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USC Engineer

A Journal for Alumni & Friends
USC Viterbi School of Engineering

Gray Matters

USC Teams with Israel's Technion to Investigate Neural Arithmetic

Postcards from Paris

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SECTION 331:

From JPL to USC and Beyond

Fall/Winter 2004

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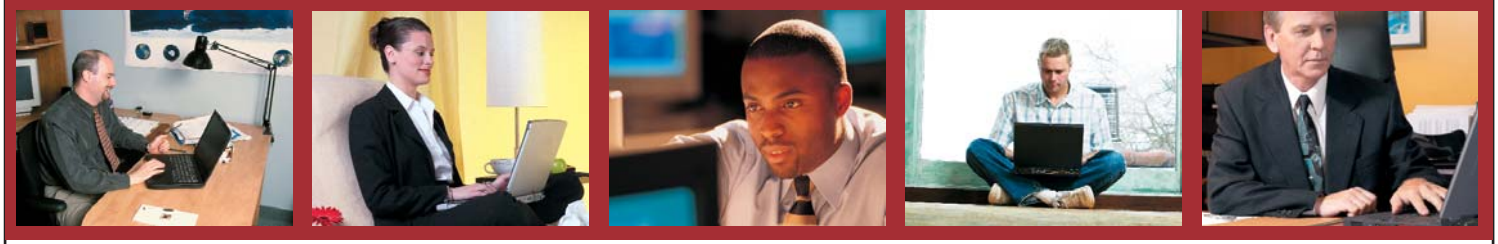

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Viterbi School of Engineering
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features

page 26

Section 331: From JPL to USC and Beyond

How a Distinguished Group of Space-Race Pioneers Landed at USC

by Carl Marziali

page 31

Gray Matters

USC Teams with Israel's Technion to Investigate Neural Arithmetic

by Diane Ainsworth

page 33

Postcards From Paris

Viterbi School Students Discover the City of Light

Compiled by Bob Calverley

page 37

Thought For Food

Computer Science Provides Better Nutrition Boost

by Eric Mankin

departments

page 3 — Dean's Message

page 4 — Editor's Note

page 5 — Straight & To the Point
Short Subjects

page 39 — Alumnus Profile
Al Dorman, MSCE '62

page 40 — Alumnus Profile
A. V. Balakrishnan, MSEE '50, Ph.D. Mathematics '54

page 41 — Alumnus Profile
Arthur P. Adamson, BSME '41

page 42 — Alumna Profile
Aimee Lopez, BSCE '99

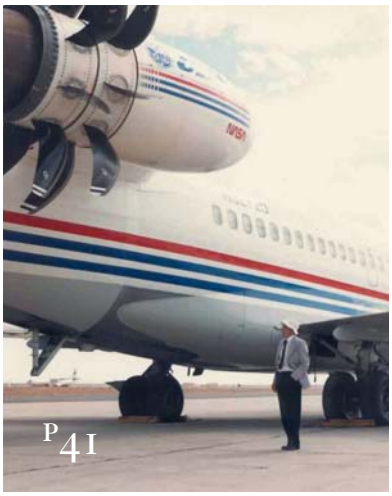
page 43 — Parent Profile
Asad M. Madni

page 47 — Snapshots
2004 Summer & Fall Events

page 49 — Class Notes & News

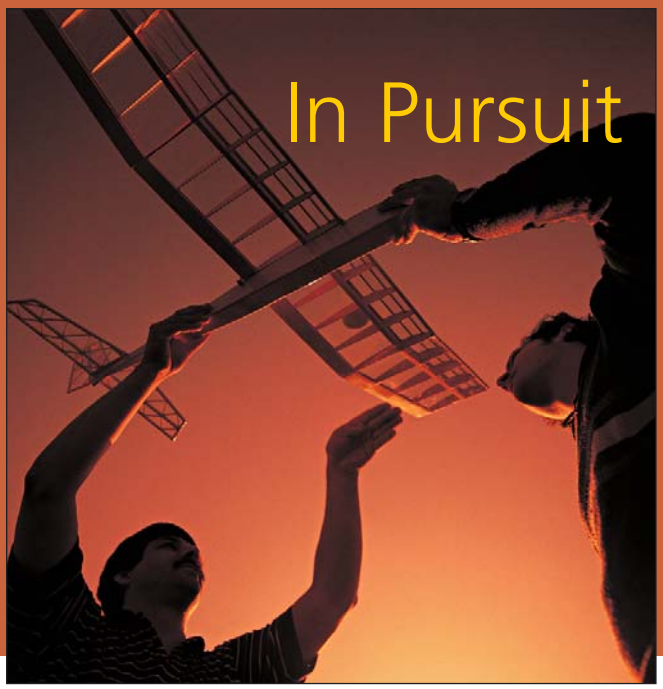
page 51 — In Memoriam

page 52 — Notebook



"It shrank the world from seven days to seven hours for a transatlantic crossing," Adamson says.

See Adamson profile on page 41



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The USC Viterbi School of Engineering thanks the following corporations, foundations and organizations for their recent gifts. Their generosity is crucial to the success of our students and faculty as they pursue scientific and academic excellence. For more information on how your firm can help to shape the engineers of tomorrow, please contact:

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The Path to Success

Engineering schools that can create dynamic collaborations among academia, business and government will be the real leaders in the 21st century. And these leaders will not necessarily be the traditional top-10 schools. If the past year is any indication, the USC Viterbi School of Engineering is becoming one of those leaders.

It has been an extraordinary year starting with an extraordinary $52 million naming gift from Andrew (Ph.D. EE '62) and Erna Viterbi. Arguably, the naming was the most significant event of the year in all of engineering education. Our School is now linked forever with a name that exemplifies academic excellence, engineering innovation and creative entrepreneurialism. Increasingly, our School reflects those values.

During the past year we secured the Biomimetic MicroElectronics Systems (BMES), our second National Science Foundation Engineering Research Center, and the Center for Risk and Economic Analysis of Terrorism Events (CREATE), the first Center of Excellence awarded to a university by the Department of the Homeland Security. In both cases, our proposals for these centers finished first in hard-fought national competitions.

Why were we successful? One reason is the truly impressive ability of the USC Viterbi School's faculty to collaborate with others. BMES is largely a collaboration between our School and the Keck School of Medicine at USC, but it also has researchers from Caltech and UC-Santa Cruz, and medical device industry participates. The CREATE team includes researchers from several other universities across the nation and other parts of USC, particularly the USC School of Policy, Planning and Development.

There are 30 faculty from the USC Viterbi School who are serving as principal investigators or co-principal investigators in cross-disciplinary research collaborations with other USC units, and the total current funding for these projects is $87 million. Our School is leading the way at USC, and increasingly, leading at a national level.

We have been blazing a trail in industry collaborations with the ChevronTexaco Center for Interactive Smart Oilfield Technologies (CiSOFT) and the Pratt & Whitney Institute for Collaborative Engineering, which also includes Korean Air. Additionally, we are close to finalizing the establishment of a third industry center to be announced later this fall.

The industry collaborations are important. If engineers are going to continue improving our quality of life in the 21st century, they must be prepared to address the real world problems found in industry and commerce.

Tomorrow's engineers are today's students, and USC Viterbi students are also pacesetters. For the third consecutive year, our incoming 2004 freshman class has the highest SAT average at USC —1386. The GRE scores of our graduate students are also among the highest at USC. If the faculty is our School's foundation then our students are its pillars, and those pillars are growing stronger.

Our Distance Education Network (DEN) now offers 24 master's degree programs — more than any other engineering school — using modern high-speed Internet technology envied by our competitors and so popular with students that enrollments grew by almost 25% this year.

Our success has not gone unnoticed. The USC Viterbi School has risen to sixth place in the *U.S. News & World Report* rankings of graduate engineering programs. While that is exciting and good news, it is not important news. For as leaders, we must continue to find our own path to excellence rather than following one dictated by the constantly shifting metrics set by others.

As we approach the year's end, on behalf of the faculty, students and staff of the USC Viterbi School, I wish all of you a holiday season filled with the close-knit warmth and joy of family and friends. And in 2005, may each of you find a path to prosperity and success.

C. L. Max Nikias
Dean
USC Viterbi School of Engineering

Nikias photo by Max S. Gerber

This year, I am celebrating my 10th reunion as a Trojan. I'm sure that many alumni have shared in the question — "Where has the time gone?" In my case, ten years has passed in the blink of an eye and in that time USC has flourished and developed into the type of university where equal numbers of alumni think, "I'm not sure I'd get in today!"

Luckily, we did get in. And we earned so much more than our degrees. We earned membership into the legendary Trojan Family. Working with alumni, I am constantly reminded of the strength of that family and the bond the reaches across cities, oceans, languages and cultures. This was never more apparent than this October when Dean Nikias and I traveled to Seoul, South Korea for the 3rd Annual USC Asia Conference. Trojans from all corners of the globe converged on this amazing city to learn more about USC, the societies of the Pacific Rim and each other. It was truly a remarkable gathering.

Just as remarkable, are our Trojans back home. Our alumni profile of Al Dorman (MSCE '62) paints the picture of an incredibly humble man, a true Renaissance scholar, whose career developed as California did, and shines just as brightly.

Always involved and engaged, Jack McConeghy (BSME '66), chair of the Alumni Advisory Board, and myself at the School's "Evening at the Hollywood Bowl" in August.

This issue's other alumni profiles are just as impressive and live up to the precedent we have set in this magazine — stories of excellence reflected in research, students, faculty and alumni.

Our alumni continue to support us and inspire us. Thank you to those who have stayed involved and engaged. I am proud to know so many of you and always look forward to meeting more. Please join our annual Homecoming picnic this November for a chance to reminisce with old and new friends and ponder once again the question — "Where has the time gone?"

Annette Blain
Director, Alumni Relations

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USC Engineer is published twice a year for alumni and friends of the Viterbi School of Engineering at the University of Southern California.

Letters to the editor and comments are welcome. Please send them to: USC Engineer, Alumni Relations Office, Olin Hall 300, Los Angeles, California 90089-1454, or email them to uscengineer@usc.edu.

This issue of USC Engineer is dedicated to the memory of Gregory Parrillo, 1974-2004.

STRAIGHT & *to the* POINT

A New Frontier: ASTRONAUTICS AND SPACE TECHNOLOGY DIVISION

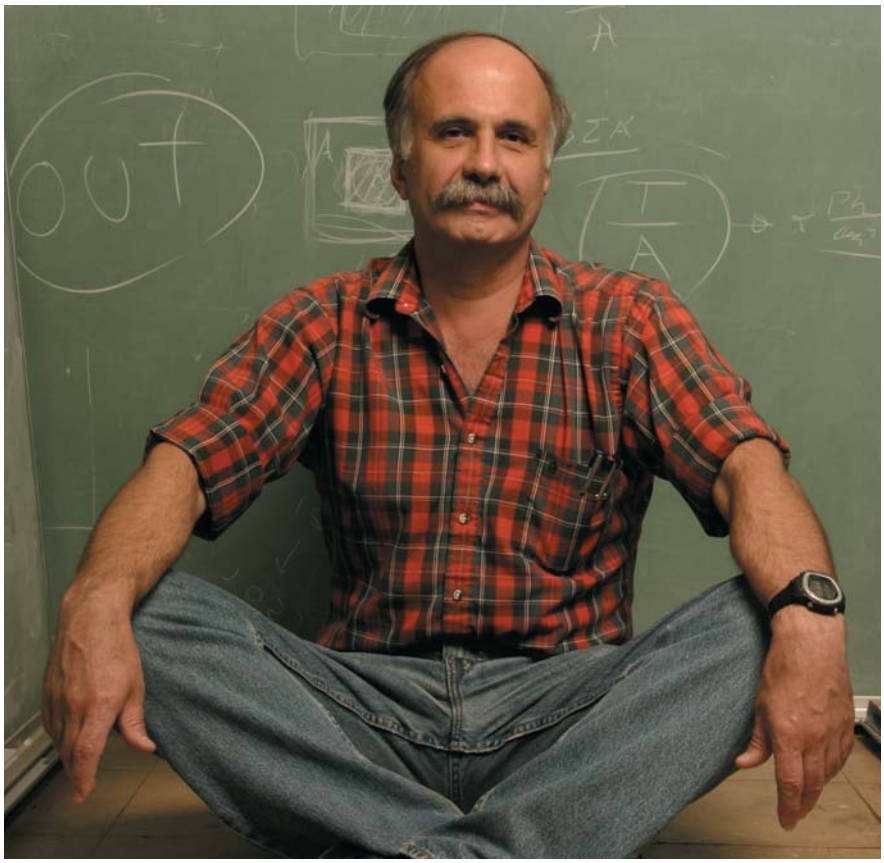
In order to position the USC Viterbi School, to take full advantage of rapidly growing opportunities in space, in August, Dean Nikias announced the creation of a new Astronautics and Space Technology Division (ASTD).

"Following the drastic funding cutbacks in the early 1990s, space technology and astronautics has recently re-emerged as an important sector of economic and engineering activity not only in the Southern California economy but also in the nation as a whole," he said. "Both defense applications and space exploration projects are driving this resurgence. However, recent congressional studies have warned of a looming shortage of engineers in this area."

The dean appointed Professor Mike Gruntman as chair of the division. Other faculty are Professors Joseph Kunc and Daniel Erwin. All three will continue to have courtesy appointments in the department of aerospace and mechanical engineering. Secondary ASTD appointments went to Professors Stan Settles, Joseph Sullivan and Peter Will, from the Information Sciences Institute (ISI).

