DON'T LOOK NOW
Superposition, mind-bending physics and one very cold computer: USC unveils first operational quantum computing center at a university.
IN MEMORIAM

On April 11, 2012, the USC Viterbi School lost two of its students in a tragic crime. Below, are excerpts from Dean Yannis C. Yortsos’ memorial remarks:

“We honor the memory of Ming Qu and Ying Wu, two bright engineering graduate students in the Ming Hsieh Department of Electrical Engineering.

This is an unprecedented tragedy in our history. Words are not enough to describe how we feel.

However, in this difficult time, we are warmed by the fact that our common bonds and connections are not circumstantial. Rather, they are a strong manifestation of our powerful and enduring association — the Trojan and Viterbi family. It is the cohesiveness of this family that gives us the strength to cope with our loss today.

We, engineers and scientists, are analytical and methodical. We want to know why things happen. When we’re confronted with an unexplainable atrocity, we struggle to understand. We can’t comprehend how the lives of two young people, full of potential, full of energy, have been taken away from them so cruelly.

As engineers and scientists and as leaders, we have solved a great number of challenges. Ming and Ying were preparing to use their skills and knowledge in electrical engineering to help solve many of these issues — and thus to empower society.

Their sudden loss, however, confronts us with a different challenge. The challenge to make this world a better place, so that the tragic events that took their lives will never happen again. Here or anywhere else.

It is a different challenge than the ones we have been used to address. It is not only technical — and it is complex. But it deserves our commitment, our unwavering commitment. It is a debt we owe to Ying and Ming.”

— Dean Yannis C. Yortsos

For more information about the Ming Qu and Ying Wu Memorial Scholarship Fund and to make a donation, contact Jane Ong at (213) 821-2921 or jane.ong@usc.edu.
INTRO DEAN’S MESSAGE

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BY THE NUMBERS

Entering freshmen are women—com- pared to 18 percent national average.

NAC members inducted in last four years

30%
13.8%

346
25,000

Players reached by video games developed by USC GamePipe Laboratory

In the past, the limitation to innovation was the implementation. Today, it is the idea—and ideas are now generated everywhere on the planet.

Quantum Power

I would like to discuss a bit on innovation and give you my thoughts about it. And then, I would like to bring in quantum computing.

Fifty or so years ago, innovation was a rather infrequent event, typically the result of laborious, methodical work in research labs, often taking a long gestation time. It was a welcome, but infrequent, supplement to the routine.

Today, innovation has supplanted the routine words such as “derivative” “out of the box” and “transformative” as the norm.

I may sound discipline-centric, but the truth is that this is because of the technological and scientific advances that sprang from advances in the semiconductor and integrated circuit in the last half century. The constant and reinforcing interplay between science and technology has resulted in Moore’s law—the doubling of the capacity of transistors every 18 months. This has brought us to what we know as exponential technological, information technology, biotechnology and nanotechnology. And along with them, the opening of the vast worlds of innovation everywhere—not only in technology and devices—but also in medicine, the arts, the social sciences and communications. Largely and fundamentally because of Moore’s law, we now see the Viterbi algorithm that we have the Internet, physics, the Human Genome Project, Facebook, computer games and interactive media, robotic surgery and the unprecedented economic development in China, India and the rest of the world.

More old lines are increasingly greater opportunities: capturing them, transforming them into marketable concepts, and generating the innovation-driven economy.

In the past, the limitation to innovation was the implementation. Today, it is the idea—and ideas are now generated everywhere on the planet.
40 MPH In a La-Z-Boy
Student Adds “Recliner Roadster” to Roster of Inventions

While most teenagers resort to sports cars or dirt bikes to satisfy their “need for speed,” USC Viterbi mechanical engineering student Christopher McIntosh turned to other, more original means.

Scouring an old, Frankish red recliner chair into a modified go-kart, McIntosh created what he named the “Recliner Roadster.” McIntosh found that developing and building his invention provided him with valuable experience in pursuing a career in engineering.

Inspired by a pop-art controlled mobile sofa chair he saw at a high school robotics competition, McIntosh first equipped his recliner chair with an electric scooter motor and basic go-kart steering in 2010. But after the motor burnt out, McIntosh decided to replace it with something significantly more powerful — a 12-volt motorcycle engine that gives the Recliner Roadster to speeds of 45 to 60 miles per hour.

Though his vehicle is not street legal, McIntosh has found plenty of opportunities to drive it on basic roads and empty parking lots in his community. He has also driven it in his hometown’s annual Fourth of July parade, where he hopes to earn “Most Unusual Means of Transportation” award honors. “And though he has fewer opportunities nowadays to use the Recliner Roadster, which remains parked in his garage-up in Northern California, he is always eager to make it out for a spin or do some fine-tuning when he travels home.”

While McIntosh had technical experiences from past projects (from a wind-blown powered hang glider to a skateboard in Mrs. Mollasse’s pool), he got his technical expertise from a high school’s welding class. For the most part, he picked up most of the necessary building skills by doing it alone.

When I first started out on this project, I thought it was going to be somewhat straightforward,” McIntosh said. “I thought I would build the car and then use it for fun, and it would be simple. I bought a hardware store… I just started realizing that it wasn’t going to happen as fast as I thought, and there are a lot of things I’ve learned since I’ve started.”

The knowledge McIntosh has gained from the project has proved helpful not just in his studies, but also in his everyday life. “I think the most important thing I’ve learned is that things are not as difficult as they seem at first,” he adds.

To open the celebration, the group diverted a small trickle of the energy flow into a boombox, which trumped out a roaring solar-powered rendition of “Here Comes the Sun.”

The class, taught by professors Alice Parker, Gordon Bookler and Katharine Shing incorporated many practical aspects. During the semester, the class heard from Michael Rovin (MS ’85, MBA ’88), project manager at Solarworld, who offered perspectives on the non-engineering issues involved in alternative energy solutions along with an overview of solar thermal technologies, an alternative to the photovoltaic panels used by the class.

Parker noted that the class embodied the vision of USC Viterbi dean, Vincent J. Yacurina. “It is interdisciplinary Engineering,” she said. “It is work on one of the National Academy of Engineering’s Grand Challenges in engineering, and it follows a vision of technology leading societal change.”

Here Comes the Sun
USC Viterbi Students Capture Solar Power for Electric Cars

The Global Electric Motorcars (GEM) vehicles that are ubiquitous on the USC campus recently plug into the power grid for a recharge. But something they may be missing is plug-in solar charging stations built and designed by USC Viterbi School of Engineering undergraduates.

A preview took place last Dec. 8, when 32 juniors and seniors in the “Alternative Energy Engineering” class set up an array of eight solar panels in brilliant sunshine, generating a 1,200-watt flow of energy into batteries and a waiting GEM vehicle.

“The Global Electric Motorcars (GEM) vehicles that are ubiquitous on the USC campus recently plug into the power grid for a recharge. But something they may be missing is plug-in solar charging stations built and designed by USC Viterbi School of Engineering undergraduates.”

USC’s Michael Waterman has been elected to the National Academy of Engineering (NAE). Named a Guggenheim Fellow in 1995, Waterman is the USC Associate Chair in Natural Sciences and professor of biological sciences and mathematics at the USC Dornsife College of Letters, Arts and Sciences and a professor of computer science in the USC Viterbi School of Engineering. Acceptance to the NAE is among the highest professional distinctions accorded to an engineer.

Widely regarded as the founding father of computational biology, Waterman’s research concentrates on the creation and application of mathematics, statistics and computer science to molecular biology, particularly to DNA, RNA and protein sequence data. He is co-developer of the Smith-Waterman algorithm for sequence comparison and of the Landau-Waterman formula for physical mapping.
Energy Geography @ USC

The USC Viterbi School of Engineering is a powerhouse of research in numerous fields related to all aspects of energy. Here’s a visual overview of who is doing what, where.

Illustration by Nuan Tran

3. Loker Hydrocarbon Research Institute

Nobel Prize winner George Olah and Goury Prakash’s contribution to energy-related issues ranges from ways to eliminate lead from gas, methanol fuel cells and a new method to capture CO2 and possibly recycle it in fuels or even animal food.

4. Hughes Aircraft Electrical Engineering Center

Viktor Prasanna’s USC Center for Energy Inforamtics connects with the USC Smart Grid, enabling demand response during peak hours. Patrício Souza’s Center for Advanced Transportation Technologies works with carmakers to make road traffic safer, faster and more fuel-efficient. Mission Patriot specializes in creating more energy-efficient “green” data centers.

5. Ronald Tutor Hall

Changwai Zhao’s laboratories focus on nanotech more storage capacity in batteries using bulk-silicon nanowires; also a new kind of transparent solar cell material. The USC Energy Institute, directed by Don Paul Scher, along with The Center for Interactive Smart Gridfield Technologies (CiSoFT) — pioneering new extraction techniques and educating a new generation of petroleum engineers, Hai Wang’s Combustion Kinetics lab studies jet fuel combustion and new, ultrathin solar materials, working with Denise Phares.

