming began in third grade when a fellow student showed him the basic terminal window on an Apple IIE computer. "I fell in love. You can type things in, and the computer does what you want it to? This is amazing!"

Years later, Mahaffey came to the USC Viterbi School of Engineering to study electrical engineering. Even as an undergraduate, Mahaffey had the entrepreneurial spirit.

"One of the things that attracted me to USC is that it's one of the top entrepreneurial schools in the world," he said. "What I loved about it was that it was a very great technical education, but it also had a great social and interpersonal education while being entrepreneurial at the same time. It's truly a great place for people choosing to go that path in life."

ILLUSTRATION: KATHERINE DUFFY

In Memoriam:

Professor Emeritus Charles L. Weber

By Ryan Shaw

CHARLES L. (CHUCK) WEBER, a longtime and highly respected USC Viterbi Professor Emeritus of Electrical Engineering, passed away on Aug. 15, 2013, at the age of 75.

Weber shined as an academic during his distinguished 45-year career at USC. He authored many journal papers and technical publications and a still-widely used textbook, *Elements of Detection and Signal Design*. Weber contributed greatly to USC as chair of the Viterbi School of Engineering APT Committee and chair of the Seaver Library Committee, and was one of the "Magnificent Seven" who established the USC Communications Sciences Institute (CSI).

Weber received the Distinguished Alumnus award from the University of Dayton in 1988, and was honored as Life Fellow of the Institute of Electrical and Electronics Engineers (IEEE). He retired from USC Viterbi in 2008.

Over his illustrious career, Weber consulted for JPL, Hughes Aircraft Co., TRW, Aerospace Corp., and Axiomatix, and advised NASA on the design of the space shuttle docking radar.

Born in Ohio, Weber earned a BS in electrical engineering from the University of Dayton in 1958. He went on to earn an MS in 1960 from USC, and a PhD in 1964 from UCLA, both in electrical engineering. He worked at Hughes Aircraft from 1958 to 1960, and joined the USC faculty in 1964.

Weber was most proud of his mentoring and supervision of 26 PhD graduates. Members of this distinguished group now hold leadership positions in technical fields and entrepreneurship, building on Weber's pioneering work.

Commenting on his legacy, USC Viterbi Professor Robert Scholtz said of his friend of 55 years: "He gave his time freely to help others and was a friend who you could always count on for support."

The Future of Commitment

A new genre of storytelling snuck into popular culture this year. Epitomized by *Her*, the Spike Jonze movie starring Joaquin Phoenix; *The Circle*, a novel by Dave Eggers; and *A Million First Dates*, a nonfiction book about online dating, written by your correspondent, this new subject is the "date-o-sphere," or what happens to people when their relationships become technology-assisted.

"Sometimes I think I've felt everything I'm ever going to feel, and from here on out I'm not going to feel anything new, just lesser versions of what I've already felt," says Theodore Twombly, the hero of *Her*. The question for Twombly, a shaky and lonely character who's separated from his wife and "dating" a Siri-like operating system, is whether he can still feel anything in a Big Data age that's increasingly turning us into isolated beings who, desperate for connection, are outsourcing the search for sex, romance and marriage to a technology that's more efficient, if not more intelligent, at procuring those things than we are.

While *Her* is set in a near-future Los Angeles of silent trains and high-waisted men's pants, Twombly's conundrum sounds nearly identical to that of Jacob, the real-life character whose story is told in Chapter 5 of my book, "Better Relationships But More Divorce: What Technology Means for Commitment." Jacob is a mid-30s single man from Portland, Ore. His experience illustrates that for certain kinds of relationships—namely, suboptimal ones—the enhanced availability of new mates via online dating will lead to an overall decrease in commitment.

What Jacob finds after joining two online dating sites is not merely access to a larger dating pool. Whereas before online dating Jacob had considered marriage in at least two relationships that, in retrospect, were both problematic mismatches, he now feels less need to invest in any given relationship. The bar for what he considers a good relationship has been raised. This, seemingly, is a positive outcome. The Twombly-esque downside, however, is that he feels less and less excitement about dating women, even ones who seem to fit the bill.

"Each relationship is its own little education," he says. "You learn more about what works and what doesn't, what you really need and what you can go without. That feels like a useful process. I'm not jumping into something with the wrong person, or committing to something too early, as I've done in the past." But he does wonder: When does it end? "Maybe I have the confidence now to go after the person I really want. But I'm worried that I'm making it so I can't fall in love."