ASTD will be solely responsible for all research and degree programs in astronautics and space technology. It will offer a program in astronautics and space technology concentrating on meeting the educational and research needs of the space and defense industries. The new division has already taken responsibility for 24 courses formerly in the department of aerospace and mechanical engineering.

The division will function as an independent academic unit within the USC Viterbi School similar to a department. It will be governed by the same rules and policies and the division chair will report directly to the dean. Like departments, the division will establish an advisory board with members from industry, government laboratories and academia.



Mike Gruntman

Gruntman photo by Max S. Gerber

"For more than a year, the USC Viterbi School of Engineering with strong support from ISI has been engaged in a carefully orchestrated effort to secure major funding in space technology," said Nikias. "I expect the creation of the new division will help bring these efforts to fruition, and look forward to the continuing close collaboration with ISI."

In the News

USC Viterbi School of Engineering projects and faculty continue to generate headlines and here are some of the highlights…

DEAN MAX NIKIAS' efforts to build bridges between the Viterbi School and industry were the subject of a major interview on ***Marketplace Radio*** May 5, which mentioned specifically the Viterbi School's $5 million research grant from Chevron Texaco. "What I watch is that we don't want to compromise any academic integrity," said Nikias. Two days earlier, ***SocalTECH.com*** published its interview with the dean about the Viterbi gift and the School's dynamic. "This place is on fire," he said.

"9/11 was a failure of imagination," said **RANDY HALL**, co-director of the USC Center for Risk and Economic Analysis of Terrorism Events (CREATE) in an August 22 ***Los Angeles Times*** story (carried on AP) about CREATE's USC campus simulation of the effects of the explosion of a dirty bomb on the L.A. waterfront. "This university center has a mission to exchange ideas to look at long-term threats." ***Voice of America***, ***La Opinión***, and ***National Public Radio*** also covered the story. Hall was quoted a few days later on ***KNBC*** on the terror situation in Russia, and earlier in the ***Washington Times*** and ***KFWB*** about CREATE's new degrees in antiterrorism.

JAMES MOORE and **NAJM MESHKATI** offered perspectives on future auto travel and safety in the August 29 ***Los Angeles Times Magazine***. Moore foresaw an increase in automatic controls on cars, while acknowledging "the stakes of failure [in an automated highway] are much higher." Meshkati, who specializes in safety problems of highly technical systems — air travel, nuclear power, etc. — noted that the interaction of human factors with automated systems was complex. A July 10 ***Times*** story about the L.A. Metro Greenline system also quoted Moore, while Meshkati was interviewed in ***The Australian*** about nuclear plant safety in an article on "Narrowing the Human Factor."

On July 6, ***The New York Times*** ran a major feature on the Information Sciences Institute's (ISI) addition of artificial intelligence and speech recognition to a commercial computer game program to create a powerful system to teach Arabic quickly to military personnel. **LEWIS JOHNSON**, the director of ISI's Center for Research in Technology for Education, and **HANNES VILHJALMSSON** were quoted and pictured in the story. The same project was featured in the June 14 ***Newsweek*** and on ***ABCNews.com's FutureTech*** on March 9.

Aerospace engineer **DON SHEMANSKY**, who has an ultraviolet imaging spectrograph on the *Cassini* spacecraft that rendezvoused with Saturn this summer, was featured in ***The New York Times*** and the ***Los Angeles Times*** on July 3, along with other stories in such outlets as ***Chemical & Engineering News***, the ***San Francisco Chronicle***, and ***Reuters***, as well as a special report in the July 9 issue of ***Science***.

Mechanical engineer **PAUL RONNEY** was the most prominently featured researcher in a long story about tiny internal combustion engines the size of a penny or smaller in the June 14 issue of ***New Scientist***. Ronney also spoke about the history of the more familiar, larger ones on "Modern Marvels," broadcast on the ***History Channel***.

ROBERT SCHOLTZ'S prestige as the world's leading authority on the technology of Ultrawideband enabled him to conduct an international experts poll on what the first uses for the new technology would be — a study reported on in CMP's ***EE Times*** and ***CommsDesign*** on June 4, ***Wireless.com***, and other industry publications. *See story on page 8.*

National Science Foundation's ***Engineering News*** ran a feature on research developed by **BEHROKH KHOSHNEVIS** to use robotic technology to build a house in 24 hours. Regarding his achievement in building a complete wall using the system, they declared it "the most historic wall since the Great Wall of China." The system has also attracted notice in publications in France, Spain, Britain, Italy, Brazil, Vietnam, Russia, Ukraine, Finland, Japan, Taiwan and Australia, along with earlier features in ***The New York Times*** and ***NBC Network News***.

IRAJ ERSHAGHI'S op-ed in the May 2 ***Los Angeles Times*** called for effective aid to small oil producers to increase the low recovery rate from the nation's oil wells. A new masters program Ershaghi has started on "smart" oil extraction technology, which will be available through the Viterbi School's Distance Education Network (DEN), was reported on in media serving oil producing areas, including the ***Houston Chronicle***, ***Bakersfield Californian*** and ***Rocky Mountain News***. Ershaghi, an expert on world oil reserves, was quoted. *See story on DEN's new degree programs on page 17.*

SHRIKANTH NARAYANAN'S work on software to detect emotion in voices continued to draw attention, adding a prominent story in ***Newsweek*** May 17 and a designation of the system as one of five "ideas to watch" by ***INC.COM***. Naranayan's work was also previously covered in numerous international print and web publications, such as the French magazine ***L'Expresse*** which headlined "Détecteurs de fureur." In June, ***Texas Innovator***, a monthly newsletter published by the state as a "toolbox for the 20th century," included it as a new tool.

Readers in Britain — and scientists worldwide — saw prominent stories on **PETER WILL** and **WEI-MIN SHEN'S** work on modular minirobots that can knit themselves together in diverse forms controlled by multipurpose "hormonal" software. ***Nature*** magazine published reportage of a London demonstration of the technology, followed by a prominent story on May 25 in ***The Times*** of London. "Professor Shen says, 'We can literally take the legs off a spider and plug them into the head and it becomes a snake.'" Will was also interviewed on space faring robots for the ***Australian Broadcasting Corporation's*** science program "The Buzz" on June 12.

A breakthrough in the use of "quantum dot" receptors for detection of infrared emissions was made by **ANUPAM MADHUKAR** of USC and Joe Campbell of the University of Texas/Austin and was heavily covered in the industrial press, in such publications as ***Compound/Semi News***, ***NanotechWeb***, the Instrumentation, Systems, and Automation Society's ***InTech***, ***Innovations Report***, and ***Compound Semiconductors***. Additionally, the Air Force Office of Scientific Research, which funded the effort, singled out the achievement as one of the "July Accomplishments" in the ***Air Force Research Laboratory News*** source.

Also in nanotech, new research on composite nanocables by **CHONGWU ZHOU** received widespread industry coverage. ***Materials Today***, ***Nanotechnology News***, the ***MEMS and Nanotechnology Clearinghouse***, ***Nanojournal***, and other specialty publications carried stories on the work. *See story on Zhou on page 25.*

LEN ADLEMAN'S work using the genetic substance DNA as a computational medium was part of an April 29 report in ***The New York Times*** about a new DNA based computer that has been proposed to diagnose disease and automatically dispense medication to treat it.

Can ISI Boost HP Server Performance?

ISI "PROCESSOR IN MEMORY" CHIPS ARE NOW RUNNING IN A STANDARD HP LONG'S PEAK SERVER

Researchers from the USC Viterbi School of Engineering's Information Sciences Institute (ISI) have successfully integrated their next-generation "smart memory" chip into a standard Hewlett Packard computer.

"It's a major milestone," says Mary Hall, co-project leader of the Godiva Team working at ISI. "Even though our chip has a fundamentally different architecture than the conventional hardware the HP platform was designed around, it's working. Now we're seeing if it will deliver the extra speed and power theory promises."

The new device is an expanded and improved version of the product of an earlier effort by Hall, hardware architect Jeff Draper and ISI Division Director John Granacki. That project, called DIVA *(Featured in USC Engineer Fall/Winter 2002)* involved a 55-million transistor processor-in-memory (PIM chip). The Godiva project chip is slightly larger (56 million transistors), offers address translation and eight single-precision floating point units, and perhaps most importantly, contains a memory interface compatible with DDR SDRAM memory buses.

Mary Hall and Jeff Draper

Both the DIVA and the Godiva designs are among the largest chips ever realized in academia and both were fabricated at Taiwan Semiconductor Manufacturing Corporation (TSMC) through ISI's MOSIS chip brokerage.

Hall is an ISI software specialist who also holds an appointment in the Viterbi School's department of computer science. She has been working on a DARPA-funded effort to improve PIM chips for more than four years. She and Draper deployed their team's new chips in HP Long's Peak server memory modules.

"And these modules are now functioning as designed, as part of a working computer," says Hall adding that HP and Rice University are also part of the project.

"Computer scientists have been talking about the potential of PIM chips for most of the past decade and have released devices they call PIM chips," says Draper, "but this is the first smart-memory device designed to support virtual addressing and capable of executing multiple threads of control."

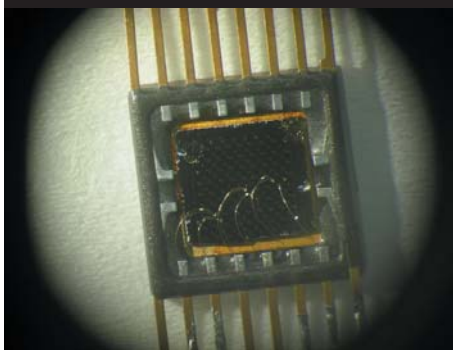
PIMs potentially eliminate the communication bottleneck that takes place when processing chips have to go back and forth to separate memory chips in order to get data for computations, and then store the results. A PIM chip can keep results and data in its own memory, resulting in dramatic gains in speed.

But this theory has proven very difficult to turn into practice. The successful integration of the new chips into a standard computer like the Long's Peak server marks a substantial new achievement, according to Hall and Draper.

The researchers and colleagues are now testing the PIM-enhanced Long's Peak server on tasks such as multimedia, complex scientific modeling and database access. "Our calculations indicate we may get as much as an order of magnitude better performance."

Besides Hall and Draper, the Godiva team includes ISI researchers Jacqueline Chame (Simulation, Benchmarking and Compiler), Tim Barrett (System Integration), Jeff Sondeen (VLSI), Dale Chase (System Integration) and Spundun Bhatt (Programming). Many USC graduate students also contributed to this project.

> "…this is the first smart-memory device designed to support virtual addressing and capable of executing multiple threads of control." —Draper



The 56-million-transistor Godiva processor-in-memory (PIM) chip is one of the largest ever created in academia.

Hall and Draper photo by Max S. Gerber

Experts Predict Commercial Applications of Ultrawideband Technology in Three Years

A USC Viterbi School of Engineering survey of academic and industry experts finds that commercial products utilizing Ultrawideband (UWB) radio technology should begin to roll out within three years. Experts predict that the new technology will first be used for range-finding applications and wireless local area networks for computers.

"Everyone is waiting to see that first consumer product come out," says Robert Scholtz, professor of electrical engineering who has pioneered UWB technology. "Judging from his survey, the world won't have to wait much longer."

UWB works by sending out very short and very weak radio pulses spread across a huge range of the frequency spectrum, while conventional radio signals use a carrier wave confined to a small frequency range of the radio spectrum.

After extensive study about whether UWB devices could interfere with broadcast media or global positioning satellites, the Federal Communications Commission approved the new technology for unlicensed use under strict power limitations for a large portion of the radio spectrum in a decision published in May 2002.

Scholtz' presented the preliminary results of his survey last month to an international UWB conference held in Kyoto, Japan. The 89 experts from academia, the business community and governments all over the world who responded were asked whether five possible applications would be viable business applications within the next three years.

The group found the two most likely commercial applications to be high-speed wireless local area networks that would have much higher data transfer rates than current Wi-Fi 802.11 technology and precise range-finding systems. Close behind in the survey were applications to use UWB technology to "look" through opaque materials, radio frequency tags and intrusion alarms.

Scholtz also asked which of the two alternative competing UWB formats now being evaluated by a standards group from the Institute of Electrical and Electronics Engineers (IEEE) was superior. Respondents were almost evenly split between a format being developed by Intel and Texas Instruments and another from Motorola. About a quarter of the respondents acknowledged having a financial interest in one or another of the formats.

Scholtz asked the group to grade the difficulty of the pending challenges to build various hardware elements for UWB systems. While UWB uses radio signals, most of the current design procedures for chips and broadcast antennas will need drastic revisions to function in UWB devices.

Scholtz also asked which of the two alternative competing UWB formats… was superior. Respondents were almost evenly split between a format being developed by Intel and Texas Instruments and another from Motorola.

In general, the experts thought meeting those challenges for most UWB hardware was now possible with sufficient effort. This included hardware such as a high quality full-band antenna, a local area network design, a unitary full-band transmitter, a 500 MHz all-digital receiver and a hybrid, analog-digital full band receiver. But they rated another desirable element; an all-digital, full frequency receiver as by far the most difficult design problem facing engineers.

The group surveyed included 29 professors, 27 advanced students, 12 government specialists and 18 industry representatives, plus three anonymous correspondents. Most were from North America (47) and Asia (27), with a fewer number (10) from Europe and other areas.