6. Vaha Hall

P. Daniel Bavon and Mark Thom’s Center for Energy Nanoscience (CEN), a DOE Frontiers Research Center, finds more efficient ways to turn light into electricity and electricity into light, among the researchers on the projects are John O’Brian, Steve Cronin, Michelle Fanevell and Jingqiang Yan. Arup Paul M. Mukhedkar has been working for years on solar power deploying quantum dot and nanowires. Steve Ney’s Gil Composites Center has pioneered next-generation composite power cables with greater efficiency. Priya Sashikanth is supercomputing to perform the largest bio-nano simulations.

7. vSpace Building Chemical Engineering

Kriston Jenson is an expert in the nonequilibrium movement of oil and gas and efficient ways to extract it, in large enough, the founding director of CiSoFT, has been leading in the development of smart energy for decades. Fred Arevabiad leads in the realm of geothermal energy, consulting with practitioners in the U.S. and abroad. Behrouz Jafari’s study of rock formations, potential oil and gas reservoirs. Theodor Tomlin’s investigations of high-performance reactions, while Mohammad Sahimi sees things like fractal geometry to model the geology of rocks.

8. Andrea Bocelli Hall

Behrokh Khoshnevis is known for Contour Crafting, a speedy, energy-efficient method of ‘printing out’ buildings. Mohsen Nasr has pioneered more efficient transportation methods for California flowers, and Najmuddin Hashkani is an international authority on energy safety, from nuclear power to petroleum refining to drilling operations.

9. Viterbi Hall

Paul Romeny is an expert on combustion, specializing in tiny electrical power generators and flames in space. Fabien Spigolopoulos and his Combustion and Heat Research lab is working with Hong Kong-based TCC Foundation and Martin Gardner (Silver Science Center) on ways to reduce marine diesel emissions.

10. Kaplan Hall

Home to the USC Center on Megacities, Lucio Saldivia looks at appliance specific feedback on electricity consumption in a building. Justin Smoof-Gibson collaborates with Cyrus Sheshani and Roger Ghoson in imagining new smart buildings that allow users to control energy use (via smart phones) for more effectively than existing designs.

11. Information Sciences Institute

Mike O’Rourke directs the consumer behavior research efforts in the LADWP/DOE Smart Grid Demonstration project. Clifford Neuman focuses on energy security; protecting personal data about our usage so it’s relayed from consumers to utilities.

CHARGED UP From a DOE-SFEDS USC Center for Energy Nanoscience (CEN) in the Los Angeles Department of Water and Power’s smart grid demonstration, researchers have a huge spectrum on energy.
Anatomy of a Video Game
How to Make a Zombie Game in Five Easy Steps

You play video games on Xbox, Wii, even your cell phone. But have you ever gotten into the ‘Advanced Game Programming’ class, eight terms create games that will ultimately be graded and presented to industry representatives? Anthony Gabrielli, a junior in computer science and producer of ‘Doomsday: Warburg and the Clockwork Zombies’ illustrates how a video game goes from ideas to your game console.

1) A Spark of Genius
The idea for ‘Clockwork Zombies’ was created back in April (2011). Gabrielli and classmate Richard Napp imagined a ‘zombie game set on a futuristic space colony where the basic mechanics of rotating gears drive the course of the game.’ The team worked 15-hour days building on their ideas, perfecting the pitch. Ideas for the video game that will be produced, as well as the actual game play design, must be presented during the ‘pitch in’ in the spring semester before production begins.

2) Team Building
Once the ideas are accepted, a team is built. The ‘Clockwork Zombies’ team was initially made up of Gabrielli, Papp and Jeremy Lo and now includes four designers, a producer, a music composer, seven engineers and one sound engineer all from the Computer Science Department and the School of Cinematic Arts, as well as six artists from the Laguna College of Art and Design.

3) Plan and Prepare
Using large goals and deadlines, each team member is responsible for different game aspects: storyboarding, levels or back-end systems by a certain date. As a motivational tool, Gabrielli had each designer prototype a level, allowing each member ownership over a specific piece of the game. Each team has a task list with specific deadlines to hit, serving “a red yellow, as green go” for their tasks based on how well they completed it.

4) Execute
Refining their goals and original vision, the game is created using a program called UDK, an engine used to help create some of the most successful games. Using the same tools as the big-name game designers, developers code using UDK’s scripting language and edit the game’s cinematic typography, lighting and animation. Each designer builds the basic properties such as walls and floors, and then adds images and characters into that landscape. Most of the game’s elements are created by the designers themselves, including models and animations.

5) Present
Execution takes about a year, but once the game is complete, teams present their games to industry representatives at a day-long ‘pitch day’ last May. Representatives from companies such as EA and Activision attend to view the games and speak with the teams to either buy the games or offer these students jobs. Booking by such major companies is what allows an original idea and vision to become a reality that anyone can play on their consoles.

Saving Da Vinci’s Last Supper from Air Pollution
Air quality monitors show dramatic reduction in air pollution at the painting’s location

Having survived long centuries, political upheavals and even bombings during World War II, Leonardo da Vinci’s masterpiece “The Last Supper” once faced the threat of dust from air pollution due to its location in one of Western Europe’s most polluted cities.

In late 2011, the refectory of Santa Maria delle Grazie Church, where the painting is located, installed a sophisticated heating, ventilation and air conditioning system to protect the painting from the polluted air of Milan.

To test the effectiveness of their pollution countermeasures, Italian officials called on Constantino Sciortino, professor of civil and environmental engineering at the USF, Viterbi School of Engineering. For his ongoing research, Sciortino designed underwater air samplers that are compact and quiet.

“These air pollution sampling technologies are ideally suited for use in sensitive facilities such as art galleries and museums. They do not disrupt the day-to-day operations of the facility,” Sciortino said.

A multinational team deployed two sets of air quality monitors for one year at the church and found that “for the most part — the Italian authority responsible for the facility housing the famous painting (Regione Lombardia per il Bambino Gesù e il Sacro Cuore di Maria di Milano) is winning the war with outdoor air pollution. Base and coarse particle mass concentrations were reduced around the painting by 66 and 59 percent, respectively from their corresponding control levels.”

“It’s a spectacular reduction,” Sciortino said. “It is, very, very impressive.”

Indoor sources of pollution, however, may still pose a threat. Nancy L. Baker, USF graduate student and lead author of a journal article on the team findings, said that “dust fumes from the skin of visitors to the church still appeared in significant quantities around the painting — even with visitors removed to the painting gallery.”

In addition to aiding in the conservation of “The Last Supper,” the team’s research can also be used as a benchmark for future studies aimed at protecting indoor artworks and antiques. — A.P. and K.S.
Center for Data Visualization and Collaboration (DVC)

Founded in 2000, the center provides the ability to view simulations generated by high-performance computers such as DVC’s High Performance Computing and Communications facility, the 7th fastest academic supercomputer in the nation. Positioned in a space formerly occupied by the engineering library, the center consists of 10 digital projectors behind the IMAX model glass AT3D® Theater, upon which 175 million pixels are projected. Three 55-inch, movable LCD screens and three suspended projectors offer additional projection options for visualizations designed by graduate students. The center is the brainchild of three professors, all in high performance computing for over two decades. Rajee Kalia, Aichiro Nakano and Priya Vashishta.

Priya Vashishta Director, DVC Center for Data Visualization and Collaboration, Professor, Materials Science

Currently working on a variety of projects funded by the DOE, NIH and NSF, Vashishta says his ongoing philosophy in creating visualization projects is to only work on the largest projects. “The Center’s working visualization should be ‘so cool that they can show it in one second and then explain it in a couple of minutes.’”

Rajee Kalia Professor, Physics

“This is the best of times for computational science and engineering; it’s where the world’s most important problems will be solved by computational science, and for large scale modeling, this is it — we have the best team in the world.”

Ken-ichi Nomura, Assistant Research Professor, Physics, Ph.D., Materials Science

For graduate students working with the center, visualization, data, and machine learning have developed a combined Ph.D. program in Science/Masters of Computer Science program with a concentration in high performance computing. Job prospects for graduates of the program have been excellent, sending them into the finance, software, drug and healthcare industries, among others. Of her experience working on a variety of the center’s important projects, Ph.D. student Max said, “Simulations are an alternate way of solving problems that aren’t necessarily be asked by traditional experiments.”

Aichiro Nakano Professor, Computer Science

“We are simulating, by far, the biggest things, and it’s not just quantitatively, but in terms of performance. It’s between the three of us, you have over 40 years of experience in this area and a great group of students.”

About the Simulation Shown in the Photo: Depicted here is the impact of a pressure boundary on a high performance computing grid. Atomic structure model of copper is shown to expand or contract according to energy and pressure, with red indicating the highest energy. This simulation research was supported by the National Science Foundation, the Department of Energy and the Department of Defense.
Dude, Where’s My Parking Space?
A mobile laboratory: USC Viterbi’s Audi smart car sparks ideas on intelligent parking, outwitting traffic and personalizing the driving experience.