Jacob's dilemma—better relationships but more breakups—was a common theme among the 100-plus online daters I interviewed, of all ages and persuasions, from gay men in their 40s to straight women in their 60s. Online dating had made it easier for these people to leave suboptimal relationships—relationships they might have maintained in an earlier era—and find new ones. When Chapter 5 of my book was excerpted in *The Atlantic*, some doubtful readers cited census data showing that divorce rates are actually declining following four decades of increase.

This is true, though it does little to rebut my thesis. Not all committed relationships take the form of marriage. There is simply less marriage these days. The marriage rate is at a historic low and continues to head south. Surely many factors contribute to that trend, such as the destigmatization of single life and heightened opportunities for women in the workplace. The result, however, is the same: A committed relationship is now more a matter of personal choice than cultural force.

People ask, so what's the fix? Times being what they are, usually the solution they have in mind is another piece of relationship technology.

If commitment is the goal, then eHarmony and other conservative dating sites do, in theory and advertising, offer the marriage-minded an option. But even assuming you can rely on an industry whose profits are tied to relationship volume, technological "solutionism" is a tricky proposition. At some point, Siri or no Siri, we have to take back responsibility for our own relationship lives. The best we can do is understand how the date-o-sphere affects relationships. Technology provides us with more choices. Judging from the stories that have emerged, this alone is a major departure from the rest of human history. But the choice is still ours to make.

— Dan Slater, a former Wall Street Journal reporter, is author of **A Million First Dates: Solving the Puzzle of Online Dating**

ILLUSTRATION: KATIE MCKISSICK

March 2, 2004: (left to right) then USC President Steven B. Sample; Erna and Andrew Viterbi, holding a bouquet of flowers; and C. L. Max Nikias, former dean of the USC Viterbi School and current president of USC.

> *"Perhaps 100 years from now, when humans are broadcasting the weather from Mars, we may be able to trace the origins of those information technologies to The Andrew and Erna Viterbi School of Engineering."*
>
> *– USC President and former Dean of the School of Engineering C.L. Max Nikias (2004)*

The Viterbi Family's Legacy

By C. L. Max Nikias, president of the University of Southern California

As we mark this milestone anniversary in the naming of our Viterbi School of Engineering, I'd like to revisit the extraordinary journey of Andrew and Erna Viterbi. In so many ways, their story embodies the American Dream: they overcame persecution and discrimination early on, then embraced the singular work ethic on which our nation was founded. Their ethos—rooted in optimism and integrity—drove them, as did their commitment to education.

Andy was born into a Jewish family in Italy, then under Fascist control. In the late 1930s, Italy enacted a Racial Manifesto, prompting Andy's father to bring his family to America. Their escape was narrow: countless Italian Jews soon disappeared, never to be seen again. And with no way to communicate, they couldn't warn each other.

Erna Finci, meanwhile, was born into a Sephardic Jewish family in Sarajevo. During World War II, they fled to Montenegro, then under Italian occupation. One day, the Resistance blew up a troop carrier, and in response, the Italian army rounded up the town's men, including Erna's father, grandfather, and uncles. The army planned to shoot every second man in retaliation. Erna cried when she saw her grandfather in handcuffs, and the vision of young Erna sobbing deeply moved an Italian officer. He let every member of her family go, eventually releasing all of the town's men.

From Montenegro, the Fincis fled to Dalmatia, where they were deported to northern Italy. When Germany invaded, the Finci family again fled, this time to Switzerland. They walked all night through the mountains, slipping across the border. After the war, Erna's family returned to Italy, where they remained in a camp for displaced persons. They applied for visas to America, and five years later, arrived in Los Angeles.

The Viterbi family also made it to the United States—just weeks before Hitler invaded Poland. Here they were safe, but faced prejudice, as Italians encountered great suspicion during the war. Jobs were scarce, and Andy's father, an ophthalmologist, had to sustain his family on meager resources. Andy's mother, meanwhile, worked as a seamstress in a textile factory in Boston, and became an advocate for the rights of workers.

Watching his parents conquer obstacles, Andy saw the power of education, and excelled as a student. He earned a scholarship to MIT, and grew interested in communications and coding theory. He soon met Erna, and they married in 1958. Four years later, he earned a Ph.D. from USC's engineering school.