Scholtz is a communications specialist who holds the Fred H. Cole Chair in the USC Viterbi School's department of electrical engineering and directs the Schools UltRa lab, a leading world center in UWB research. His work, both theoretical and practical over the past decade, has been widely recognized as central in the field.

The complete survey can be downloaded at the UltRa laboratory website http://www.ultra.usc.edu/New_Site/

Robert Scholtz

Scholtz photo by Max S. Gerber

No Folding Required

A Super Map for Soldiers or Other Travelers

Meet the 21st century map. The military already has it and the rest of us soon will.

Decades worth of detailed, accumulated geographical information is now available to front-line troops in a concentrated, portable, easy-to-use laptop package created by the USC Viterbi School of Engineering.

HeraclesMaps can instantly solve life-and-death tactical questions like, "Help us find a route from point A to point B where we cannot be observed (or shot at) by someone at point C."

It can instantly dissect the geography of a city, displaying man-made features such as buildings, the electrical power grid, railway tracks, roads, pathways and more, both in map and photographic form. After intensive trials over a five-year development period, it is now in use by selected units of the U.S. armed forces in training.

Computer scientist Craig Knoblock of the Viterbi School's Information Sciences Institute (ISI) led a team that developed the system working with specialist veteran consultants.

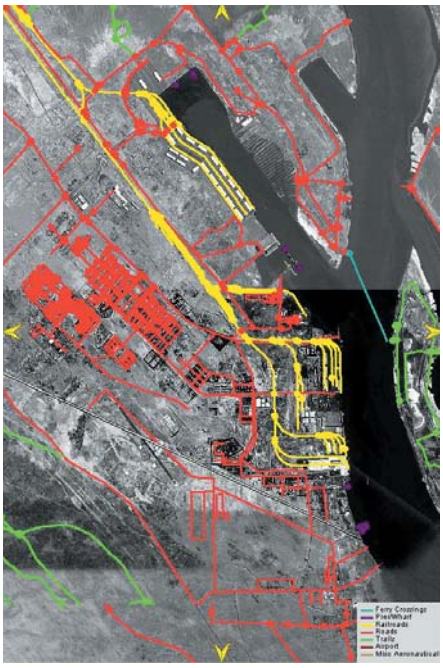
Knoblock says that the main challenge was that information "obtained from various data sources may have different projections, different accuracy levels, and different inconsistencies. The applications that integrate information from various geospatial data sources must be able to overcome these inconsistencies accurately, in real-time and for large regions." HeraclesMaps digests satellite imagery and mapping data, and allows users to access the full range of the data quickly and intuitively through an interface that anticipates questions.

"This material had been distributed on multiple CDs that essentially only specialists could use," says Knoblock. "HeraclesMaps lets strategic and tactical planners ask their own questions and get their own answers, on the spot, instantly and easily, using a portable laptop computer"

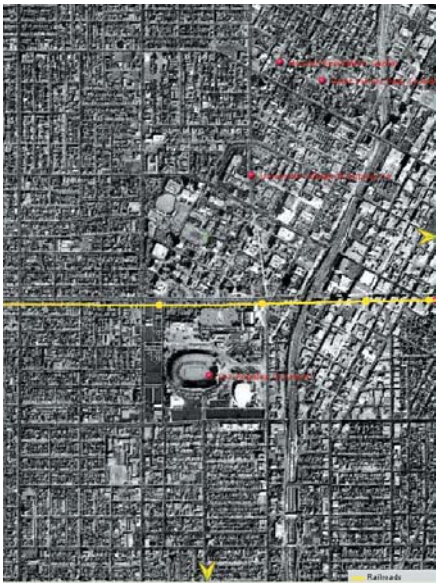
According to Knoblock, HeraclesMaps has many potential civilian applications including an extremely powerful travel planner. The Heracles Project, the parent of HeraclesMaps, uses a variety of powerful tools including artificial intelligence agents to extract and dynamically reconfigure information from diverse sources. Other Heracles applications can potentially add data from online or other sources. For example, one might access additional databases to highlight the cheapest fuel available or find all-night restaurants serving a specific cuisine.

Knoblock is a senior project leader at ISI and a research associate professor of computer science. For his work on such agent-driven information collection and organization systems, Knoblock was honored this year by being elected a fellow of the American Association for Artificial Intelligence, one of only six researchers worldwide so honored in 2004.

Craig Knoblock



HeraclesMap of Iraqi port of Um Qassr with overlay showing ferry crossings, piers/wharfs, railroads, roads, trails and airport.



HeraclesMap of USC campus neighborhood with overlay showing railroad line.

Knoblock photo by Max S. Gerber

Body Mechanics

UNIQUE, 3-D MODELING TECHNIQUES HAVE HELPED TURN SOME USC ATHLETES INTO OLYMPIC MEDALISTS

What makes Lenny Krayzelburg's backstroke gold medal material? What sets Kaitlin Sandeno apart from her swim mates in the 800-meter freestyle? What nuances of form did Klete Keller use to close in on Michael Thorpe's world record in the 400-meter freestyle recently?

Skill, a lot of practice, and in some cases, a little help from some high-tech biomedical modeling going on at the USC Biomechanics Research Laboratory. The lab, in collaboration with the USC Viterbi School's departments of biomedical engineering and aerospace and mechanical engineering, is running an experimentally based research program to develop state-of-the-art biomechanical modeling techniques for USC athletes, some of whom went to the summer Olympic Games this year in Athens.

Jill McNitt-Gray

"We look at ways to improve a swimmer's flips, dives and strokes, or show sprinters how to spring from the starting line," says Jill McNitt-Gray, associate professor of kinesiology, biomedical engineering and biological sciences. "In gymnastics, we'll videotape and model someone's performance to get a sense of how they are generating vertical and angular momentum when they launch a back flip from the balance beam. We can advise them on how to shift their weight just a little or spring up just a little sooner to perfect the performance."

McNitt-Gray specializes in force impact to the lower extremities, an experimental modeling technique in kinesiology that can be applied to a wide range of skilled performers — athletes, musicians and workers at risk of developing repetitive stress injuries — to improve performances without overloading the musculoskeletal system.

MUSCULOSKELETAL DYNAMICS

"Integrating experimental and modeling approaches of the study of human movement allows us to understand how the nervous system takes advantage of musculoskeletal dynamics, and how it distributes load during human movement," she says. "We use engineering mechanics, biology and neuroscience to develop three-dimensional dynamic models of the human body, and then use experimental and simulation results to determine the internal and external forces at work on an athlete's body when they maintain balance, change directions, sprint, flip, or land," says McNitt-Gray, who directs the biomechanics research laboratory at USC.

The field is called "sports biomechanics," a relatively new field of inquiry spawned by the convergence of knowledge in kinesiology, engineering and human biology. Kinesiology has been around for 35 years, but it has lately experienced a renaissance with new electronics, video and modeling techniques.

McNitt-Gray's approach takes several steps. She starts by talking with coaches and athletes to understand the athlete's performance problems. Then she attaches electrodes to the athlete's body to measure muscle firing patterns and neural control during their performance. With runners, she uses force plates to measure the amount of push being generated. The data she records during a performance will show her how much force is exerted by different muscle groups and joint movements. She then combines that model with a video of the performance to come up with some answers.

KRAYZELBURG'S PERFORMANCE

For instance, an analysis of force measurements and slow-motion video might show her how former Trojan swim champion Lenny Krayzelburg is moving his shoulders after undergoing two shoulder operations. Or they could tell her how Klete Keller, another Trojan swimmer, is shifting his weight — and how he might adjust it — to increase his speed.

"Simulations will help us identify and evaluate potential solutions that are feasible for each individual athlete," McNitt-Gray says. "Then during training, the coaches will work with the athletes to execute whatever it is — a jump, fall, dive, flip — just a little bit differently, but enough to make a difference."

She works with Henryk Flashner, a USC Viterbi School professor of aerospace and mechanical engineering, to model the control and dynamics. They concentrate on studying the central nervous system to understand how it is generating force.

Flashner's job is to convert the motion, force and muscle activation data acquired during an athlete's performance into 3-D coordinates and equations of motion. This interdisciplinary approach is based on well-established principles in aerodynamics, he says, and allows the researchers to characterize movements of the spine, joints, arms and legs. The researchers use customized

McNitt-Gray photo by Max S. Gerber

Kaitlin Sandeno, Athens gold medalist.

kinetics-processing and dynamics-processing software to crunch the numbers and render 3-D movement simulations. As the simulations are viewed, the researchers can ask a series of "what if" questions about the athlete's movements.

"What ifs are questions like 'what if the athlete modifies the timing of the arm swing? Or what if she strengthens her hip muscles? Or he pushes on the ground in a different direction?'" says McNitt-Gray. "How will these modifications of someone's technique improve the consistency of the athlete's performance under the stress of Olympic competition?"

U.S. DIVING TEAM

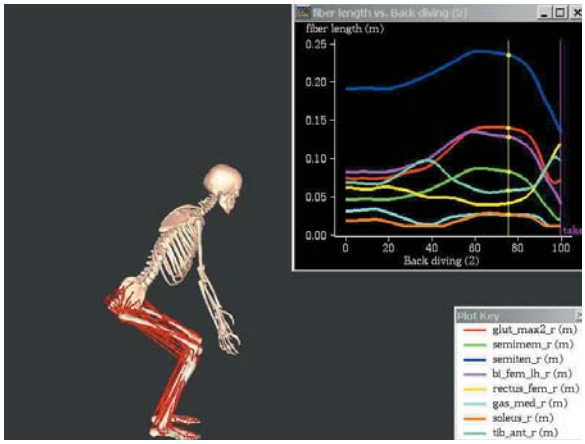
The researchers' unique modeling has been instrumental in a number of sports training programs, most notably the U.S. diving team. McNitt-Gray takes her lab on the road and works with athletes where they train and compete. She works with divers training at the U.S. Diving Centralized Training Center in Woodlands, Texas, all of whom qualified during trials held in late June 2004 for the U.S. Olympics diving team. She also coaches multi-event athletes at the ARCO Olympic Training Center in Chula Vista, CA.

In addition to Olympics athletes, McNitt-Gray works with some of USC's coaches who want to integrate the latest scientific findings into their athletics training programs. She worked with Mick Haley, head women's volleyball coach, and former assistant coach, Olympian Paula Weishoff. The work seems to have paid off: USC's women's volleyball team scored two consecutive NCAA championships in 2002 and 2003.

But she also uses these techniques in a collaborative project with Phil Requejo, a senior research scientist at the Rancho Los Amigos National Rehabilitation Center, to study wheel chair propulsion and balance control in older adults. And the pair collaborates with Rick Naill, a musician and master teacher at the Colburn School of Music, as well as Anna Pattison and Peggy Tsutsui of the USC Dental School, who are training the next generation of dental hygienists.

"If we understand an individual's body mechanics and control mechanisms, we can help them refine their movements and avoid injury to the body," McNitt-Gray says. "This goes for dental technicians, athletes, children who play sports and people who are trying to recover from crippling injuries, such as damage to the spinal cord or losing a limb."

"We use engineering mechanics, biology and neuroscience to develop three-dimensional dynamic models of the human body, and then use experimental and simulation results to determine the internal and external forces at work on an athlete's body when they maintain balance, change directions, sprint, flip, or land," says McNitt-Gray



A musculoskeletal model of the launch of a back-dive shows acceleration forces in different muscle groups, which are color-coded. Sports kinesiologists and biomechanics will study this motion data and recommend strategies to compensate for weaknesses in the diver's performance.

Electrodes attached to a runner's body will record the electrical activity of different muscle groups as the athlete shoots off the starting block.

Lessons in Light

MIDDLE SCHOOL TEACHERS GO BACK TO SCHOOL AT USC

How do you create a five-point star with a pencil-thin beam of laser light?

Fifty middle school science teachers and industry experts from Los Angeles, Orange and Ventura counties gathered for three days last summer at USC's Waite Philips Hall of Education to find out. Armed with laser lights, mirrors, protractors, paper cups and magnifying glasses, the teachers bounced, bent and magnified light as part of the Mathematics, Engineering, and Science Achievement (MESA) program's new optics training institute. The USC Viterbi School's MESA program co-hosted the conference with the Optical Society of America (OSA), the International Society of Optical Engineering (ISOE), and the National Optical Astronomy Observatory (NOAO).

"This is a great opportunity for science teachers to brush up on their science and learn about some of the technologies we see, but take for granted, in our everyday lives," says Larry Lim, director of pre-college programs at the Viterbi School. "We wanted to make the learning fun."

Connie Walker, a NOAO education specialist, helps Darren Hayes, a Santa Ana teacher, left, and Richard Farnsworth, right, of Lawrence Livermore National Observatory, design a five-pointed laser star using a single beam of light and some mirrors.

FIRST OF ITS KIND

And fun it was. The workshop integrated lessons in optics with fun-filled technology demonstrations, featuring everything from laser experiments to building telescopes.

"The kids are going to love this," exclaimed Darren Hayes, a science teacher at Willard Intermediate School in Santa Ana, after he learned how to build a kaleidoscope and teach the lesson in his own classroom.

"This is so neat," said Alyne DeCoteau, a MESA teacher at Mt. Adams Middle School in White Swan, Wash., who drove to Los Angeles for the session with four other teachers.