Julie Higle
USC Viterbi School of Engineering

Julie Higle has announced the appointment of Julie Higle as chair of the Chair of the School of Engineering’s Department of Industrial and Systems Engineering. The appointment, effective January 1, 2012, has an expected term of three and a half years.

Higle is an associate professor in the School of Engineering and has been associate chair of the Industrial and Systems Engineering department. Higle, who joined the faculty in 1998, became associate professor in 2003. He was awarded a Ph.D. in Civil Engineering from the University of California, Berkeley, in 1998.

Higle’s research focuses on developing information technologies for design and management of complex systems, including buildings, utility systems and transportation systems. His work includes the development of optimization methods and algorithms, with a focus on efficient buildings, intelligent infrastructure and structural-health monitoring systems.

Pirates Beware: Viterbi Mini Satellite Will Be Watching

New Cube Satellite First to Track Cargo Containers Over the World’s Oceans

Earlier this August, USC’s Space Engineering Research Center (SERC) was siding to launch its current satellite, a modified Cube 1 “cube-sat” called Annis. Launching from Vandenberg Air Force Base near Lompoc, California, Annis joins seven other miniaturized satellites on a United Launch Alliance Atlas V rocket.

Viterbi Engineering Professor David C. C. Greenfield and his research team are the first to create a microsatellite system that can track cargo containers throughout the world. The Annis satellite contains 17 high gain, high data rate antennas that are capable of communicating with hundreds of shipping containers at any given time.

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Maseeh Entrepreneurship Prize Competition (MEPC)

An annual business plan competition to help inspire Viterbi student innovators to be at the forefront of the NIKE Innovation Challenge. Through a generous gift from Farbod Maseeh, MEPC provides a $50K award in seed funding. Here’s a sampling from the 2013 competition, from virtual concerts to water conservation.

Photography by Iden Montes

Club Consortia

Company
Andy Martin
Viterbi M.S., Computer Science for Game Development

School of Business
Matthew L. sausage, UI/UX M.S., Head of Business Development

Ajinkya Waghade
Viterbi M.S., Computer Science for Game Development

Team Members
Robert Allen
Alex Villard

The Pitch
“Club Consortia is a persistent virtual concert environment where people worldwide can participate in a 3D simulation of a real-time live artist performance. Each participant will be able to customize their own personal avatar for the concerts while earning and purchasing unique ranks, dance moves, archived performances, and more.”
DropOff LLC

Company: Sputnik
MBA candidate, Marshall School of Business
Jonathan Beckhardt
MBA candidate, Marshall School of Business
Jay Shah
Viterbi M.S., Electrical Engineering
Team Mentors: Ali Fakhari
Ivan McGrady

Creative impulse:
"I was driving through a school zone and realized that the real-time radar display system created a feedback loop of information that caused me to slow down. I realized that this feedback loop was so simple and yet such a powerful tool to modify human behavior. It was a logical progression to apply this concept to energy and water conservation.

DropOff automatically provides real-time water usage information for college dormitory residents in the shower, increasing water conservation behavior and providing efficiency and cost savings."
The River and the Sky

Bringing Fresh Water to the People of Two Honduran Villages

By Jon Campbell

Augusto “Ozone” Alonso stood by the river, saturated from hard work and the Honduran sun. His team of student volunteers and local villagers had spent three miserable days fighting La Enfamella, a wide, heavy river running below the village that shares its name. They had finished building the small levee of sandbags and mud protecting their project site, and the ground had begun to dry down, about seven feet would be laid and concrete poured for a dam that would bring badly needed water to the village above. The team was in country for seven days, and with three already spent on the levee, they were desperately short of time.

For Alonso, a biomedical engineering student and member of the Engineers Without Borders chapter at the USC Viterbi School, last December was his fourth trip to Honduras, all as an EWB project manager. He and 10 other Viterbi students are the latest in a half-dozen efforts to provide freshwater to isolated villages in rural Honduras.

They drew from Los Angeles last winter break to work with local villagers on the small dam, which will power a water wheel, pump and force water up a steep hill into the village above. For this trip, their plan was to build a small 10-foot portion of the dam while educating locals in the details of its construction. But the river would not be ignored, and as Alonso watched, a single sandbag began to slide off the levee. Within minutes, bags and mud gave way, flooding the site and setting the team back by at least a week.

Alonso wondered, “Are we going to be able to do this?”

La Enfamella is a village of 300, located 10 miles outside the modern city of Marcala. A steep dirt road leads from the city and into the rural countryside, where locals still lack clean water and sewage systems of any kind. They rely on natural springs and ground water, shared with farmes and livestock. Dehydration and gastrointestinal illnesses plague the villagers, as agricultural runoff, waste oil and fecal matter contaminate their sole source of water.

If the construction of the dam was not completed before spring, the wet season would flood the river and the whole project would have to be postponed for another year. The night of the levee collapse, Alonso began planning the only solution: start construction on the opposite river bank and build the dam backwards from the original plan. The workers of a dozen trips to the village materialize from Alonso in one almost desperate sentence, “We have to be in full force to do this.”

Three miles to the east, co-project leader Kristen Showcase leads another group of EWB students in the village of Corral de Piedra. The village suffers from the same poor quality water as La Enfamella, but is too far from the river to be a viable source. Instead, they are building a rainwater catchment system that will store several thousand gallons of water collected during the rainy season in massive tanks that were donated by the government of Marcala. Their previous trip focused on building the concrete pads for the heavy tanks and now the system of PVC pipelines that transports the captured water must be finished.

Shaver is excited with the local response. They were handout at first, but with communication and our commitment to the project, they have started to embrace the possibilities the tank and filters will offer.”

As the dam site, Alonso’s teams are finishing the first section of the sloping concrete and eastern dam. It’s their third day in country and he is optimistic. “After the sense of hopelessness, I am more confident than ever that the dam will be completed before the wet season in May.” While the EWB teams have brought blueprints and schematics, the local villagers, “weavers in concrete” according to Alonso and Shaver, have spread plastic sheeting and straw rice fresh concrete, allowing it to cure in the end, the dam’s completion will not with them. Shaver is especially aware how their experience is altering the idea of charity. “The EWB is about expanding our perception on solutions that weren’t in the First World could be a solution in rural Honduras. These projects have to focus on sustainability, on keeping things as simple and low cost as possible. We focused on the right solution for these villages and went with it. What we created now will last.”

Story update: As of this printing EWB-HWB has completed both projects in Honduras. The school children of Corral de Piedra are happily enjoying clean water with their school lunch, and the people of La Enfamella are preparing to open their distribution system to provide clean water directly from the river to the top. This fall, EWB-USC eyes a return with all new projects.
Books of the Future

The Engineering Behind Electronic Ink Displays

The following is an abridged version of an article published by Illumin Magazine.

The article in its entirety can be found at http://illumin.usc.edu.

How Does it work?

The most commonly used type of electronic ink works through electrophoretic technology. Electrophoretic ink takes advantage of different colored, oppositely charged particles moving into view to form patterns. Electrophoresis separates particles by their charge by applying voltage via electrodes; positively charged molecules are attracted to negative voltages, and negatively charged molecules are attracted to positive voltages. The ink itself consists of
countless solid microparticles that have three main components: Negatively charged black particles, positively charged white particles, and transparent liquid.

To make an electronic paper display, the ink is poured onto a sheet of plastic, forming an evenly distributed film of ink microparticles. The plastic sheet is laminated to a layer of country, then another transparent plastic layer is then applied on top, creating the microparticles between the two sheets. The embedded electrodes use negative and positive charges to attract and repel the colored particles, forming text and images.

A Sustainable Alternative

According to the Green Pages Initiative, the U.S. uses more than 20 million trees to make paper for books and almost 95 million for newsprint each year. The cost for the Harry Potter book series alone is estimated at 5 billion trees.

Electronic ink may help in sustainability efforts. One small reader can display many different books in a case, saving both landfill space and trees. Electronic ink price labels in retail stores can be reset at any time and reused, saving countless paper slips. A university study estimated that the use of paper books led to four times more greenhouse gas emissions, three times more water usage, and thirty times more water consumption per person than the use of e-readers. In addition to producing less waste and using fewer resources, electronic ink devices use little power, making them a viable replacement for paper products that produce waste and consume valuable trees.

Reading into the Future

There are known issues in the current state of electronic ink, and the technology is commonly thought of as highly specialized, nearly limited to use in e-readers.

Though most devices now use the method described above to make an electronic paper display, the ink can be printed on a variety of substances, glass, paper, plastic, and even fabrics. Recent breakthroughs in adding color to electronic ink, along with efforts to develop thinner, more flexible, and more durable displays with responsive, touch-screen capability promise a world of applications beyond the range of traditional LCD displays.