It was on this foundation—borne from the principles of hard work and a dedication to learning—that the Viterbis built their life together. Andy pursued research on digital communications, and produced the now-legendary Viterbi algorithm. This elegant innovation remains central to satellites, silicon chips, cell phones, and cable television. There is such poetry in this history: it was a human whose ancestors suffered so much from the lack of communication who took worldwide communications to an entirely new level.

Throughout this time, Erna has been Andy's partner and inspiration—the rock on which the Viterbi family flourished. Andy performed national security work at JPL, co-founded Linkabit, and later co-founded Qualcomm, one of the world's foremost companies for technological innovation.

In retracing the Viterbi family's journey, we see the profound power of education: its ability to endow a person with choices, to transcend the humblest of starts, and to gird against repression. This is why the Viterbis chose to name our engineering school: they understand that education is the great equalizer in society. They appreciate the transformative role it can play in each person's life.

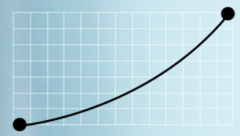
This is also why USC created the Viterbi Museum. For generations to come, we hope the museum will keep Andy and Erna's extraordinary legacy fresh for students, faculty, and visitors, both native and foreign-born. Its message—which speaks to the exceptional potential of our country, a sound education, and each person's ingenuity—certainly bears revisiting, now and forever.

In 2004, Andrew and Erna Viterbi named the USC Viterbi School of Engineering.

VISIT THE VITERBI MUSEUM
Open from 10:30 am to noon on Fridays, the museum features artifacts, photographs and mementos of Andrew Viterbi's illustrious career. Located on the second floor of USC's Ronald Tutor Hall, special tours can be arranged by contacting Antoine Rose: antoinmr@usc.edu (213)740-4175.

"I believe that the greatest value that we can pass on to future generations is to develop our American universities, and we're very proud that USC is one of the leading ones."

– Andrew Viterbi (2004)



The total number of graduate applications has nearly tripled from 4,989 (2004) to 14,862 (2014).

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In the period 2009-2014, no other engineering school in the world has as many faculty with this distinction.

Between 2009 and 2013, **seven** USC Viterbi faculty members were selected as TR 35 young innovators, "the world's 35 top innovators under the age of 35."

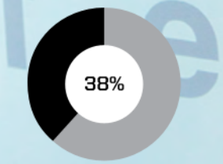
13

Since 2004, **13** USC faculty have been elected to the National Academy of Engineering, one of the highest professional distinctions accorded an engineer.

In 2010, the **Maseeh Entrepreneurship Prize Competition** (MEPC) was created.

In 2011, **Computer Science at USC** received the highest amount in federal research funds.

In 2013, the **USC Viterbi Startup Garage**, an early-stage technology accelerator for student and alumni startups, was launched.



In 2013, **38%** of USC Viterbi's entering freshmen were women. That compares to just 23.6% in 2004.

In 2014, *U.S. News & World Report* ranked the USC Viterbi School's Distance Education Network (DEN@Viterbi) as the **No. 1** online graduate program for the **second consecutive year**.

1

U.S. News & World Report has consistently ranked USC Viterbi among the nation's **top** graduate engineering schools.

In 2014, USC Games was named the **No. 1** game design program in North America by *The Princeton Review* for the **fifth consecutive year.**

In 2004, the **Stevens Institute for Technology Commercialization** was established.

In 2005, the **USC Mork Family Department of Chemical Engineering and Materials Science** was named.

In 2006, the **Klein Institute for Undergraduate Engineering Life** (KIUEL) was established.

In 2006, the **Ming Hsieh Department of Electrical Engineering** was named.

In 2010 the **Ming Hsieh Institute for Research on Engineering-Medicine for Cancer** was established

In 2002, **Daniel J. Epstein Department of Industrial and Systems Engineering** was established.

In 2013 the **Epstein Family Engineering Plaza** was named.

In 2007, the **USC Sonny Astani Department of Civil and Environmental Engineering** was named.

In 2010, the **Department of Astronautical Engineering** was established.

In 2014, the **USC Michelson Center for Convergent Bioscience** was established.