"Southern California has never held a hands-on teacher training institute like this before," said Anthony Johnson, a professor of physics, computer science and electrical engineering at the University of Maryland's Center for Advanced Studies in Photonics. Johnson is the principal investigator of a three-year, $3-million National Science Foundation grant to develop and distribute the optics training modules to Southern California MESA schools. "Educators are looking at the next 10 to 15 years and asking where U.S. scientists and engineers are going to come from, so we're going after untapped potential — women and underrepresented minorities at the middle and high school levels. I'm really fascinated at what I'm seeing here."

'MISSION IMPOSSIBLE'

The hands-on projects were imaginative but designed to be simple, using ordinary inexpensive materials so that teachers could easily recreate them, explained Michelle Hauer, a USC electrical engineering graduate student who volunteered to staff the event. One of the projects — called "Mission Impossible" — was to design a laser security system intricate enough to protect a fictional museum's prized, 20-karat diamond. "If someone were to intercept a beam, an alarm would go off and alert the guards," the instructions read. "Use every single one of the mirrors and lasers provided to cover the floor of the room with laser beams. Test out your setup by having classmates try to walk around without getting hit by a laser beam. Protect that diamond!"

The teachers turned off the lights and positioned a neon red laser beam so that it ricocheted off six mirrors to form a web of light that no intruder could step through.

"We use lasers because they're everywhere, in CD players, scanners, security systems, surgery and military weapons," said Jason Briggs, OSA education program manager. "The physics and technology of lasers are ideas every student should be learning, but you've got to get the teachers onboard with the ideas first."

Teachers scope out the classroom lighting using the new telescopes they built.

As the magic of light and optics came alive, teachers were given an opportunity to build simple optical instruments. They started by constructing a simple refracting telescope using cardboard tubing. Then they added multi-colored beads to create kaleidoscopes. "It's important to reach these teachers, because they are really critical to MESA's mission of improving students' aptitude in math, science and engineering by the time they reach college," Connie Walker, a workshop coordinator and science education specialist at NOAO in Tucson, Arizona, stressed. "The sixth, seventh and eighth grades are the perfect time to catch kids and teach them about science and technology," she continued, "because by high school, they've shied away from it. It's not cool enough."

Photos by Irene Fertik

Reaching Out to Latin America

HONDURAN CIVIL ENGINEER DAVID MURILLO STARTS MASTER'S DEGREE PROGRAM, THANKS TO A PROFESSOR'S FELLOWSHIP PROGRAM

George V. Chilingar and David Murillo

David Murillo can turn textbook accounts of Hurricane Mitch into spine-tingling tales. Sitting in a classroom at USC, the 31-year-old Honduran engineer tells students about the floods that destroyed 94 bridges and altered the course of the Choluteca River forever.

Hurricane Mitch was one of the worst storms to hit Central America in recent memory. It killed 10,000 people in November 1998 and left a path of destruction that is still noticeable today. Hundreds of Hondurans perished, nearly 2 million residents were left homeless and an estimated 70 percent of the country's most important crops — bananas and coffee — were destroyed.

Murillo is something of a rarity at USC, not because he survived the disaster, but because there are only two other Honduran engineering students who know first-hand how much damage was done.

"Honduras doesn't have many students who are studying environmental engineering," says George V. Chilingar (BSPE '49, MSPE '50, Ph.D. GEOL '56), professor of civil and petroleum engineering who serves as one of Murillo's advisors. "They need them very badly, just like other Latin America countries. David is one of the few who went to college and got a job in the field."

Murillo became the third Honduran student to enter the USC Viterbi School of Engineering this fall, thanks to Chilingar's own Varos Chilingarian Fellowship Program in Environmental Engineering, an endowed fellowship that covers his tuition for a year-long master's degree program in environmental engineering. Named in honor of his father, Varos, Chilingar established the fellowship with a personal donation to encourage more students in Honduras to study environmental engineering and use their newly acquired skills in the service of their country.

Chilingar is a longtime champion of international partnerships with resource-rich and resource-poor nations. Born in Russia and of Russian and Armenian descent, he was the first American petroleum geologist to be elected to the Russian Academy of Sciences. He is considered an ambassador of goodwill by many nations, including Honduras, which 20 years ago named him an Honorary Consul of Honduras in Los Angeles. Recently, Chilingar was instrumental in establishing cooperation between USC, Russia's Nuclear Research Center and the International University of Dubna in Dubna, Russia, in order to form a collaborative partnership of academic and scientific research.

In 50 years of teaching at USC, Chilingar has designed many collaborative programs under different deans, but none has gone as smoothly as his work in Latin America. He credits Dean Nikias with his success in reaching out to Honduras.

"Because of his support, I am attempting to convince the U.S. Agency for International Development (USAID) to sponsor more Honduran fellowships," Chilingar says. "None of it would have been possible without him. He has been wonderful in helping us open the doors to Latin America."

Murillo jumped at the chance to spend a year in Los Angeles studying under Chilingar. "David was the best applicant for the fellowship," Chilingar says. "He scored high on his exams and had a lot of practical experience."

Eight years to be exact. Murillo earned his undergraduate degree from the University of Honduras in 1996 and then went to work for the Honduran government.

"After Hurricane Mitch, I was part of a coordinating unit set up by the Honduran government's department of transportation to repair all of the bridges and roads that were destroyed in the storm," Murillo explains.

His unit was based in Tegucigalpa, the capital of Honduras, but Murillo and his team traveled to five or six of the largest cities in central Honduras to restore roads, bridges and other fragile infrastructure. Some of the country's oldest and most critical bridges — such as the Choluteca Bridge — were completely obliterated by the hurricane.

"I'm looking forward to learning new techniques and principles in civil engineering, not just for repairing roads and bridges, but for addressing other environmental problems," Murillo says. "This is a wonderful opportunity."

It's his first time in Los Angeles, but that does not faze Murillo. He lives with a Honduran family close enough to campus to ride his bicycle to school every day. Chilingar, who is committed to his academic success, helps him navigate the campus and stay on top of his studies.

He keeps in touch with his wife and five-year-old daughter in Tegucigalpa via email, but he does not plan to go home before he finishes his degree.

"I have to study all the time," he says, "and I will be in school the whole year, no breaks."

That doesn't faze him either. He is all smiles.

Cyrus Shahabi Wins High Honor from U.S. Government

Cyrus Shahabi (Ph.D. CS '96), associate professor of computer science and research area director of information management in the Viterbi School's Integrated Media Systems Center (IMSC), has been awarded a coveted 2004 Presidential Early Career Award for Scientists and Engineers (PECASE).

Shahabi was recognized for his innovative work in multidimensional databases and related techniques for storing and analyzing streaming data. These large, complex streaming technologies have wide-ranging applications in a variety of fields, including scientific data

Cyrus Shahabi

analysis, medicine and education. A prototype streaming architecture, called Yima, has already been developed at USC to handle multiple simultaneous high-bandwidth streams of images and sound, all synchronized to single-frame accuracy over the Internet.

"Cyrus's accomplishments are nothing short of remarkable for a young faculty member," says Dean Nikias. "We are very excited that he is being acknowledged for his exceptional talents in streaming technologies. He is extraordinarily gifted and has the ability to make real headway in this field."

The awards, presented in early September in a ceremony at the White House, are given annually to approximately 60 of the finest junior faculty in science and engineering across the country. According to the President's Office of Science and Technology Policy, which administers the awards, recipients possess "talents and potential that are expected to make them leaders in 21st century science and technology."

Shahabi is the fifth member of the Viterbi School faculty to win the award, which is supported by nine federal agencies, including the National Science Foundation (NSF). NSF contributes to the awards program through its own prestigious Faculty Early Career Development (CAREER) program. Junior faculty receiving one of these grants become eligible for PECASE awards, but only 5 percent of CAREER awardees will receive the PECASE award annually.

Shahabi won an NSF CAREER award in 2003. The grant provided him with $400,000 over five years for research, teaching and outreach activities in the management of immersive sensor data streams.

In his award letter from the Office of Science and Technology Policy, Shahabi was called "a shining example to future generations of researchers" and cited for his "talent and commitment" to the field.

Shahabi is currently at work on AIMS, "An Immersidata Management System." "Immersidata" consists of multidimensional sensor data streams produced by a user's interaction within a 3-D environment of images and sound. Users interacting in a typical immersive environment are tracked and monitored through various sensory devices, such as tracking sensors that they wear on their heads, hands and legs, or by using video cameras and haptic devices, such as a "cyber glove."

"These are the user interfaces of the future," Shahabi explains, "which will become increasingly popular as the next generation of the Internet — Internet 2 — comes online."

"Internet 2 promises to be totally immersive, involving processing and accessing enormous amounts of data," adds Gérard Medioni, chairman of the computer science department. "Shahabi's work on multimedia indexing, using feature extraction and wavelets is clever, elegant and efficient. It has the potential of becoming the reference in the field."

The main objective of the AIMS project is to address the challenges involved in managing the multidimensional sensor data streams generated in immersive environments.

"Immersive data can be multidimensional, spatio-temporal and delivered in continuous data streams," Shahabi says. "At the same time, it can be potentially large in size and bandwidth requirements, and it can be noisy."

Currently, Shahabi is applying the techniques developed in the AIMS project to design backend storage and database architectures for two different application domains. One is in the area of scientific data analysis, supported by a grant from NASA/JPL and ChevronTexaco's Center for Interactive Smart Oilfield Technologies (CiSoft) at the Viterbi School. The other is in the area of education, with development of the "20/20 Classroom," which gives users an interactive classroom environment in which to learn via the computer. Shahabi co-leads that project, which is being conducted within the IMSC, a National Science Foundation-funded engineering research center.

"Receiving this kind of national recognition and encouragement puts an extra responsibility on my shoulders to conduct the highest quality research for the broadest impact on society," Shahabi says. "My dream is to make these data tools practical and readily available to every scientist, engineer and researcher who works with immersive applications. That would have a significant impact on science and engineering."

Shahabi has received four significant grants in the last year in the field of multidimensional databases and scalable, end-to-end streaming architectures. These technologies enable efficient delivery of multiple synchronized streams of high quality audio and video data over the Internet.

He holds a Ph.D. in computer science from USC and has been a key investigator in the IMSC since it was founded in 1996. Shahabi came to USC from Iran in 1992, after earning a Bachelor of Science degree in computer engineering from Sharif University of Technology. He also directs USC's Information Laboratory.

He is a resident of Irvine, CA, and the author of two books, more than 100 articles, book chapters and conference papers.

Shahabi photo by Max S. Gerber

Ellis Meng Joins Department of Biomedical Engineering

Ellis Meng, a specialist in microelectromechanical systems (MEMS) fabrication processes, has been appointed assistant professor in USC's biomedical engineering department.

Meng, the first woman to join the department's faculty, will also be affiliated with the Viterbi School's Biomimetic Microelectronic Systems (BMES) Engineering Research Center. The Biomimetic Microelectronic Systems Center is a National Science Foundation-funded interdisciplinary research center aimed at developing novel implants to treat disabilities such as blindness, paralysis and memory loss.

Ellis Meng

"We are very excited to have Professor Meng on our faculty," says Michael Khoo, professor of biomedical engineering and holder of the department's Dwight C. and Hildagarde E. Baum Chair. "Her work will help us pave the way for the development of some novel new biomedical devices."

Meng specializes in MEMS fabrication. MEMS are tiny machines made using manufacturing techniques developed in the integrated circuit industry. Meng has developed the first highly sensitive parylene-based thermal microsensor, which is capable of detecting flows as small as 0.5 microliters a minute. These biological microsensors could be used one day to build new cortical and sensory pathways in the brain or allow physicians to implant devices to monitor medications.

Microsensors, micropumps and microvalves are combined with tiny microchannel networks to create "lab-on-a-chip" systems.

"These miniaturized, high-performance, integrated systems have tremendous potential for revolutionizing biomedical engineering," Meng explains. "Our current research focuses on developing novel biomedical devices that may one day be used to treat many more incurable or degenerative diseases."

In addition to that work, Meng has also developed a novel process for fabricating parylene-based "neuron cages," and has demonstrated that neurons in the hippocampus of a rat's brain can be successfully grown in these cages. The work will help researchers at USC develop bionic chips to restore neural pathways in the brain and eye.

Meng says she was attracted to USC by the unique opportunity to collaborate on highly interdisciplinary topics with a top-flight group of researchers and students.

"The Alfred E. Mann Institute and the BMES Engineering Research Center make USC a particularly exciting research venue for the development of innovative biomedical devices to improve our quality of life," she says.

Meng, a native of Southern California, received her Ph.D. in electrical engineering from the California Institute of Technology in January 2003. She became an assistant professor in UC Davis's department of mechanical and aeronautical engineering before joining USC. She has two patents to her name and has published 10 scholarly papers.

Meng photo by Max S. Gerber

Intensive Care

A WOUNDED FACULTY MEMBER DISCOVERS HE HAS A TROJAN FAMILY

There really is a Trojan Family, unique and special and caring, and Mihran Agbabian, emeritus professor of civil engineering, learned just how special on March 1, 2004.

Agbabian and his wife, traveling with another couple, were on their way home from San Diego to Santa Monica when his friend lost control of his car on the I-5. The car banged into the guardrail, spun around several times and came to a stop in the middle of the freeway.

"Fortunately the other cars were able to stop," says Agbabian. "But I don't remember it because I lost consciousness."