Conclusion

Electronic ink is bridging the gap between the brightness of screens of the digital age and the traditional world of pen and paper. Electronic ink has taken off in the past two years, and further advancements in the technology will likely revolutionize its application within another decade. Regardless of whether you want to conveniently download and read college textbooks or save the planet by converging trees, look forward to seeing more and more electronic ink options in the future.

More at http://illumin.usc.edu

Thought Controlled Wheelchair

Spread the Starch: A Brief History of Music Reproduction

Composite Technology and the Hockey Stick Revolution

"Layers of paint are simply covering what’s below the layers."
— Frances Adkins, author, "The Hitchhiker’s Guide to the Galaxy"

PHOTOGRAPH COURTESY OF AMAZON.COM, INC.

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ILLUMIN’S mission is to illustrate the many ways engineering breakthroughs impact life in the community, nation, and world, and published by undergraduate stu- dents at the Viterbi School of Engineering.
NASA Funds USC Plan to Print Out Moon Buildings

Viterbi and Architecture Schools partnering on lunar Contour Crafting effort

The natural home for a revolutionary USC Viterbi School of Engineering technique for "printing out" Fahrenheit-building buildings may be the moon.

Belinda Roberson, a Viterbi School professor with appointments in three departments, has received funding from the National Aeronautics and Space Administration (NASA) to test the Contour Crafting system for lunar construction.

Roberson and collaborators will be designing such items as lunar roads, landing pads andopping pads, walls, doors, and windows for buildings on the lunar surface. "We have a lot of experience on the Mars, as well as the Moon, so this is nothing new for us," says Roberson. "But it's the first time we're building structures on the Moon, which is a different challenge."

The funds from NASA will allow Roberson and her team to design and construct a small-scale model of a lunar habitat using the Contour Crafting technique. The goal is to demonstrate that the technique can be used to build structures on the Moon, which could potentially be used as temporary habitats for astronauts during missions to the Moon or Mars.

Roberson and her team plan to use the Contour Crafting technique to build a small-scale model of a lunar habitat using 3D printing technology. They will use a special 3D printer to print out the walls, floors, and ceilings of the habitat, which will be made of a materials called "lunar soil" or "regolith" that is similar to the soil found on the Moon. The habitat will be designed to accommodate two astronauts and will include life support systems such as air supply and water purification.

The project is expected to take about six months to complete, and the final product will be a small-scale model of a lunar habitat that can be used as a prototype for future missions to the Moon or Mars. The model will be tested for structural integrity and will be evaluated for its potential use in actual missions to the Moon or Mars. The results of the project will be used to inform future NASA missions and to help develop new technologies for building on the Moon.
I never saw a real computer until college, but I had friends named Roddenberry and Nimoy. They told me about computers that could pilot starships or solve the world’s greatest riddles.

Ten years ago, I started doing very theoretical research. Algorithms that used randomness to coordinate robots on the surface of Mars.

Computer science was a riddle to my parents. What was it exactly? You can’t see it like a 2,000-meter bridge.

Turns out, we don’t need randomness on Mars. We needed it here on Earth.

My mentor once told me: “You don’t choose the problem. The problem chooses you.”

I didn’t know it then—but one day in September, the problem chose me.
WHAT'S NEXT

How can we use randomness to stop the terrorists? I turned to something called "game theory."

Imagine you have eight doors you need to protect, but you have only one cop. What if -- what if you could create the illusion that you actually had eight cops? It would be like your own Phantom Army.

Working with my students at the USC Viterbi School of Engineering, we created a software program called Armor.

q A couple months ago, there was a rash of thefts in a neighborhood like clockwork. The thieves knew exactly when people left and returned home.

The terrorists are the same. In a world of schedules, of patterns, they learn to exploit them. They like predictability.

Since 2012, it's used 'intelligent randomness' to protect everything from airports, passenger jets, U.S. ports, and public transportation.

There are six inbound roads to LAX. Not enough police to man checkpoints on all roads at all times. These are eight terminals. Not enough BY units to patrol all of them.

For the bad guys, what they don't know -- what gives them pause -- is where and when these limited security forces will be deployed on the day they attack.

That's what Armor decides.

There are thousands of international flights every day in the United States. We don't have an air marshal for every flight. The bad guys know this, too.

We created Armor to keep them guessing.

Someone once asked, "Where did you get all these extra boats?" I said to laugh. The Coast Guard has the same boats as before.

Armor is not limited to just security. In a world where computer algorithms help find the underhanded big-league pitcher or predict the weather months in advance -- it can be used for any problem you have limited resources and can't be everywhere at once.

A personal favorite: Protecting endangered tigers in the Indian subcontinent.

I never built a bridge or a highway. My work is invisible. I can take my kids to see a checkpoint at LAX, but it's not quite the same as the Taj Mahal or the Howrah Bridge.

My success is based on a non-event. I'm OK with that.
1972. The space shuttle program began; the CD, the digital watch, Fortran and C programming languages were invented; and the Atari Company released an explosively popular new product called Pong. In the midst of this, 40 years ago at USC, three remarkable institutions were born.

Here are the stories from then and now: the USC Distance Education Network, the Signal and Image Processing Institute, and the Information Sciences Institute, all about big promises made — and delivered.

Signal and Image Processing Institute (SIPI)

The cover of the November 1972 issue of USC Engineer contains a photo image of Earth from the new “image processing.”

About this entire issue that follows is dedicated to the achievements of a remarkable group of researchers who found each other at USC in the 1960s—led by alumni William Pratt (EE 549, 61 Ph.D. ’69) — and went on to history, a history that included embedding the basis of a Playbooy model as an icon in the literature.

In 1972, a major grant to Pratt led to the founding of the USC Image Processing Institute (SIPI) which subsequently transformed the discipline, creating software that remains in daily use today, as the ubiquitous file label “JPEG” illustrates. SIPI was later renamed as the Signal and Image Processing Institute (SIPI) to reflect its expanded research activities.

Pratt now at Portland State began a USC graduate student under Irving Reed, a pioneer in the field of information theory. Reed steered him to research in video coding which became his Ph.D. thesis, one that opened the field to research.

At the time, simply capturing an image — either video or still electronically — had already been solved. Pratt and his backers created SIPI to solve three related problems: “image coding, image restoration and enhancement, and image data extraction.” Coding models reducing the amount of information required to transmit or reproduce video or photos so that, for example, a space satellite could send back volumes of usable images despite severe weight, space and energy limitations.

Lots of the initial work was done on a single image machine — half a picture from a Playbooy scanned by a student, wound up being propagated around the research community and was the prototype subject for a type of coding that is now ubiquitous, the JPEG.

The invention of JPEG was not an isolated achievement for SIPI. Other outstanding achievements, many by faculty still at the Viterbi School, include:

- MOSAIC, the storing image equivalent to JPEG in economic recording and transmission of video, with major innovations in fast motion search and rate control contributed by C-C. Jay Kuo and Antonino Lopes, respectively
- Image recognition and detection, pioneered by Pratt’s close colleague Larry Andrews
- Medical imaging developments, including the “Keinein” software system created by Richard Loebel.

FROM PIONEERING THE INTERNET, SENDING SATELLITE IMAGES THROUGH SPACE OR BRINGING EDUCATION ACROSS CONTINENTS, THREE VITERBI INSTITUTIONS ARE JUST GETTING STARTED. BY ERIC MANKIN
Distance Education Network (DEN)

In 1972, the expression "distance education" was born, and slowly and widely embraced. For decades, some had written about the promise of live television for teaching leading the FCC to license local TV transmitters by colleges in 1955. But few real world examples existed when USC's Educational TV Environment took the lead in creating the Norman Topping Instructional Television Network (ITTV) to address the continuing needs of engineers working in the service for the PBS. The architect of the system was Jack Malir. In the early 1970s, Malir came to USC in 1969 from Hughes Aircraft. "To an extent few people realize, we at the institute were fortunate to have Jack Maley following Norman Topping's passing in 2005. When the DEN

Artificial intelligence, teaching machines to think the way humans do is a primary focus at ISI, which has led to using these techniques to help write the IBM Watson system that won "Jeopardy!"
2012: A Quantum Odyssey

How USC Became Home to the World’s First Operational Quantum Computing Center at a University and Why It Matters

by Adam Smith, photograph by Adam Voorhes

At noon, on December 23, 2011, the USC Viterbi School of Engineering awakened its first volcano.

Odd thing is, despite its location in Marina Del Rey, this particular “volcano” was situated in one of the coldest places on earth – 100 times colder than intergalactic space.

The crown jewel of the USC Lockheed Martin Quantum Computing Center, the 128 qubit Rainier chip – christened after the massive stratovolcano outside Seattle – became operational two days before Christmas last year. There was no fanfare of trumpets. No banks of coruscating neon lights.

Somewhere in the USC Information Sciences Institute (ISI), inside a 12-foot black box, a tiny quantum processor began to stir. The culmination of 12 years of work by Canadian-based D’WAVE, Rainier had found its first customer in Lockheed Martin, the world’s largest defense contractor.