THE MANY LIVES OF ENGINEERS

"My focus on socially assistive robotics came about as a direct result of having children. Quite early on, children ask, "Mama, what do you do at work?" And not too long thereafter they ask, "Mama, why do you do that?" I realized that having a good answer to both of those questions is really my legacy, and so I ended up shifting my research emphasis entirely from curiosity-driven research to real-world, need-inspired, human-centered research. That's what drove me to identify a niche and create a new field in robotics."

— MAJA MATARIĆ, Chan Soon-Shiong Chair of Computer Science, Neuroscience and Pediatrics, founding director of the USC Center for Robotics and Embedded Systems, vice dean for research at the USC Viterbi School of Engineering

PHOTOGRAPHY BY NOE MONTES

"I personally enjoy magic as an art form and love to watch others perform, especially after a busy day. Of course, as a scientist, I am also interested in how it is done. Clearly, magic is based on scientific principles, but I was very happy to find out that magic recently has also informed science."

— SVEN KOENIG, professor, Department of Computer Science

"I've always liked a challenge. . . . The mental toughness required to get through my engineering degrees translates quite perfectly to CrossFit. CrossFit takes both physical and mental toughness. When the physical exertion peaks during a workout, mental toughness kicks in to push me through the last few seconds."

— STACEY GRAHAM (BS '08, MS '12), CrossFit trainer, industrial engineer

THE ORACLE OF ATHERTON

Venture capitalist Mark Stevens (BS '81, MS '84) on the future, driverless cars—and his favorite mistake.

Tell us about your favorite mistake—a time when you failed but you learned a valuable lesson.

In the venture capital business, you learn much more about your failed investments. The first investment that I recommended at Sequoia [Capital], that I went on the board of, was a failure. We lost 100 percent of our money. I won't mention the company name—protect the innocent! (Laughs.) I learned a lot about how to work with peculiar or unusual founders. I learned a lot about going up against entrenched competitors and the power they have. I learned a lot about timing—how important it is to get your product out in the marketplace as quickly as possible. Time is of the essence in a startup. I joined Sequoia in 1989, made my first investment in 1990, and this thing failed at the end of 1991.

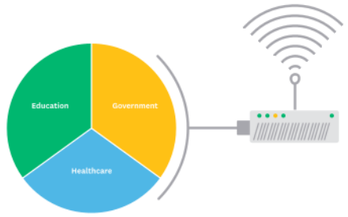
What was the reaction from the partners? Were they like, "Let's not give this guy Stevens any more money"?

It was OK, actually. I had a senior partner, the founding partner of Sequoia, who'd worked with me on the company. In Silicon Valley, there's a culture of failure. You have to embrace risks. Measured risks. But you do have to take risks. Any venture capitalist who ever says, "I've never lost money," they're either lying or they're not taking enough risk. You're always backing founders and companies with imperfect information.

As managing partner of S-Cubed Capital and former managing partner at Sequoia Capital, you're used to making big bets on the future. What are some areas that you think will transform the lives of Americans that most of us aren't paying attention to?

One area is the whole application of information technology to health care. If you look around the Internet, cloud-based computing's had a huge impact on most industries, whether it's the media industry or manufacturing. But the three big parts of the American economy where you haven't seen as much impact are education, government and health care. If we're going to lower the cost of health care and get better outcomes, we're going to have to get better data. We have to be able to ID disease states earlier. We have to be able to track people's health care along the entire life cycle.

For our kids, it will mean much more personalized health care. In the past, if you took your kid in for an earache, it's not clear what's causing the earache. The doctor does a blind prescription of antibiotics, which may or may not work. It's almost a random diagnosis with a random treatment. But if we had much more insight into that kid's DNA and that kid's history, we could prescribe remedies that are that more pinpointed, that are more customized. If you can identify a genetic marker for a disease state, in some cases you can almost prophylactically prevent that disease before the gene is expressed. In the next 10 years, there's going to be a lot of interesting companies at the intersection of IT and health care delivery.



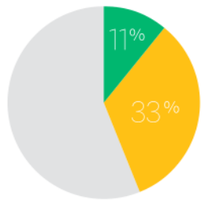
What's the last bit of technology or innovation that just floored you? That just reduced you to a slack-jawed gawker?