The three others in the car weren't injured but Agbabian was whisked to Mission Hospital Regional Medical Center in Mission Viejo suffering from a large gash on his forehead and a broken hip. He was in intensive care for 12 days and in the hospital for a month suffering further complications of a blot clot and pneumonia.

"During the time I was in intensive care, it was pretty close as to whether I would pull through. I thought a lot about my whole life and what was going to happen," describes Agbabian. "I was entirely dependent on doctors. I thought if they do a good job, I will pull out. If not, I will die."

Agbabian discovered that he and his doctor shared that special Trojan kinship. Someone had told the doctor, Edward Bestard, MD, that Agbabian was a USC emeritus professor.

"I'm cardinal and gold all the way," said the ebullient Bestard, an orthopedic surgeon who received both his undergraduate degree (Biology '75) and medical diploma ('82) from USC. He also did his internship from '82-'83 at L.A. County-USC Medical Center. "I took special care of him and gave him the works. We hit it off."

Agbabian said he found someone to talk to who was clearly taking a special interest in his treatment. He noted that he himself is a graduate of UC-Berkeley where he has continued to maintain ties and where graduates have a strong mutual respect.

Mihran Agbabian

"But they don't have the intimate relationship, the same warm feelings as among Trojans. I was at USC for ten years. That's all, not a very long time. But it was long enough to make me an intimate member of the community," says Agbabian.

Bestard described Agbabian as a "great motivated patient" who did everything he was asked and who did well because of his motivation. "He was a very nice man and very appreciative of his care."

Bestard, who said he spent most of his time as an undergraduate in the biology buildings, only vaguely recalls the engineering school. He occasionally returns to campus for football games, but his Trojan ties remain strong. His sister, his wife's brother and her father all attended USC.

Is there truly a Trojan Family?

"For sure!" exclaims Bestard.

Agbabian agrees. He is still recovering, but is now looking to the future. Before the end of the year, he hopes to return to the American University of Armenia, where he is president emeritus. That university was founded by Agbabian and a UC-Berkeley colleague.

He also looks forward to resuming his luncheon engagements with colleagues in the Viterbi School's department of civil engineering. After all, they are part of the same special family.

FACULTY HONORS & AWARDS

UNIQUE WORK BY SPECIAL PEOPLE

Alexander A. Sawchuk, a professor of electrical engineering in the USC Viterbi School and deputy director of USC's Integrated Media Systems Center, has been awarded this year's Distinguished Service Award by the Optical Society of America (OSA).

The award, honoring outstanding service to the optical community, was presented to Sawchuk for 23 years of dedicated efforts on behalf of OSA, including vital contributions to publications, meetings, international relations and general governance.

"Optics and photonics technology is leading the way in a variety of fields, including telecommunications, biomedical engineering, even manufacturing," says USC Viterbi Dean Nikias. "Sandy's creativity and ingenuity have helped to speed that revolution and improve our understanding of physics and the natural environment."

Sawchuk's contributions to OSA have included chairing the Society Objectives and Policy Committee and Technical Council, as well as serving as a publications editor and chair or member of various other committees, including his current role on the OSA board of directors and OSA foundation board.

"The OSA board of directors is proud to bestow awards on this year's recipients," added OSA President Peter Knight. "The winners have advanced the science of optics and the entire industry through their persistence and ingenuity."

Sawchuk was formally awarded at a ceremony on October 12, during the Society's annual "Frontiers in Optics" meeting in Rochester, NY.

Elaine Chew, assistant professor of industrial and systems engineering and an IMSC researcher, was recently selected to participate in the National Academy of Engineering's Frontiers of Engineering program. This program brings together approximately 100 outstanding young (ages 30-45) engineering

DEN Offers Six New Master of Science Degrees and SAP Certification

The USC Viterbi School of Engineering Distance Education Network (DEN) has added six new Master of Science degrees this year bringing the number to 24 programs available entirely online. DEN now offers more engineering degree programs online than any other leading research university.

"DEN has experienced exponential growth," says Kelly Goulis, DEN's executive director. "In the past two years, DEN has doubled its degree offerings. As technology advances in new fields, we continue to provide professional engineers the skill sets they need to further their career and education."

Added this year are two master's degree programs in petroleum engineering, which involves the technology of economically developing subterranean reservoirs of oil, gas, steam and hot water. One of the petroleum degrees is in Smart Oilfield Technologies, a unique program based upon the petroleum industry's request to train staff on the operation of smart oilfields.

According to Iraj Ershaghi, director of the petroleum engineering program, "simple, traditional drill-and-pump methods leave as much as 80 percent of the oil in a reservoir in the ground. The modern methods we will teach can recover 60 percent of the in-place hydrocarbons, or even more."

Other new programs are in medical device and diagnostic engineering; biomedical engineering (medical imaging and imaging informatics); computer-aided engineering and system safety and security. This last degree emerged from the new Department of Homeland Security Center of Excellence at USC. It is designed to develop leaders in

Photo by Brian Morri

industry and government who will be trained to develop and evaluate systems that protect against natural disasters, accidents and attacks by terrorists or criminals.

"One of the particular emphases of the center will be attacks on infrastructure, because of their potential not only for loss of life, but impact on the economy," says Randolph Hall, center co-director, senior associate dean for research and professor of industrial and systems engineering in the USC Viterbi School of Engineering.

DEN is also offering an academic certificate in SAP, one of the world's leading client/server enterprise application software packages. The objective of the certification program is to give undergraduate and graduate students an opportunity to gain knowledge of the SAP R/3 system, currently used in over 19,000 companies worldwide. SAP is the world's largest inter-enterprise software company, and the world's third-largest overall independent software supplier next to Microsoft and Oracle.

"As technology continues to evolve, knowledge of this widely used system will enhance the careers and education of our students," says Goulis.

Curriculum for the new program comes from state-of-the-art courses in the School's information technology program as well as SAP, and is designed to provide professional engineers and human resources, finance and other business executives with education in the theory and practice of information technology.

FACULTY HONORS & AWARDS

talents from industry, academia and government. **Chris Kyriakakis**, associate professor of electrical engineering, helped organize this year's program and **Paul Debevec**, an assistant researcher professor of computer science and executive producer of graphics research at the Institute for Creative Technologies, is a featured speaker.

Dean Nikias has appointed Professor **George Chilingar** as the USC Viterbi School's first International Advancement Ambassador. The dean cited his successes in promoting Saudi-American friendships and his teaching, research and philanthropy.

Firdaus Udwadia has been elected a fellow of the American Society Mechanical Engineers (ASME). Udwadia is a professor of civil engineering and aerospace and mechanical engineering in the USC Viterbi School; a professor of mathematics in the USC College of Letters, Arts and Sciences and a professor of information operation management in the USC Marshall School of Business.

Computer scientists **Gerard Medioni**, professor and department chair; **Isaac Cohen**, research assistant professor; **Jinman Kang**, doctoral student and **Kalpitkumar Gajera**, master's student, were honored with a best paper award at the first annual workshop on Object Tracking and Classification beyond the Visible Spectrum in July. Their paper, "Detection and Tracking of Moving Objects from Overlapping EO and IR Sensors," was one of two singled out at the workshop attended by researchers from academia, the vision industry and military laboratories.

The USC Viterbi School has scored another trifecta in the competition for the prestigious Okawa computer science grants. The awards went to **Ramesh Govindan**, a specialist in embedded networks and director of the Embedded Network Laboratory; **Maja Mataric**, an expert in adaptive and imitation robotics who is the founding director of the USC Center for Robotics and

continued on page 19

Ultrasound Imaging in Three Dimensions

Jesse will get under your skin with new ultrasound imaging technology

Three-dimensional ultrasonic imaging systems became an indispensable diagnostic tool in obstetrics the minute they were introduced. Now researchers at USC's Viterbi School of Engineering are delving into 3-D ultrasonic scanners to detect breast, liver and kidney cancer.

The key to this technology's commercial success depends on advances in the design of "2-D array ultrasonic transducers." These transducers are the ultrasound source and act as both the receivers and "ear pieces" of the system, says Jesse T. Yen, a USC biomedical engineer and designer. He has built the largest transducer around — an array composed of over 65,500 individual elements, 169 transmitter elements and 1,024 receiver elements — giving it four times the imaging sensitivity of his previous arrays. The instrument operates at five Megahertz and can produce 3-D volumes rather than 2-D slices of a targeted organ.

"This technology promises to give physicians a much better diagnostic tool for spotting lesions in the breast, as well as for detecting carotid arteries or disease in other organs, such as the liver," Yen says.

"The arrays are able to focus ultrasound beams in three dimensions simultaneously, which gives doctors a 3-D view of the target area, rather than a two-dimensional plane, like you see using other imaging techniques, such as x-rays or magnetic resonance imaging."

Unsurpassed Diagnostic Tool

Three-dimensional ultrasonic imaging is already an unsurpassed diagnostic tool in prenatal care. The imaging technique is relatively inexpensive and non-invasive. It does not use harmful ionizing radiation and it allows obstetricians to detect fetal heart defects, spina bifida (curvature of the backbone), cleft palate and other prenatal deformities.

Yen says one of the first commercially available 3-D systems based on 2-D arrays like his, is the GE Voluson, which is ideally suited for fetal imaging, while the SONOS 7500 from Philips is used mainly for cardiac applications.

Ultrasound transducers come in different shapes and sizes, and are used to scan different parts of the body, Yen says. Because of the very high frequencies they emit, pulsed ultra-short sound waves can be aimed at specific targets, such as lesions the size of an apple seed in the breast or liver.

"As transducers emit ultrasound in rapid pulses, the waves travel through the fluid and tissues of the body and are either reflected, refracted or absorbed," says Yen. "Only the reflected sound waves are processed into images that can be displayed on an oscilloscope screen or a video monitor."

Sound waves propagate at a speed of approximately 1,540 meters per second in soft tissues. Yen explains that the thickness, size and location of various soft tissue structures, such as subcutaneous layers of skin, muscle and tissue masses, can be determined based on their distance from the transducer. The variations in the acoustic impedance of the tissue being targeted will determine the strength and shape of the reflected sound wave and give physicians clues about its origin and composition.

Higher frequency ultrasound waves are better at resolving small structures, but they are not able to penetrate very deeply into soft tissues, so Yen's arrays are best at spotting lesions about two centimeters (less than one inch) below the skin. Conversely, a transducer emitting lower frequencies will provide greater depth of penetration but won't be able to produce images that are as sharp. Eventually, Yen hopes to develop a transducer array that operates at ten Megahertz.

Jesse T. Yen

Narrowing the Sound Beam

Focusing and aperture control technology is often used to narrow the sound beam along its entire path to achieve maximum resolution laterally or parallel to the transducer face.

Voluson uses a traditional 1-D array and an automatic electronically controlled motor to scan the imager up and down over the body. Images are "stacked up" to create a 3-D volume. Yen's 2-D arrays do not have any moving parts. Instead, they can focus the ultrasound beam in two lateral dimensions simultaneously.

"My transducer is a 2-D array of elements that will image in both the X and Y planes," he says. "The way it works is simple: I launch sound out into the body, which we refer to as the 'volume' of space in which the sound wave is propagating, but then in receive mode, I can focus the ultrasound beam in these two dimensions, right down to a single point."

The images are more accurate because the array has not moved up and down over the body and because he is focusing in two lateral dimensions instead of the single dimension of a 1-D array, he says.

Yen photo by Max S. Gerber

Close-up of Yen's transducer, the largest ever built, with over 65,500 individual elements, 169 transmitter elements and 1,024 receiver elements. That gives it four times the imaging sensitivity of previous arrays.

Yen built his 65,500-element array at Duke University, where he received his Ph.D. in electrical engineering in 2003, and is continuing the work in collaboration with Kirk Shung, professor of biomedical engineering in the Viterbi School. He uses flexible printed circuit boards, which are found in desktop computers, laptops, stereos and other standard electronic equipment. The flex boards are bonded with a ceramic material called PZT (lead zirconate titanate), which emits sound when electrically excited and converts received echoes into electrical signals.

Cross Configuration

The array of electronic elements sits in the center of the flex circuit, and the ends of the flex have solder pads. It looks like a large cross. The cross configuration fits into the volumetric scanner so that a connection can be made.

The array area is 38.4 by 38.4 millimeters. Yen routed 169 transmitters along four "wings" of the cross-shaped array, so that the north, west, south and east wings have 48, 48, 37 and 36 transmitters, respectively. Each wing also contains gold pads for 256 receivers for a total of 1,024 receivers.

Using artificial, tissue-mimicking phantoms, he has been able to detect cysts two centimeters (about one inch) in diameter, as well as smaller cysts measuring one centimeter and half a centimeter (0.2-inch diameter).

"The images showed marked improvement over the previous array," Yen says. "I've also been able to see real-time images of in vivo hepatic blood vessels using this array technology."

The new imaging technology is bound to improve current cancer screening techniques and help revolutionize prenatal care by allowing physicians to visualize and detect fetal heart defects and other inherited deformities in time to correct them with surgery.

"The ability to visualize organs in multiple planes, in real-time motion will give physicians an incredible advantage in finding and treating disease," Yen says. "The technology isn't far from becoming standard. Give it, maybe, three to five years."

Yen's work on 3-D ultrasonic devices was featured on the cover of the February 2004 issue of *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control* and he presented his findings at the August 2004 international IEEE conference on ultrasonics in Montréal, Canada.