Lockheed Martin, in turn, had found a home for the cold, black box at ISI, the university’s storied research institute.

In the years to come, the USC Lockheed Martin center may prove to be the testbed for a whole new generation of quantum engineers. It may begin to solve the sort of optimization problem that outstrip classical computers. Indeed, Rainier’s successor – the 512 qubit Vesuvius chip – has the potential to solve problems in 120 milliseconds that would take the world’s most powerful supercomputers 380,000 years.

For now, December 23, 2011, may be remembered as the day a payroll tax cut was passed by Congress. Or the first Friday of the Mayan doomsday calendar.

Or something else entirely.

The Conversation

(Bill Allen, Lockheed Martin’s chief scientist, had a problem.

All sophisticated hardware, from the Chevy Volt to the M16, has lots of code. But when an operating system fails, it’s a major annoyance. When a multi-billion dollar F-35 Joint Strike Fighter (software bugs, it’s mission critical).

In January of 2010, Allen requested a meeting with Daniel Loker, professor of electrical engineering and director of the USC Center for Quantum Information Science & Technology. Loker thought it was a meeting about potential funding from Lockheed Martin; he talked quickly turned to jet fighters.

As Loker notes, “Microsoft can release a version of Windows whenever they want, and the worst thing that can happen is customers will complain that the operating system is crapping out. But when you talk about an airplane, it won’t even get off the ground until you have convinced the people in charge the software runs correctly.”

Allen explained that means a process called V&V, verification and validation – whereby Lockheed engineers essentially test to exhaustion either of bugs or the engineers themselves. Lockheed Martin’s F-35 jet fighter has
With quantum computers we should be able to solve problems in a matter of hours, instead of... the age of the universe

QUANTUM QUOTABLES

“My career started with programming Von Neumann’s original machine. Fortunately or unfortunately, I go back a long ways in this computing racket. And to me, the best part of (the D-WAVE machine) is if I go downstairs – it’s a real machine, it’s hardware. I can get my hands around it. I think we’re at the dawn of a new era of computing in our lifetime.”

Hartmut Neven
Executive Director, USC Information Sciences Institute

“Sixty years ago, the UNIVAC I (the Universal Automatic Computer), the first commercially available computer in the United States was first sold to the U.S. Census Bureau. It was initially conceived for business and administrative use – it could add two 10-digit numbers at a rate of almost 30,000 additions per second. It even predicted the election victory of Douglas D. Eisenhower the following year. Even so, anyone, predicted that this 14-ton machine would revolutionize every aspect of how we live and work.

ENIAC was the first modern computer in the United States – all subsequent computers have been merely improved versions with more advanced microelectronic, memory and communication technology.

The D-Wave One Adiabatic Quantum Computer represents not merely the latest sunset of UNIVAC, but the next big leap – the advent of viable supercomputing.”

Vernon C. Torbert
Dean, USC Viterbi School of Engineering
Q&A: SETH LLOYD AND DANIEL LIDAR

SL: Why are you interested in adiabatic quantum computation, and what made you decide to help Lockheed Martin operate their adiabatic quantum computer?

DL: My interest in adiabatic quantum computation (AQC) is driven by my perception that it is likely to be the approach that will lead to the first realization of a truly large-scale quantum computer. I am also fascinated by the intrinsic beauty of the idea of guiding quantum dynamics to find the solution to hard problems. AQC is still relatively unexplored compared to the circuit model, which means that there are still major open questions to be answered.

Regarding Lockheed Martin, USC is grateful to the company for its decision to partner with us, and to establish a joint and equal partnership research center.

SL: Although the jury is still out on whether adiabatic quantum computers can provide an exponential speed-up over classical computation, many quantum computer scientists with whom I have spoken have expressed skepticism that adiabatic quantum computers can provide such a speed-up even in principle, let alone in practice. What do you think?

DL: We know from theoretical work that in principle AQC is “computationally equivalent” to standard, circuit model quantum computing. This means that any computation performed on one model (fully-fledged or circuit) can be simulated with modest polynomial overhead using the other model. In this sense, any exponential speed-up over classical computation that is known to exist in the circuit model immediately translates over into an exponential speed-up in the adiabatic model. You are probably referring to the fact that we don’t yet know whether adiabatic quantum computers can be made fault-tolerant and thus resistant to decoherence and noise, and that this seems essential to ensure a speed-up, at least based on our experience with the circuit model. And here I must agree that the jury is still out... in summary, I do not share the skepticism that there is some fundamental reason that adiabatic quantum computers cannot provide a speed-up. Whether we can achieve this in practice is of course a very different question, and one of the reasons we want to work on what can be done with the D-Wave chip.

SL: Are the D-Wave adiabatic quantum computers ending up in their ground state—and so solving the desired problem—after a fully coherent quantum process, or do they end up there after some messy, noisy, quantum thermal process? If you think that they are operating coherently, what experimental evidence can you adduce that suggests that?

DL: We know that the D-Wave chip doesn’t always end up in the ground state. But this is OK as long as it ends up in the ground state with high probability. We can run the computation a few times and amplify our confidence that we obtained the right answer. This is the general procedure also in classical probabilistic computation, and so doesn’t present a problem. The fact that the D-Wave chip doesn’t always end up in the ground state also teaches us that the process is to some extent incoherent, noisy, and quantum thermal. On the one hand we can expect that some of this can be engineered away. On the other hand, you hope the more interesting question is whether it is really essential to strive for completely coherent adiabatic evolution in order to start to outperform classical computation. There is theoretical evidence that even partly localized quantum processes can outdo classical computers in certain tasks. In any case, the question of the “quantumness” of the D-Wave chip is probably at the top of our research agenda at USC, and is one we are actively investigating.

SL: What kind of hard problems are you currently posting to the adiabatic quantum computer?

DL: Under the very able leadership of Dr. Sergio Hono, who was recently hired as our first Quantum Applications Engineer at USC, we are currently performing very detailed benchmarking of the D-Wave chip. We are studying primarily medium-dimensional quantum state spaces and noisy quantum lattices. The one-dimensional chains are “easy,” in the sense that we know right off the bat what the ground state should be, and so we can characterize the actual performance of the processor relative to what is expected. The two-dimensional lattices are more interesting and more challenging, since it can be very hard to find the correct ground state even classically. In fact, the layout and connectivity of the D-Wave processor was designed to enable the chip to solve a problem that is in NP-hard to the ground state of the classical Ising model on a 2D lattice graph. We don’t yet know whether the processor can solve this problem with any speedup compared to classical computers, and our benchmarking is designed to address this very question.

SL: Are you optimistic about the future of adiabatic quantum computing?

DL: I’m an optimist by nature. We already have preliminary numerical indications that there is entanglement in the state of the D-Wave chip, and I think that is suggestive of the required quantum magic is present. Ultimately, I believe that some form of error correction will be necessary in order to ensure continued scaling, and this will probably be the main obstacle. I hope that the work we are doing at USC with the D-Wave chip will serve to inspire others to continue to work in this area, even to the point of gambling. It will be the first demonstration of a quantum computation that runs faster than any current classical machine will be done using adiabatic quantum computing.

DL: As Neil de Broglie famously said, “Prediction is very difficult, especially about the future.” Through the USC Lockheed Quantum Computing Center is still in its infancy, its research has profound implications for aerospace, medical imaging, robotics, finance, web search, bioinformatics and other disciplines. Here’s just a sampling of potential applications:

What Quantum Means For You

As Neil de Broglie famously said, “Prediction is very difficult, especially about the future.” Through the USC Lockheed Quantum Computing Center is still in its infancy, its research has profound implications for aerospace, medical imaging, robotics, finance, web search, bioinformatics and other disciplines. Here’s just a sampling of potential applications:

Cheaper, More Efficient Solar Power

More sunlight falls on the surface of the Earth in one hour than is necessary to provide energy for the entire world for a year. The problem is a matter of efficiency—most of that energy is wasted. So what are scientists best at trapping sunlight or converting to electricity? It’s an optimization problem with so many variables, only a quantum chip has the processing speed to deal with it effectively. For example, working in concert with Harvard’s Alanasuring, the D-Wave machine is now analyzing 10 million molecules that might be per-fect candidates for cheap photovoltaic plasmas.

Image Recognition

This is essentially an area of machine learning—how do you teach a computer to find a needle in a haystack? With the advent of digital photography, the world produces billions of photographs. Humans, of course, can easily identify objects in a photo, but computers can’t. Enter quantum. Imagine a future when you can search Google images and find anyone wearing your high school class colors or the EPA can detect the slightest changes to pollock lepores from a waist of satellite imagery.