I just bought a Tesla. It's the best car I've ever driven. It's like driving an iPad with wheels. It's an interesting integration of technologies that is delivering a totally new transportation experience. Lithium ion batteries—you now have a car that can go 250 miles on batteries, which you couldn't do before. Wireless connectivity—I get software updates every quarter to make the car better.

The next logical step is driverless cars, which Google is doing. This is going to be a huge thing. Can you imagine what that will mean for eliminating traffic? Reducing the cost of insurance? For reducing accidents and deaths? All these things can be vastly reduced.

I tend to keep cars for 10 years. I tell my friends in Silicon Valley that my next car will be a driverless Tesla.

Let's talk about engineers as leaders. According to *The Wall Street Journal*, in a study of 36 million Facebook profiles, 3,337 company founders and CEOs across all industries hold an advanced degree in engineering, while 1,016 have advanced business degrees. Thirty-three percent of S&P 500 CEOs were engineering majors, compared to only 11 percent in business administration. What's the story here?



I have two engineering degrees from USC, and I have a Harvard MBA, and it's a very good mix in terms of academic preparation for my career. But I always think of those engineering degrees at USC as the real foundation of my career. And the business school education—not to disparage an MBA or Harvard—I would think of as finishing school, as kind of the icing on the cake. The real body of the cake was the engineering degrees from Viterbi.

The story is that as an engineer you're trained to think very critically and rationally. To synthesize a lot of inputs quickly and make go/no-go decisions quickly and efficiently.

With the business school training, it's more focused on processes and techniques. I think of an engineering school curriculum as being much more intellectually rigorous. It's a much better preparation for the wide span of activities and the wide span of decisions you have to make in running a large business. CEOs and senior managers of large organizations are simply better prepared by having engineering degrees than simply having a business degree.

It's been said that as the economy becomes increasingly tech-centric it may be easier for an engineer to learn, say, finance or marketing, than for someone with a business background to learn the technology. Is there some truth to that?

I totally agree with that.... There are a few cases where a bright person with a business degree or more of a general business background can learn to understand or appreciate and manage an organization that is a technology-oriented company. But it's pretty rare that you see that. I think it is easier for someone with an engineering background to acquire the basic skills of accounting, finance, etc., and integrate with their technical background.

You co-teach a class called "The Art and Adventure of the Start-Up" at USC. Tell me one crazy adventure story from your own experiences.

Entrepreneurs by their very nature are quirky, unusual. They see the world differently. They see around corners. They see opportunities that 99 percent of the rest of the population did not see. They are not normal in the classical sense. They don't look normal, they don't talk normal. And that's part of the fun of being a venture person. [There was] one situation where the [entrepreneur] came in and presented to myself and the founders at Sequoia. The premise of the company was to bring 3-D games to the PC. And at that point in time, who'd want to play a 3-D game on a PC? The PC was to do spreadsheets and Word documents. If you wanted to play games, you'd go to your Nintendo or your Sega. Or if you really needed 3-D graphics to build something, you went to a $100,000 Silicon Graphics workstation.

One could argue that at that point there was a zero billion-dollar market for that—you couldn't measure that market right then. It was a very radical idea at the time, but a few years later it became more ubiquitous.

We first invested in Yahoo! at Sequoia in 1994. The two founders essentially came up with a table of contents for the Internet. And we sat around in their bungalow at Stanford. They didn't have any idea how they were going to make money, and we didn't have any idea. But we gave them a million dollars, and they figured out over time there would be an advertising model—and the rest is history. That was kind of a crazy bet. But we knew that a table of contents for the Web was needed, it had utility, people would use it. We just didn't know how to monetize it.

Speaking of big bets, you're a part owner of the Golden State Warriors. How would you characterize their chances of hoisting the Larry O'Brien Championship Trophy in June?

I think this June—that's optimistic. But the Warriors are one of the five or six best teams in the NBA. We have a great culture, and there's a real sense of family. The goal of the ownership, very simply, is to bring a championship to the Bay Area.

As someone who has spent years at the heart of arguably the most forward-looking place in America, how much do you cling to the past? For example, whether it's books or Blockbuster video stores, any things you would be reluctant to part ways with?

I push myself to embrace new technologies and new ways of doing things, but I still find a joy in reading the newspaper every morning with my breakfast. I still like the feel of a physical book. I like having books in my home and my office. Those are two things I still cling to.

As told to USC Viterbi Magazine Editor Adam Smith

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