FACULTY HONORS & AWARDS

Embedded Systems (CRES); and **Aristides Requicha**, who is a specialist in nanorobotics and is associate director of CRES. "This is the first time ever that the computer science department has received three Okawa grants in one year," says department chair **Gérard Medioni**. "Considering that our faculty goes head-to-head against Stanford, UC Berkeley, UCLA and Caltech in the competition for these prizes, I think our record speaks for itself."

Last year two researchers in the department received Okawa awards — **Milind Tambe** and **Aiichiro Nakano**, while a third went to electrical engineer Melvin A. Breuer.

USC Viterbi School graduate student **Sundeep Pattem** won a prestigious best paper award at the ACM/IEEE International Symposium on Information Processing in Sensor Networks (IPSN). The paper, "The Impact of Spatial Correlation on Routing with Compression in Wireless Sensor Networks," was co-authored by electrical engineering professors **Bhaskar Krishnamachari** and **Ramesh Govindan**.

Henry Koffman, professor of civil and environmental engineering, has been elected to the board of directors of the Construction Management Association of America [CMAA] Foundation. CMAA's mission is to set and promote professionalism and excellence in the management of the construction process, and to make owners, developers and other industry participants more aware of industry standards.

Terence G. Langdon, the William E. Leonhard Professor of Engineering and a professor of aerospace and mechanical engineering, will receive the Structural Materials Division Distinguished Materials Scientist/Engineer Award for 2005. Presented annually by The Minerals, Metals and Materials Society, Langdon is being honored for his "long-lasting contributions to the fundamental understanding of microstructure, properties and performance of structural materials for industrial applications." Langdon has also been elected an honorary member of the Japan Institute of Metals (JIM), in recognition of his "outstanding contributions in the field of metallurgy and materials science." He will accept the award in March 2005 at the JIM Annual Spring Meeting in Yokohama, Japan.

Fire on the "Vomit Comet"

TINY PELLETS OF FUEL MAY BE SAFER AND BURN MORE EFFICIENTLY

Researchers from the USC Viterbi School say solid fuel particles may be safer for hazardous environments on earth and burn more efficiently in the microgravity of space than gaseous fuels, which are more combustible and difficult to transport.

In the Spring 2004 issue of *NASA Space Research,* Fokion Egolfopoulos and Charles Campbell, of the department of aerospace and mechanical engineering, report that they have made significant progress toward understanding the complex chemical processes that take place when tiny particles of solid fuels burn.

Their findings could lead to the design of safer and more efficient solid fuels for propulsion in space or for maintaining human outposts on the moon or Mars. Their research could also benefit fire-prevention practices.

"Understanding the thermal effects is a first step toward improving fuel economy in both space vehicles and those we use on Earth," says Egolfopoulos. "It's also a good start towards preventing spontaneous combustion in dangerous work environments, like in lumber milling, in grain elevators or in mine galleries. It's a sort of walk-before-you-run kind of thing."

Funded by NASA, the researchers made detailed studies of solid fuel combustion, including the effects of gravity on the process. They measured the burning characteristics of various solid fuel particles on earth and in microgravity, using NASA's KC-135 aircraft — known as the "Vomit Comet" — to simulate the weightlessness of space.

"It takes some getting used to, but after a while, you learn to conduct the experiment very precisely," says Mustafa Gurhan Andac, a postdoctoral research associate from the Viterbi School's Combustion and Fuels Laboratory, who ran the experiments in the nearly weightless environment aboard the NASA aircraft.

"You only have about 23 seconds in zero-g, so you have to ignite the flame before the zero-g parabola starts and be sure to finish the experiment and record the data during those precious seconds of weightlessness."

In their experiments, the team used two laminar, smooth-burning flames in an "opposed-jet" configuration to compare the consumption of solid fuel and gaseous fuel. The bottom burner slowly spews gas to carry solid fuel pellets to the flame, while the top burner issues particle-free gas to fuel the flame.

Fokion Egolfopoulos

Mustafa Gurhan Andac

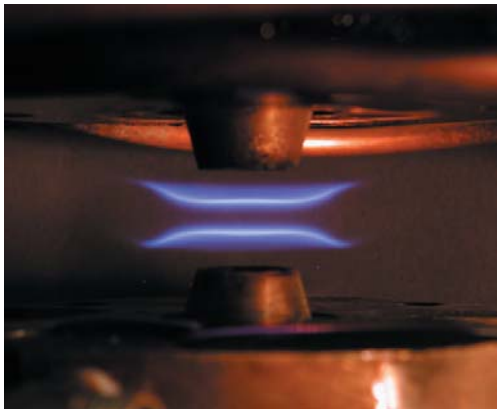
"Depending on the prevailing flow conditions and characteristics of the particles, some particles will ignite and burn completely, whereas others behave as half-inert and burn only partially," Egolfopoulos says. The researchers measured particle size, speed and distribution to determine the optimal conditions for efficient combustion.

"In reduced gravity, a low-speed gas was more effective for complete fuel consumption," explains Campbell. "However, when we ignited the pellets in our laboratory at USC, in earth's gravity, a much higher gas velocity was needed to carry the pellets to the flame. Increased speed caused some of the fuel pellets to burn incompletely."

NASA is finding additional applications for the work as the space agency looks to longer spaceflight missions and human exploration of the moon and Mars. In trips to the moon or Mars, solid fuels derived from the lunar or Martian soil, or solid carbon, extracted from the Martian atmosphere, may fuel the astronauts' return flights to Earth.

The researchers have created a computational model to numerically simulate their experiments and predict the combustion of solid fuel particles in a gaseous stream, based on thermal conditions and particle properties.

They presented their findings at the 30th International Symposium on Combustion held this past July in Chicago.



Researchers are studying how gravity influences the combustion of solid fuels using this opposed jet flame configuration.

Egolfopoulo and Andac photos by Max S. Gerber

Bullets and Baseballs

A USC Medical Researcher and Engineer Join Forces to Improve Body Armor

A .45-caliber pistol bullet slams into soft body armor with the same impact as a 90 mile-per-hour fastball whacking a bare chest

This is one of the findings from an unusual study by a team of USC medical and engineering researchers that could lead to a better bulletproof vest, and possibly to super strong and "intelligent" armor.

"We studied how it would feel to get shot while wearing armor or bulletproof vests," says Bart Kosko, a professor of electrical engineering in the Viterbi School. The armor experiments involved handguns and ordnance gelatin while the data analysis employed a novel mix of standard statistical methods and the more exotic neural-fuzzy rule-based techniques.

"This told us how much injury to expect from a handgun bullet hitting armor," Kosko explains. "We quantified the baseball comparison to help understand gunshots and armor. Handgun bullets are like baseballs. They do not knock people backward as in the movies. Instead they bruise soft tissue."

Kosko teamed with noted medical researcher W. French Anderson, director of the USC Keck School of Medicine Gene Therapy Laboratories, and Viterbi School Ph.D. student Ian Lee on the paper "Fuzzy Modeling of Gunshot Bruises in Soft Body Armor," published for the 23rd International Conference of the North American Fuzzy Information Processing Society held in June.

Kosko has authored many books, both technical and popular, on fuzzy logic, a technique that uses shades of gray rather than simple yes/no answers and that allows humans to program computers with commonsense rules such as, "If the air is cool then set the air conditioner to slow."

The research commenced from a simple question: What can science tell us about the bruising and other effects that result when someone gets shot wearing soft body armor? There had been virtually no scientific work on the problem —yet it is a question that many police officers and soldiers face every day.

"The FBI had asked me to look into this, and I immediately thought of Bart Kosko. Bart is an original thinker, and his 'fuzzy logic' sounded perfect for this task." Anderson says.

The available evidence was scattered and incomplete. The FBI published statistics showed that no handgun bullets killed armor-clad police officers by piercing. The military inserts so-called "trauma plates" in a soldier's flack jacket to stop rifle bullets.

The National Institute of Safety and Technology (NIST) developed armor test procedures that used modeling clay to measure the backface deformation — the deformation in the armor's backing material after a gunshot.

The research commenced from a simple question: What can science tell us about the bruising and other effects that result when someone gets shot wearing soft body armor?

But what does a 10-millimeter deformation in clay correspond to in a body? The researchers developed a trainable fuzzy system based on data that they obtained from numerous test firings of four different caliber bullets (.22, .38, .40, and .45) into ordnance gelatin-backed vests and other materials. Their analysis was based on bruise patterns from actual shootings.

The backface deformation depth and width on the armor estimated the trauma that would have been produced on the body beneath the armor. Timing established the average speed of each box of bullets.

The simplest findings dealt with bullet momentum (mass times velocity) and bullet energy. The energy of a speeding bullet grows with the square of its velocity. But slower moving heavy bullets (like the .45 caliber) bruised more than high velocity lighter ones (like the .22 caliber). Impact depth correlated better with momentum than with kinetic energy.

To get a clearer and more intuitive understanding of the actual impact, the experiments backed the armor against Plumbers' Putty,

Bart Kosko

measuring the impact, and then comparing the impact with that of baseballs hurled by a pitching machine. While a .45 hits a bulletproof vest with the impact of a major league fastball in the ribs, a .22 is equivalent to being hit by a ball going 40 mph, the researchers found.

"This finding can help armor makers improve the tradeoffs involved in making thin extended-wear armor that minimizes gunshot bruises," Kosko explains. "It can also help give police officers a better sense of what it feels like to be in the literal line of fire."

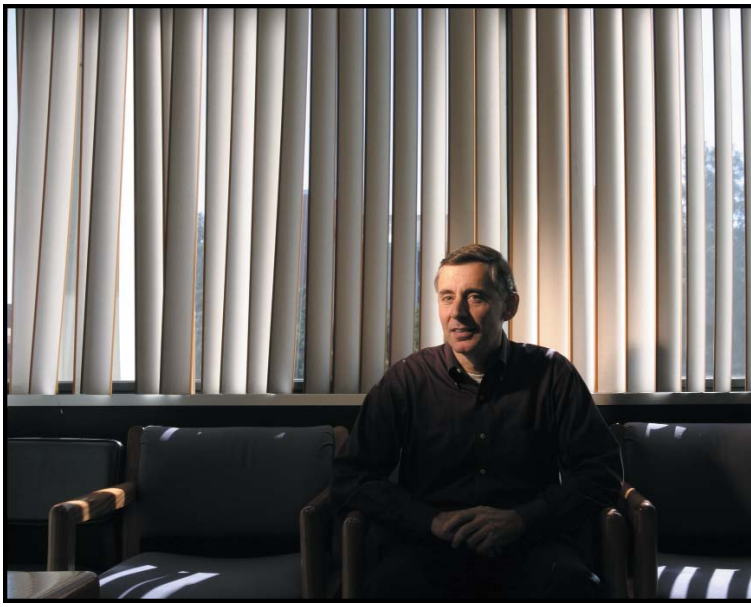
"I often make presentations to law enforcement personnel about surviving deadly

continued on page 23

Kosko photo by Max S. Gerber

BMSR Wins $5.9 Million, 5-Year Renewal

Better Treatments through 'Quantitative Medicine'



David D'Argenio

The Food and Drug Administration (FDA) recently approved two new drugs — Enbral, for treating adult and juvenile rheumatoid arthritis, and Xolair, the first monocloncal antibody for treating allergy-related asthma.

The testing of both drugs — and many others before them — relied heavily on the work and products of one of the USC Viterbi School's longest standing and most productive research efforts, the Biomedical Simulations Resource (BMSR). Dean Nikias calls the BMSR "a brilliant model for what creative university engineering research should be."

Once a daring vision, the BMSR has developed the classic, basic engineering tool of "systems modeling" into well-used technologies. These technologies have been applied by front-line medical researchers and industry to various biomedical problems. All 15 of the world's largest pharmaceutical companies now use BMSR-developed methods as part of their process for testing new drug candidates.

The BMSR's astonishing track record was validated by this year's five-year renewal of its funding from the National Institutes of Health (NIH). The new grant of $5.9 million running through 2008, will bring the total funding to $21.4 million and like the previous ones, the renewal was competitive.

"It is difficult to get NIH center grant funding," says BMSR co-director David D'Argenio, "and even more difficult to maintain it, let alone for more than 23 years."

The record achieved by BMSR co-directors Vasilis Z. Marmarelis and D'Argenio of the Viterbi School's department of biomedical engineering is the result of negotiating a promising but very difficult path. In many areas of engineering, success in understanding physical processes and improving devices and techniques has come from devising mathematical models based on theoretical principles, and then refining these models by checking their predictions against observations, in an iterative process. The key is to precisely quantify predictions, so that the model's fit to reality can be measured.

Engineers have long used the technique to improve aircraft, chemical plants and automobile engines, as well as the construction of structures ranging from the atomic to the skyscraper level. But applying the technique to biology and medicine was still fragmentary and unsystematic when Marmarelis and D'Argenio made their initial NIH application in September 1984. They proposed a research unit with a mission "to advance the state of the art in biomedical systems modeling," working on both basic research methods and practical software development.

Now, as the project approaches the midpoint of its third decade, biomedical modeling has become established and applied to conditions such as Alzheimer's disease, stroke, diabetes, cancer, AIDS and sleep disorders.