New Designer Drugs

Proteins are the workhorses of the body, taking a wide variety of tasks. They fight infection, turn food into energy, copy DNA and oversee chemical reactions. Insulin is a protein, as are antibodies and many hormones. And like a piece of biological software, the protein folds itself into the form necessary to carry out the job. Without the shape, the protein would be worthless. It’s very hard to simulate protein folding, even on the most powerful supercomputers. If you want to make a designer drug, for instance, you don’t know how the right atoms would be arranged. What shape will they be in? That’s a quantum problem.

Web Search

Today’s internet landscape has billions of web pages. Google’s PageRank algorithm must go through all these sites on a routine basis to curate your search results. But this problem quickly becomes one of scale—what happens when there are billions of web pages? It turns out that PageRank can actually be mapped to quantum computing and made faster. Though the computer is huge, the underlying principle is simple and will be crucial to how we consume information across all of digital universes.
Digital pioneer Sol Golomb celebrates 50 years at USC

by Eric Mankin, photography by Nao Montes

More than six decades ago, a Baltimore-born prodigy graduated from Johns Hopkins University with a B.S. in mathematics before his 18th birthday. That individual remains brilliant in 2022, celebrating his 80th birthday and his 50th year on the faculty of the USC Viterbi School of Engineering—a school named after the young graduate student he mentored many years ago.

Pioneered a U.S. radar defense system in World War II, a computer in the 1950s and a cryptosystem in the 1960s. He is a Distinguished University Professor of Electrical Engineering and Computer Science.

Golomb received his Ph.D. from Stanford University in 1953, where he worked on error-correcting codes. He is a member of the National Academy of Engineering and was elected to the American Academy of Arts and Sciences in 1974.

Golomb is known for his work in coding theory, combinatorics, and graph theory. He is the author of several books on these topics and has published over 500 papers in scientific journals.

In 1957, he co-authored the paper "A Mathematical Theory of Information," which laid the foundation for modern information theory.

Golomb is also known for his work in cryptography, where he developed methods for encoding and decoding messages that are resistant to eavesdropping.

In the 1960s, Golomb worked on the development of the first digital computer, the DEC PDP-1. He also worked on the design of the first digital television system, the RCA 1701, which was used to transmit the first television broadcast from Hollywood to New York City.

Golomb is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and the National Academy of Engineering.

He has received numerous awards for his work, including the IEEE Centennial Medal, the IEEE Centennial Medal, the IEEE Millennium Medal, and the IEEE Centennial Medal.

Golomb is currently the Allen and Mary S. Puckett Professor of Electrical Engineering and Computer Science at the University of Southern California.
Golomb insights enabled the Mars rovers to send back clear video images of what they saw on the surface of the red planet: 100 million miles away.

The Many Facets of SOL

THE WUNDERKIND
Mars images that required 400,000 calculations per second. (Analog photo of early SOL team.)

THE GREAT COMMUNICATOR
Charles, whose SOL team was responsible for organizing the waveforms of the spacecrafts' signals.

THE LEGEND
A symbol of true courage and determination, the SOL team worked tirelessly to send back images from Mars.

THE GAME-MASTER
A master of the art of communication, Sol Golomb developed the coding schemes that allowed the spacecrafts' signals to be transmitted without error.

THE POLYOMINOMES
Polynomials are a fundamental concept in mathematics, and Sol Golomb's work in this area has had a significant impact on the field.

THE ORIGINALIST
Known for his work in the field of originalist research, Sol Golomb has made significant contributions to the field of electronic systems.

THE HONOREE
An honored member of the SOL team, Sol Golomb has been recognized for his contributions to the field of electronic systems.

POLYOMINOMES
For Sol Golomb's work on polyominoes, he received the Fulkerson Prize for his contributions to the field of mathematics.

THE IN THE BEGINNING
At age 8, Sol Golomb's father, a professor of mathematics, noticed his keen interest in numbers and encouraged him to pursue a career in science.

THE WUNDERKIND
Sol Golomb, at age 8, was already solving complex mathematical problems.

THE GREAT COMMUNICATOR
Sol Golomb, known for his ability to communicate complex ideas in a clear and concise manner, has been a key figure in the field of electronic systems.

THE LEGEND
An unsung hero of the SOL team, Sol Golomb's contributions to the field of electronic systems have been celebrated and recognized.

THE GAME-MASTER
A master of the game of life, Sol Golomb has developed algorithms that are used in electronic systems.

THE POLYOMINOMES
Polynomials are a fundamental concept in mathematics, and Sol Golomb's work in this area has had a significant impact on the field.

THE ORIGINALIST
Known for his work in the field of originalist research, Sol Golomb has made significant contributions to the field of electronic systems.

THE HONOREE
An honored member of the SOL team, Sol Golomb has been recognized for his contributions to the field of electronic systems.
CHARIOT RACE

During the 1970s and ’80s, the 6-week chariot race was among the fondest memories of many USC engineers. According to Raymond Lowe (CE ‘84, BSEET ’83), all manner of engineering clubs, fraternities and societies would compete for Ben-Hur-esque glory, designing and building the perfect chariot or Rickshaw-based transport, assigning two runners and a jockey to complete one full lap around the engineering quad.

“The lightest guy was always the jockey,” said Lowe, “and that happened to be me. If the handle broke or if the two runners lost control, the jockey was in a bad place. Our chariot actually broke, and I ended up flat on my butt ... the mechanical engineers always won.”
Fire in Two Valleys

Former Silicon Valley entrepreneur turned V.C., Feng Deng (MS ’93), is looking to ignite the Chinese Silicon Valley

by Adam Smith

It was 1995 – nearly 10 years after Chairman Mao’s death and the end of the Cultural Revolution. Twenty-two-year-old Feng Deng sat in his room at Tsinghua University and read stories about another revolution: this one some 11,000 miles away.


It was the first time he’d ever heard of a place called Silicon Valley. In China, our English wasn’t so good, we called it Silicon Valley. It was also the first time he learned another company stood for entrepreneurship. That concept, for Deng and his fellow classmates, simply didn’t exist.

“Those people changed the world,” said Deng. “They created things and changed the world.”

While in China, the (few) people’s lives were like at that time—after graduation, you [died] look for a job. The government would say: Hey, your background is in this area, we’ll give you a job over there. They allowed jobs to the graduates of that time.

Deng read “Fire in the Valley,” noticing, leading to a bit of a shock in his own mind, namely to the idea that he couldn’t choose his own path.

Half a lifetime later, Deng’s path has hopped across the Pacific Rim, first as a USC Viterbi student (MS in Computer Engineering, 1993), then as a Silicon Valley entrepreneur with NetScreen Technologies and today as the co-founder of Northern Light Ventures Capital, one of China’s leading investors in Zhongguancun — the Silicon Valley of China.

Today, one of his greatest ambitions is to fashion a bridge between these two alien makers, USC and Tsinghua. Deng imagines a future where highly skilled technical students from China can receive a dual master’s degree from both institutions one year at Tsinghua and one year at USC where they gain exposure to the state of the art research, innovation, and above all-culture.

For Deng, gone are the days of taking Tudou — the instructions he received from the Chinese state on how to interact with Westerners during the 1974 Nixon visit. Not too hot, not too cold, not humble, not arrogant. Give us as much information as required — politely — and then go. Deng, the product of a global education, is now among its principal cheerleaders.

In contrast to his time at USC, Deng, creatively, in Deng’s view remains a challenge for the current Chinese education system. “I feel no such sympathy for the current Chinese students,” said Deng. “They study as hard as we’re competitive. For an elementary school student, they start at probably 10:30 hours per day, seven days a week.”

Deng considers himself sufficiently fortunate that he came of age in a People’s Republic of China that, comparatively, was only just beginning to re-embrace its ancient state examination in the wake of the Cultural Revolution.

One of the defining moments of his childhood, in fact, was the 1969 Sino-Soviet border conflict. Fears of an imminent Soviet invasion prompted a massive state-ordered evacuation of Beijing. Within three to four weeks, all of the city’s economic and government officials, including Deng’s family, had been relocated west to Hohhot, Inner Mongolia.

But for Deng, that two-year exodus wasn’t exactly a time of terror. It was a time of exploring the rural countryside, of learning to swim in the Yangtze River, of exploring the relics of ancient wars and watching movies.

“It was actually (a) pretty happy time for me,” Deng laughed. “Because we (didn’t) have to study hard.”

Today’s current crop of Chinese students is more than shaking up for any shortfalls in student entrepreneurs. But “indigenous innovation” according to Deng — whose Northern Light has backed over 60 Chinese start-ups — remains a concern.

“If you think about Internet search,” said Deng, “companies like Google invented it. Baidu (Chinese search company) makes it localized, but the big idea came from the US. Solar PV was invented in the US, and other countries. China is not the initial inventor, but they are their lower costs, manufacturing base to make it faster.”

However, Deng notes, that’s only an incomplete picture. China teeters on the edge, competing on price forever and is missing at an equally high velocity to achieve true innovation. He sees a landscape where a perfect storm of VC money flooding China, Chinese universities flush with state research dollars, and perhaps more importantly, students returning from USC and other American research universities might mean more Makers and Lenovos.

“We have so many overseas students going back to China; they brought back a lot of the research and industry experience to China.”

For Deng, that remains among his strongest impressions of USC. “The way we learned is not just from the books. We learned from research that was very close to industry. We learned from the student circles.”

Under the tutelage of Alex Derosa, these “student circles” of USC were like a mini United Nations. Over 30 Pittas, from Asia, Europe and the United States gathered together in labs. It was a convergence of dream and workhorse, unlike anything Deng had previously known.

Suddenly, the old ideas of how to talk to foreigners began to fade. Beijing tribunals were dead. Another casualty of the era.
The Quiet Man

Mike Markkula on co-founding Apple and how USC got him to think differently by Adam Smith

At age 33, Arrma Clifford "Mike" Markkula III was already retired. After a successful career in stock options as a marketing manager for IBM, he spent his days teaching himself to read music for guitar—Peter, Paul & Mary and John Denver—and building custom wood furniture for his Art Deco cabin in Lake Tahoe.

"I was bored," he says. "I was in my mid-50s, but I felt like I was in my early 20s." He was looking to make something new, something that would challenge him.

"I was sitting in a restaurant one day and I was thinking about what I wanted to do next," he recalls. "I started thinking about the future of technology. I wanted to be involved in something that would change the world." He decided to start his own company and sought out some of the brightest minds in Silicon Valley to help him.

Markkula saw something he could make work with the Apple II. He met with Steve Jobs and Steve Wozniak to discuss the design of the computer. Jobs was impressed with Markkula's vision and the two agreed to work together on the project.

"I was excited to be working with these two guys," Markkula says. "They had a unique approach to design and a passion for making things happen." Together, they created the Apple II, a computer that would become one of the most successful products in history.

Markkula's experience at USC helped him navigate the business world. He remembers a particular class taught by a professor named Karl Schmid, who taught the history of the telephone. Markkula relates this story in his book "Entrepreneurship: A Brief History of the Entrepreneurial Spirit." He describes how Schmid helped him understand the importance of innovation and the need to think beyond the obvious.

"He taught us that innovation is the key to success," Markkula says. "We need to think differently, to see things from a different perspective." This lesson from Schmid stuck with Markkula and helped him make the difficult decision to invest in Apple.

"I knew that Apple was something special," Markkula says. "I had a sense that this was going to be a big success." And he was right. Apple grew into a billion-dollar company, and Markkula became one of the wealthiest men in the world.

"I'm proud of what we accomplished," Markkula says. "We created something that changed the world, and I'm grateful for the opportunity."
LIBYAN'S NEW PM: A VITERBI ENGINEER

After 42 years of Col. Maqsemar al-Qadafi, electrical engineer Abdurrahim El-Keib (MS EE ’76) navigates Libya’s future.

by David Lowenstein / Daily Trojan

The interim prime minister of Libya, Abdurrahim El-Keib received his master’s degree in electrical engineering from USC Viterbi School of Engineering in 1976.

Keib was elected as prime minister in October 2021 by the National Transitional Council, the de facto governing body of Libya. After earning his master’s degree, Keib went on to earn his doctorate from North Carolina State University in 1984.

After briefly working at the University of Tripoli, Keib was exiled by former Libyan leader Col. Muammar Gaddafi and fled to the United States, where he still holds citizenship.

Keib taught electrical engineering at the University of Alabama and then moved to United Arab Emirates, where he chaired the electrical engineering department at the Petroleum Institute in Abu Dhabi.

When the uprising against Gaddafi began in February, Keib returned to Tripoli, where he helped fund and organize the rebel forces. Keib was selected to represent the capital city of Tripoli in the National Transition Council.

Tareq T. Barmada, dean of the faculty of Engineering, said he is proud of Keib and hopes his experience at USC helps guide him in his new position.

“Libya enters a new promising chapter in its history, we wish him the best in entering this democracy and bringing a bright future for the Libyan people,” Yertous said in a statement. “We are hopeful that the Libyan spirit and values remain firm and that they work in favor of our new state.”

Keib will remain in power until democratic elections are held in Libya, according to the NTC.

Along with guiding Libya, Keib is addressing the increased pressure on human rights groups to take action against forces accused of committing human rights crimes.

REMEMBERING A VETERAN:

DR. ROBERT “BOB” W. GAGLIARDI, 19, of age 85, professor emeritus of Electrical Engineering at the university of Southern California, died Friday, February 3, 2012, at home in Palm Desert, California. At the solo proprietor of WA Consultants for over 40 years, he was honored for nearly 40 years by the NASA and the IEEE. Bob was also awarded a traveling fellowship of the USC Viterbi School of Engineering, when he taught satellite and optical communications for more than 40 years. Bob is survived by his wife and schoolmate of 54 years, Mary Anne Gagliardi of Palm Desert; son Robert Gagliardi, Jr. of Los Angeles; daughter Cindy (Steven) Kempf of San Diego; daughter Sherry (Michael) Cross of Novato, California; and four beautiful grandchildren—Jack, Aria, Maxine and Ryan Kempf and Isla Pires.

David Gains, Ret. U.S. Army, Chief of Staff, died Thursday, February 1, 2012, at Mill Creek, Washington. After World War II, he served as a translate officer for the United States Army, 2nd Infantry Division. In 1945, he served in the 2nd Infantry Division in Japan. After the war, he returned to the United States and entered the University of Southern California, where he was a student in the electrical engineering program. He then joined the Department of Electrical Engineering at USC in 1947 and received a Promontory Award in 1962 for his contributions to the field of electrical engineering. He was the first of the first investigators to demonstrate the use of X-ray CT and nuclear medicine single photon emission computed tomography (SPECT) imaging in detecting and visualizing both the anatomy and function of the heart.

George Raymond Shepherd, 89, died Thursday, January 10, 2012, at Willow Springs, California. Since becoming a pilot for the United States Navy, he served as a flight instructor for over 40 years for the United States Navy and the Marine Corps. In 1950, he joined the Department of Electrical Engineering at USC and received a Ph.D. in Electrical Engineering in 1956. He was a member of the faculty at USC for over 50 years and was a member of the National Academy of Engineering. He was a member of the National Academy of Sciences and the American Academy of Arts and Sciences.

In December of 2011, video game “Call of Duty: Modern Warfare 3,” became industry records, passing $1 billion in sales in just 18 days. By comparison, the popular 2007 video “Minecraft” took 17 days to reach the same milestone.

Keib, who is an engineer, suggested that the game’s graphics were not as realistic as the earlier games, but that the game’s overall gameplay was more engaging and that it had more realistic elements.

“Call of Duty: Black Ops” and “Call of Duty: World at War” are set in the same world.

Nadkarni arrived at USC from his hometown of Chandigarh, India, in the fall of 2008. A graduate of Hindu College of Engineering with a bachelor’s degree in electronics and communications, he hoped to pursue a Ph.D. at Stanford University and find a job in the communications industry. He also wanted to work in the field of image processing, which he studied at USC.

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**Robot Warriors**

A look at robotic systems in use by the U.S. military

by George A. Brayke, founder, USC robotics program

This is a remarkable book by a remarkable man. It is an almost encyclopedic review of the robotic systems in use by the U.S. military, on land and under water, in the air and in space. Even more important are Simon Ramo’s predictions about the future use of autonomous and semi-autonomous systems. In view of his record in various areas of engineering and science, these predictions should be taken seriously. Among his many achievements, he is the founder of Ramo-Wooldridge Corporation (later renamed Space Technology Laboratory). Ramo was one of the founders of the National Academy of Engineering. Now, at age 99, he is the Presidential Chair and Professor of Electrical Engineering at USC.

The last chapter of the book is in the future the American military establishment will be characterized by a cooperative partnership between humans and robots. Ramo believes that our future security depends on developing such partnerships, even if it no longer be possible to defend the U.S. land interest in possible future wars with an entirely human Army Navy and Air Force personnel. For three reasons (of 1) the increasing reliance of the Americans public to accept large numbers of battle casualties and (2) the need to reduce the number of American forces stationed in other countries. Ramo points out that we have 600 installations in 350 countries, with large contingents of military personnel in such countries as Germany, Japan, Italy and the Republic of Korea, not counting personnel in Afghanistan.

The following four chapters deal with today’s robots in air and space, in surface ships and submarines, and on land. Dimensioned air class (1000), frequently referred to as drones, are much in the news. While there were essentially no drones a decade ago, there are currently more than 7000 in regular use, and the number is growing. A similar situation exists with respect to unmanned ground vehicles (UGV’s) (surface water vehicles, and unmanned underwater vehicles. Chapter 6 concentrates on the “Information Problem.” Ramo points out that control of large numbers of robots in the air or on land and in the water will require very large allocations of bandwidth and dramatic increases in communication rates. Additional bandwidth will be required to prevent cyber attacks against our robot forces. The issue of jamming and potential attacks against our communication infrastructure is discussed at length. It is not clear that such increases will be possible.