"The FDA has recognized the importance of an expanded role of systems modeling in drug development," notes D'Argenio, "and a recent white paper has called for the creation of a new product development toolkit that includes computer-based predictive models to improve and accelerate the drug approval process." D'Argenio was recently appointed to the FDA Clinical Pharmacology Subcommittee, the only engineer on this twelve member panel that provides advice to the FDA on drug response modeling, pharmacogenomics and pediatric clinical pharmacology. "It is gratifying to see that the systems modeling framework, as well as the methods and tools created and refined at the BMSR, are playing an increasingly important role in drug development," says D'Argenio.

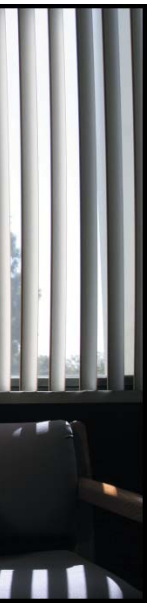
This great success was not achieved overnight.

"The challenge in biomedical systems modeling," explains D'Argenio, "is biological processes are nonlinear, with complex feedback mechanisms operating within and between at least five interconnected, but separate levels: the molecular level, the cellular level, the intercellular level, the organ level and the whole body level. Accordingly, the methods and tools we develop must be able to describe the autoregulatory consequences of these feedback processes at all levels, both in health and disease."

Diabetes, which Marmarelis, a professor of biomedical engineering and electrical engineering, has recently been studying, is a classic example. The condition results from a single, simple well-understood cause — the failure of cells in the pancreas to manufacture enough of the blood sugar regulating substance insulin. The results of a shortage of insulin, however, are anything but simple and Marmarelis has played a key role in better understanding diabetes. The condition affects almost every organ in the body differently, and in different degrees (in non-linear fashion). Because the functioning of different organs is interconnected, the initial effect of reduced insulin production triggers a cascade of other effects, creating the bewilderingly broad clinical picture of diabetes.

Marmarelis uses modeling methods to analyze the complex dynamic interactions between insulin, glucose and free fatty acids, with the goal of achieving the long-held dream of an "artificial pancreas." Such a device would maintain the level of blood glucose fairly constant throughout the life of diabetics in an

Photo by Max S. Gerber



automatic fashion. This advanced scientific understanding also reveals critical aspects of the causes of obesity and offers clinical solutions for this growing epidemic threat.

"Ultimately, our goal is to understand the full complexity in the dynamic nonlinear interactions among the metabolic, the endocrine, the cardiovascular and the nervous system, thereby ushering in a new era in quantitative medicine," Marmarelis asserts.

Clinical research has given physiologists a general, qualitative overview of what the mechanisms are, but in order to better control the disease, it is crucial to have a dynamic, unified, quantitative model. Such a model must integrate the multiple interconnected variables that enable an experimenter to see, in a simulation, what happens to the whole system when individual inputs change.

Marmarelis' BMSR work serves as the basis for a new book, *"Nonlinear Dynamic Modeling of Physiological Systems,"* just published by Wiley Interscience and IEEE Press.

D'Argenio has applied the BMSR systems modeling philosophy to therapeutic drug development through "in silico methods," using it to study and evaluate candidate drugs to treat cancers, viral, autoimmune and other diseases. He has developed sophisticated methods to model the way drugs work, from their action on molecular targets through clinical disease response. He has created software, embodying the methods and models, that other researchers can use in their work, whether for drug development or physiological study.

"To date," says D'Argenio, "more than 4,500 biomedical researchers worldwide have used BMSR developed software." The titles include the drug effect modeling software ADAPT, the general biological modeling system LYSIS, the neural modeling system EONs and PNEUMA, a set of programs describing cardiorespiratory function.

BMSR techniques and software require training and since 1985, 2,400 researchers from all over the world have attended 23 short courses and 19 workshops on BMSR techniques.

In addition to Marmarelis and D'Argenio, University professor Theodore W. Berger and Michael C. K. Khoo, professor and chair of the department of biomedical engineering, serve as main BMSR investigators.

Khoo's research focuses on improving the modeling of biological control systems and how they feedback on each other, with particular emphasis to the intricate teamwork between heart and lungs. His applications to cardio-respiratory coupling in sleep disorders were highlighted in the Spring/Summer 2003 issue of *USC Engineer.*

Berger's long-term collaboration with Marmarelis centers on modeling neural activity in the brain, specifically the hippocampus. This research has been the springboard from which he embarked on his now widely known efforts to create sophisticated microelectronic components that can emulate the physiological function of parts of the central nervous system. He hopes to eventually repair damaged neural tissue and is also attempting to better understand the processes leading to Alzheimer's disease.

Marmarelis is more enthusiastic than ever about the prospects for BMSR as a leader in promoting a new quantitative medicine that will be more flexible and effective, and give more bang for the experimental buck.

"I believe the best is yet to come in our area," he says. "Over the past twenty years, we established elements of biomedical modeling using the computers and software tools of the time," he notes. "But I believe the accelerating improvement in computers, and advanced methodologies of biomedical data analysis and collection, is going to have an explosive impact on our specialty, and on medicine as a whole. And I think when the history of this impact is written, USC biomedical engineering will have a striking role."

Bullets and Baseballs *continued from page 21*

confrontations, but no one could explain in an understandable way what it feels like to be shot in the chest wearing soft body armor. Finally we have something. Being hit by a baseball is something we can relate to," explains Anderson.

The researchers believe new nanomaterials may also provide the protection of heavy bulky trauma plates in a lightweight flexible armor. Other researchers have already shown that super tough nanotube threads can augment or replace the Kevlar fibers to strengthen armor vests.

A shear thickening fluid helps treated armor vests resist bullet penetration and reduce backface injuries. These and developments in smart materials and nanoscale devices promise super strong armor that can detect approaching bullets, report a soldier's vital signs and injuries, and then change armor nano-properties to react to threats.

Such super strong armors that could process signals would be "intelligent" in the primitive but important sense that they would be able to make appropriate vest changes in response to new threat stimuli. Ian Lee is pursuing such designs as part of his Ph.D. work in the new field of nano-signal processing.

The researchers used no public research funding of any kind for this study. Ammunition, rental firearms and facilities came from the Orange County Indoor Shooting Range, in Brea, California. The researchers performed the baseball comparison trials in the batting cages at Home Run Park, in Anaheim, California.

A 14-ply Kevlar soft body armor panel (a Superfeatherlite vest from Second Chance) and some sample cartridges (.22, .38, .40, and .45 caliber). Different caliber bullets struck the sample armor.*

student works

INTO AFRICA

Undergraduates transcend the classroom to help an African village

Shelley Howard, a 22-year-old chemical engineering major, is passionate about environmental conservation in Africa. During the spring 2004 semester, without leaving the classroom, the graduating senior helped an impoverished Central African village design its first water and power system.

"As soon as I heard that one of the projects in this class was about Africa, I jumped right on it," she says excitedly. "This is real life stuff. Africa is going to be developed in the next 30 years and I fully intend to use my degree to work on international issues and environmental conservation there."

Her classmate, Eric Lim, a junior civil engineering major, was just as excited to work with the Central African township of N'Djili. Hoping someday to "serve people as an engineer," he says developing his proposal to design a water purification system made him realize just how undeveloped Third World countries really are.

Howard and Lim participated in a new program to support undeveloped Third World countries as part of their course, WRIT 340, "Advanced Writing: Communication for Engineering." Now in its sixth year, the course employs an innovative, hands-on approach to improve engineering communications skills of the juniors and seniors who "transcend the classroom" and put their technical know-how to work on local community service projects. But in this case, the community lay on the other side of the world.

N'Djili, a French-speaking town of 277,000 people, is about five miles from Kinshasa, the capital of the Democratic Republic of Congo. A huge portion of adults have died of AIDS and 40 percent of the children do not attend school.

Overcoming Barriers

The engineers faced daunting geographic, cultural and language barriers to develop their infrastructure projects, explains Steven Weinberg, a lecturer and one of six faculty who teach the course.

"They had to come to a cultural understanding about N'Djili to understand that they were dealing with a people who don't have a sanitation system for their town, but are capable of having an Internet video-conference," Weinberg describes. "Given these unique circumstances, we asked the students to think creatively and come up with new approaches to solving some of the town's needs."

The African Millennium Foundation (AMF), a Los Angeles-based nonprofit organization dedicated to the improvement of economic, educational and health care standards, and general social and economic empowerment in impoverished areas of Africa, acted as the students' go-between.

"N'Djili is like many parts of Africa," says Malena Ruth, AMF president. "It's a town with no infrastructure, no power or electricity. People drink contaminated water from ground wells and wash their clothes in the river. The children don't know about flush toilets and the adults are being wiped out by AIDS."

Students quickly learned that N'Djili "wasn't just L.A. with dirt," Weinberg says. But they focused on the "customer's needs" to find solutions that made sense to N'Djili.

The students broke up in teams of four to work on water treatment and purification systems; drip irrigation systems; small, auxiliary hydroelectric power units and a computer lab. They only got one chance to speak directly to N'Djili officials, during a two-hour videoconference that required French-speaking translators on both ends. Whatever wasn't answered during that videoconference had to be researched or answered via email.

The lack of contact with N'Djili frustrated many. "Glitzy technology is wonderful, but if you don't have enough information to choose the right power system, it won't work," states Morgan Hendry, 21, an astronautics major. "There is no substitute for visiting," adds Matt Feehan, 22, a civil engineering major.

Just Like the Real World

Shunning conventional pedagogy to the end, the students eventually found

Stephen Bucher, director of the Engineering Writing Program, introduces his students to the N'Djili officials at the beginning of the class videoconference.

Left to right, Kathrun Ceballos, Victor Mitsouka and Morgan Hendry discuss questions they will ask the N'Djili representatives during a videoconference.

Student works photos by Irene Fertik

themselves in formal business attire and armed with PowerPoint slides to present their recommendations for building water, power and irrigation systems to the African Millennium Foundation.

"We asked them to own their projects and do whatever it took to finish them, like they'll have to do in the working world," Weinberg explains.

The foundation will use the students' reports to fill out grant applications. If they come up empty handed, the next crop of students taking the course will pick up where this group left off. Or, they will likely tackle other AMF projects.

"It's just the start of a long-term partnership between USC and the foundation to create mutually beneficial relationships in Africa," Weinberg says.

USC'S Engineering Writing Program has helped a number of service organizations in the Los Angeles area and a growing number of them are asking program director Stephen Bucher for help. Students have done everything from reconfiguring computer labs to designing playgrounds. Bucher says organizations have used the student reports to obtain grants ranging from $5,000 to $800,000.

USC's Civic and Community Relations Office brought AMF to Bucher. AMF's president, Ruth, says the first set of proposals was "truly groundbreaking." She added that N'Djili could probably begin to build some rudimentary power and irrigation systems, and try some new ways of cooking, before the year is out. The students were elated.

"That's what we wanted students to experience," Bucher explains. "We wanted them to know that there was much more than a grade at stake here. They got to see how their ideas directly affect others."

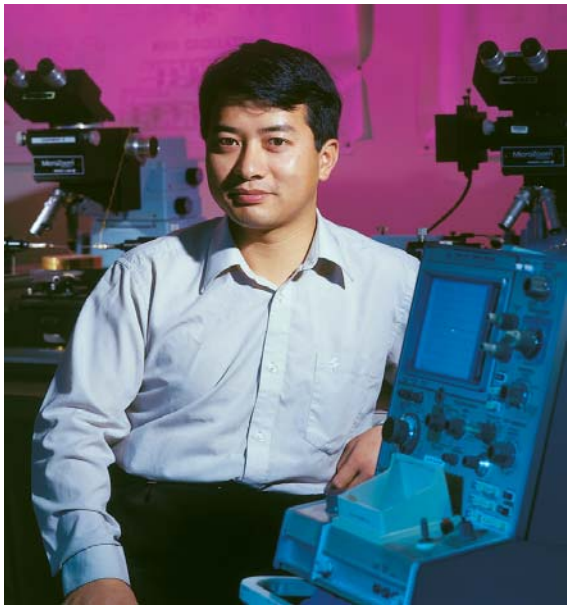
For more information about the Engineering Writing Program, contact Stephen Bucher at sbucher@usc.edu .

Zhou photo by Michelle A. H. Smith

Growing Nanocables: *Bigger and Better*

A USC Viterbi School engineer has discovered a way to manufacture composite "nanocables" from a potent new class of substances with extraordinary properties called Transition Metal Oxides (TMOs).

Chongwu Zhou, an assistant professor in the USC Viterbi School's department of electrical engineering, is creating dense arrays of ultrafine wires made of magnesium oxide (MgO), each coated with uniform, precisely controlled layers of TMO.



Chongwu Zhou

In the last decade, TMOs have been intensely investigated because they demonstrate a wide range of potentially useful properties, including high-temperature superconductivity. Because of the great potential for applications research, investigators have tried for years to create TMO nanowires, but so far have had limited success.

"But now we can supply a group of previously unavailable materials to the nanotechnology community," Zhou says.

The Zhou team demonstrated their technique with four different TMOs: YBCO, a well-known superconductor with a high transition temperature; LCMO, a material showing "colossal" magnetoresistance; PZT, an important ferroelectric material; and Fe3O4, known as magnetite in its strongly magnetic mineral form.

The new structures all start with a new technique Zhou and his co-workers developed to create arrays of nanowires by condensing magnesium oxide vapor onto magesium oxide plates using gold as catalyst. This produces a forest of magnesium oxide nanowires, each 30-100 nanometers in diameter and three microns (100 millionth of an inch) long, all growing parallel at a constant angle to the substrate plate.