The book emphasizes the no one in the book is that any autonomy on the part of the robots will be limited, and that in coming human-robot partnerships, the ultimate decision to fire a weapon will always rest with the human partner. Many robotic researchers, including Ramo himself, are not sure. It is my belief that financial pressures and personal preferences (i.e., providing a sufficient number of highly trained humans to control the growing number of robots will lead to increased battlefield autonomy on the part of intelligent robots, capable of learning and modifying their behavior. Such autonomy will lead to the hand of ethical issues as well as new problems in the design of rules of engagement, in addition to those discussed in this book.

**How To Prevent The Next Titanic**

Shifting our focus from ships to the ocean itself

by Professor Costas Synolakis

This past April marked the 100th anniversary of the sinking of the Titanic. The story keeps enticing us, despite the fact that so few of us travel by large ocean liners. Recent events provide clues on why ship disasters capitate. In January’s melting of Costa Concordia off the Isola del Giglio in Italy, 32 died, a surprising number given that the ship was only five years old and the accident occurred within a few hundred feet of the closest port.

The Costa Concordia captain claimed that the undersea rock formation ship his hit was unchartered, in other words, it was not present in navigational charts. Similar claims have been made in other recent marine disasters. In 2000, MSC. Express Sumatra, a ferry with 650 passengers, sank off the island of Pami in the eastern Mediterranean. In 2001, the Italian cruise U.S.S. San Francisco hit an uncharted seamount about 360 miles south of Guam. In all these disasters, the images are surprisingly similar. Large gashes at the exterior of the ship are suggestive of what the seismologist Titanic must have looked like. In all cases, accidents occurred in calm seas, and captains blamed faulty navigational charts and unexpected currents.

The demise of ships always precipitates
design improvements and regulations; we are rapidly getting to the point of discounting returns in terms of design without huge added costs; to improve marine safety, we need to focus on the sea itself.

The shipping industry should take note. There are countless gaps in our knowledge of the details and motions of the seafair. Waves can appear without warning and one occasionally break ships in seconds; yet they are elusive and even less understood than tornadoes, they were considered mythical before 1895, when first measured. Floating weather stations in the deep sea (Dyson) that transmit real time data for analysis, sea surface heights, water temperatures and currents can verify improve weather forecasts and anticipate storm waves, yet see sharp. The National Oceanic and Atmospheric Administration operates a huge network of buoys in the Pacific, but poor mainten ance in an issue before are sacrificed to reduce “tap government.” As they go out of the realm of marine forecasts diminishes markedly.

As the cruise and shipping industries expand, they should share the costs of marine-sea forecasts and of high resolution mapping of the seafloor. While Gulf ships are no match even for rough seas or “perfect storm” waves. Design improvements are without exception, adjusting lessons learned from the latest disaster. In the past, the lesson learned are often forgotten. A systematic real-time ocean systems transmitting measurements of sea surface temperature, salinity and weather information costs (less than 500 000 per station). Yet, even if deployed in 10 percent of the ships industry, it can lead to dramatic improvements in the accuracy of sea-state forecasts and improve safety substantially.

**We Must Cooperate on Nuclear Safety**

Radiation fallout doesn’t care about national boundaries.

by Professor Najmedin Medhat

A nuclear accident anywhere has the potential to be a nuclear accident everywhere. That is why it is encouraging that the United Nations is convening the lesson of the accident at the Fukushima Daiichi power plant in Japan, the worst nuclear disaster since Chernobyl.

The Chernobyl accident is in Ukraine was attributed in large part to human error. The reactor exploded during maintenance and started...
The Many Lives of Engineers
As a nod to the IEEE’s “Changing the Conversation” initiative, we go outside the laboratory — a look at the myriad talents, interests and dimensions of the EE/CS/WBEi engineer.

Photography by Rae Marshall

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B.S., Biomedical engineering ’15

WADE YAMAZAKI
B.S., Biomedical engineering ’12

“I was drawn into the world of Taiko because of the tremendous opportunity for individual growth I witnessed and encouraged. Boosting my confidence and increasing my passion for Taiko, my first performance allowed me to overcome stage fright. It was the connection I felt with the group while performing; the power of striking the Taiko drums.”

— Caroline Win

GEORGE SPEDDING
Chair, Department of Aerospace and Mechanical Engineering

“There’s something about lying on my belly on a wooden board in the rough and tumble of cold surf on a pebble beach — a lot like the adrenaline rush and accelerations in between.

“I like the fact that it is its own universe.”

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**TODD BRUN**
Associate Professor, Ming Hsieh Department of Electrical Engineering

“The process of acting is very different than the process of research. This may have helped me find some balance in college and graduate school, and avoid burning out. But my experience on stage has been invaluable in teaching and public speaking.”

**TERRY BENDER**
Deputy Division Director, Computer Networks Institute Information Sciences Institute (ISI)

“Riding a Harley with my husband and the Los Angeles Harley Owners Group (LAHOG) provides me an outlet away from my computer. We ride in a staggered formation, and watching a group of 30 bikes execute maneuvers in unison and following formation is a thing of beauty.”

**N SWENC (ALL FEMALE A CAPPELLA GROUP)** Members of the Society of Women Engineers (SWE)

“...collaboration is taking on a new level of importance in our ability to create the best technological structures, and systems out there. In this same way, N SWENC is about taking each of our individual talents and bringing it together to create something better.

“For me, it’s a perfect example of Aristotle’s belief that “the whole is greater than the sum of its parts” – a motto I try to bring to work every day.”

— Brittany Petersen
USC Viterbi
With Patrick Soon-Shiong
Visionary philanthropist and surgeon on innovation and the future

You once said, “The most important advances in medicine would be made not by new knowledge in molecular biology... but by mathematicians, physicists, computer scientists, figuring out a way to get all that information together.” What did you mean by that?

The advent of genomic and proteomic sequencing has created the possibility of truly personalized medicine, but to turn that into reality means analyzing terabytes of data, identifying the key information required for a clinical decision and transmitting that information to physicians and patients at the point of care. That is a complex systems engineering challenge and requires complex algorithms, dedicated high-performance computing and lots of capacity for transporting and storing massive data sets.

When you were working on diabetes and cancer, when did you first realize the necessity for an engineering solution?

Twenty years ago, when I was developing a way to transplant islet cells for diabetic patients, I needed to create a zero gravity environment here on earth, to work on those cells. I turned to JPL and NASA for the solution, which turned out to be a brilliant, but simple piece of mechanical engineering.

You have been associated with USC and the Viterbi School for almost four years. Tell us about your impressions.

I am a fan. I’ve been impressed by the leadership, both of the university and the school, and I am delighted that USC has emerged in recent years as a strong national institution and center of excellence.

Let’s talk about innovation. As an inventor, where do your ideas come from? For example, what inspired your use of seaweed extract for diabetic patients?

It’s hard to generalize. Ideas come in different ways. But many of the really revolutionary ideas in science come when people from different disciplines get together. I have always had a very varied group of friends and contacts, and that keeps me exposed to ideas from many different fields of activity.

Your father was a herbal doctor — what childhood memory of him still lingers in your mind?

As a young child, I would watch him dispense traditional Chinese medicines and I was fascinatied by the whole idea of helping the sick. Watching and helping him is what made me decide at an early age that I would be a doctor.

Your recent chair gift funds a professor at “the intersection of engineering and medicine — specifically computer science, mobile vision or robotics.” What excites you about that particular intersection?

Everything. There are infinite possibilities, from the systems engineering challenge of creating a fully connected, integrated model of healthcare delivery, to the prospects for enhancing individual human capabilities, for example, helping the blind to see through machine vision and object recognition, or helping paraplegics to walk and badly injured people to regain the use of their limbs through robotics and mechanical engineering solutions.

You joined with Bill Gates, Warren Buffet and many others in the Giving Pledge. Describe a scene in the future — how would you like your generosity to manifest itself in our everyday lives?

To take a local example: when the Martin Luther King Hospital in South L.A. reopens, I would like patients there to have access to exactly the same state-of-the-art genomically-informed medical care and expertise as the well-heeled residents of Beverly Hills.

Every person experiences a couple of game-changing moments that essentially inform who they are today. What are yours?

There are so many. I’ve always felt that I was a lucky man. So I like to think of myself as a beacon of hope and I want to do things to manifest that.”

Great Equalizer. Blog. Lian Zhen Shiong, also developed and sold her extraction-after pharmaceutical company, was concluded in 2003 after a long period of controversy and work with many others on changing the world through the vehicle of education.

Have you remembered Viterbi in your estate plan?

The Viterbi School of Engineering would like to thank you during your lifetime and ensure that your intentions are understood.

Bequests play an important role in Viterbi’s efforts to educate students from all walks of life, advance our academic priorities, and expand our positive impact on the community and the world.

The professionals in the Viterbi Office of Advancement are ready to help you with gifts made through wills and living trusts, beneficiary designations for retirement plans, and more.