"Now the magic starts," Zhou says. A laser vaporizes the TMO, which then condenses directly out of the gaseous state onto the waiting magnesium oxide cores in very precise fashion. This process is called "pulsed laser deposition."

The final product looks like nano-sized coaxial cable, with a magnesium oxide core and TMO sheath. "The trick is we can preserve the TMO composition using this technique," says Zhou, "while other techniques cannot."

Zhou's paper, "Nano Letters," recently accepted for publication and currently circulating on the Internet, that the assemblies "can be tailored for a wide variety of applications, including low-loss power delivery, quantum computing, ultrahigh density magnetic data storage, and more recently, spintronic applications."

"We expect that these TMO nanowires may offer enormous opportunities to explore intriguing physics at the nanoscale dimensions," says Zhou.

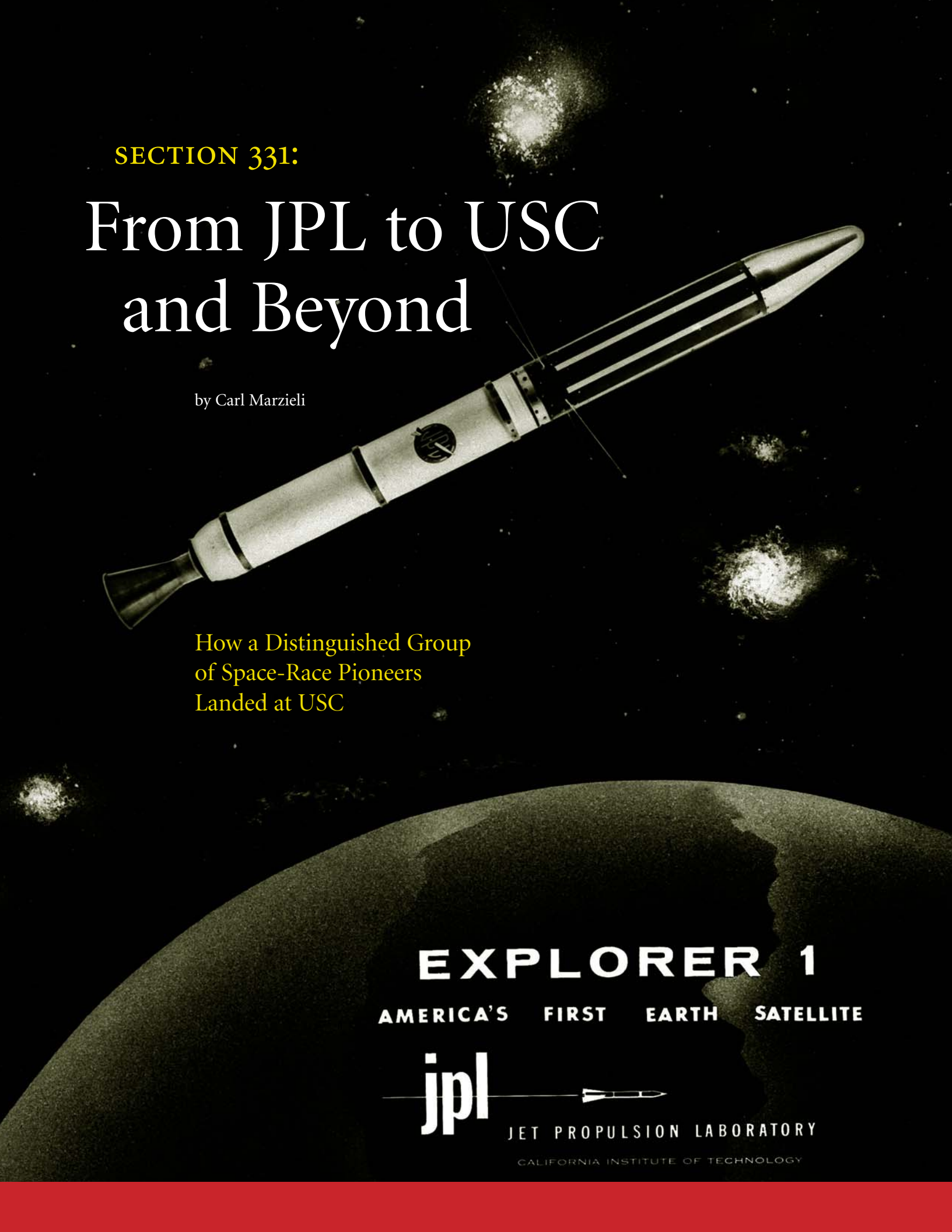
Zhou, the winner of the USC Viterbi School's 2004 Junior Faculty Research Award, believes that the four new nanowires are only the beginning. "Our synthetic approach will lead to other new nanostructures," he says.

Working with Zhou are Song Han, Chao Li, Zuqin Liu, Bo Lei, Daihua Zhang, Wu Jin, Xiaoleiu Liu and Tao Tang. A National Science Foundation CAREER award and DARPA supported the research.

SECTION 331:

From JPL to USC and Beyond

by Carl Marzieli



How a Distinguished Group of Space-Race Pioneers Landed at USC

In the smoggy 1950s at Pasadena's Jet Propulsion Laboratory, there were days when you could not see the mountain from the junior scientists' trailers at the base of the Arroyo Seco.

But inside those trailers, a rare clarity of thought emerged creating an unlikely alliance of mathematicians and engineers. Bridging disciplines that were as easily mixed as oil and water, a small progressive group laid the foundations of the digital age.

They were brilliant minds in their early twenties, fresh out of school and culled from every corner of the country. Later, most would join USC's engineering school, turning it into a leading presence in digital communications and information theory. One would put his name on that school. At the time, however, academic honors were far from their minds. The race for space was on, and the Soviets were in first place.

In 1957, William Lindsey, now a professor at the USC Viterbi School of Engineering, was an electrical engineering junior at Purdue University when the launch of *Sputnik* shocked America. Every 96 minutes the small aluminum can flew over the United States, and with every pass the country's reaction grew more dire. What was next: nukes in space?

More intrigued than alarmed, Lindsey hooked up a radio to a speaker to see if he could pick up any signals. There it was — a steady beep in the ham frequency range, put there by the Soviets to make sure every American got the message. Lindsey knew the signal came from *Sputnik,* because it was Doppler-shifted: that is, the beep rose in pitch as the satellite approached and dropped down as it receded, every 96 minutes, exactly.

"When I hooked the speaker up to this audio signal and we could hear the Doppler shift, the whole university came running. It spread like wildfire through campus. The whole student body came to listen to this tone," Lindsey remembers, still wide-eyed.

He realized two things: anything involving space was going to be a hot area for career-minded scientists; and, if you could pick up a signal from space, you could also modulate that signal and use it to carry information. It was at that moment Lindsey decided to become a communications engineer.

"I knew there was something there," he says.

Soon Lindsey joined the trailer group, formally known as Communications Section 331 in JPL's Division 33. It was home to the theorists, and had been their home for some time. Lindsey was one of its youngest members.

There was Eberhardt Rechtin, now an emeritus professor at USC, but then the long-serving head of Division 33 and in his words "chief architect of the whole shebang." He was in charge of the systems for space communications, networks and devices.

There was mathematician Solomon Golomb, chief of Section 331 and father of the shift-register sequences used universally in message coding. Golomb now holds the Andrew and Erna Viterbi Chair in Communications at the USC Viterbi School. His contribution goes beyond mathematics, however. Both at JPL and later at USC, Golomb demonstrated a keen eye for talent and team-building.

MAN'S STEP ON THE FIRST RUNG OF SPACE TRAVEL, THE SOVIET UNION LAUNCHED AN 184-POUND *SPUTNIK* VEHICLE LIKE THIS MODEL INTO EARTH'S ORBIT, OCTOBER 4, 1957. LEFT, PERIOD POSTER FROM JPL CELEBRATING EXPLORER I.

"He had collected a very striking group of mathematicians and mathematically oriented engineers," says Thomas Kailath, who spent a year at JPL and is now professor emeritus of engineering at Stanford University. "Section 331 was actually a powerhouse."

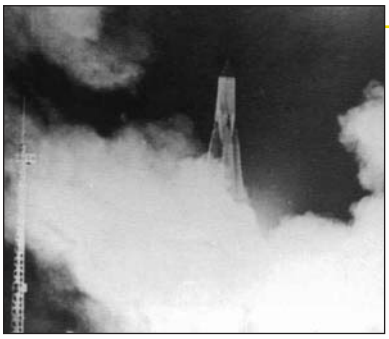
Kailath credits Golomb for having the vision to erase some traditional boundaries.

"In those days mathematics and engineering were still regarded as somewhat separate entities," Kailath says. "This was one of the groups that helped bridge that gap and showed the power of mathematical reasoning and mathematical modeling. That was the main contribution of the place."

Besides Lindsey, Golomb recruited Lloyd Welch, who with Leonard Baum developed the Baum Welch Algorithm, an important tool used in

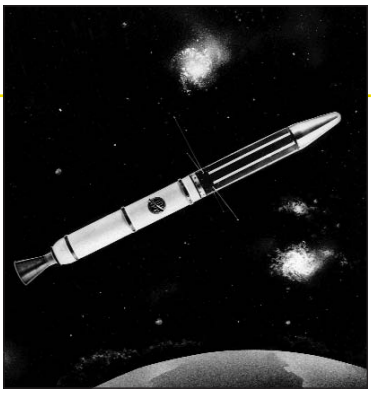
Sputnik photo by Michael Rougier, Time & Life Pictures

THE RACE IS ON...



1957

Soviet Union launches first two earth satellites, Sputnik I and II, using R-7 rockets.



1958

Explorer I, first successful U.S. spacecraft, carries instruments to study cosmic rays & micrometeorites.

speech recognition and other areas. He is also now professor emeritus at USC. Golomb also recruited a 22-year-old Andrew Viterbi (Ph.D. EE '62), who would later become the co-founder of the cell phone giant Qualcomm. Today, Viterbi holds the Presidential Chair in Engineering at USC, and he and his wife Erna are donors of an endowed chair as well as the most generous naming gift to any engineering school in the U.S. Modern wireless technology is based in part on the Viterbi Algorithm for error decoding, the mathematics of which Viterbi says he learned from Golomb.

"I landed at JPL in a den of mathematicians," Viterbi says. What a contrast from his previous employer, Raytheon, whose engineers Viterbi remembers as being "rather dismissive" of mathematical theory. Viterbi himself was right in the middle: a prolific thinker with an innate nose for the most fruitful intersections of theory and practice. Lindsey, who remembers himself as a naïve theoretician when he began working at JPL, credits Viterbi for redirecting him to problems that were not only intriguing, but important. And just in time: Viterbi arrived in June of 1957, three months before the launch of *Sputnik* turned the place upside down.

BILL LINDSEY, CENTER, WITH JPL SUPERIORS, RECEIVING A DIGITAL DATA TRANS—TRACKING LOOP AWARD PATENT.

While *Sputnik* is credited with giving the U.S. space program a much-needed kick in the pants, few realize that JPL was ready to launch a satellite a full year before the Soviets. Just like *Sputnik,* the American version would have been small and rudimentary and, most importantly, first in space.

In September 1956, Golomb recalls, the directors of JPL and a sister group in Alabama brought the satellite proposal to the White House. It was discussed by scientists on President Eisenhower's committee for basic research. That committee was supporting a rival project, called *Vanguard.* In addition, a majority on the committee felt that the exploration of space should be a non-military activity. Since JPL was run by the Army in the pre-NASA era, its proposal was dead on arrival.

"The Eisenhower administration was not aware that we were in any kind of a race at that point," Golomb says. The launch of *Sputnik* raised their awareness level substantially. Within three months the government was ready with its counterpunch. In December of 1957, the U.S. invited the world's press and television cameras to witness *Vanguard's* debut at Cape Canaveral, Florida. Embarrassingly, *Vanguard* blew up on the launch pad.

"And that was our competition," says Golomb.

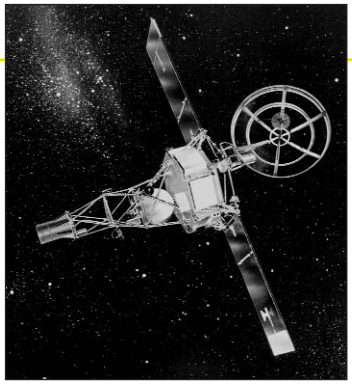
A month later the scientists at JPL had their own answer to *Sputnik,* called *Explorer I.* Much to the Eisenhower administration's relief, this one made it off the ground in one piece on January 31, 1958. There were clenched fists and cold sweats in the Pasadena control room when several tracking stations around the globe failed to detect the satellite at the expected times. The communications team later realized that the thrust of the *Explorer I* boosters had been greater than planned, making its orbit longer and therefore delaying its progress by about 15 minutes.

The ultimate barometer of national enthusiasm — *Life* magazine — featured photographs of Golomb and Viterbi in the control room. More importantly, the satellite's success ensured the work of Section 331 would have far-reaching impact. By helping the satellite and mission control to communicate reliably, the scientists in the trailer had solved much more than the problem at hand. They had been drafting the blueprint for modern wireless communications.

The basic achievement had been the transport of information in a noisy environment with low-power transmitters. Out of that came satellite communications solutions, coding technology, the ability to track vehicles in space and time, the development of masers and rubidium, cesium standards for frequency and timing in all types of communications. It was a time of wide-open frontiers.

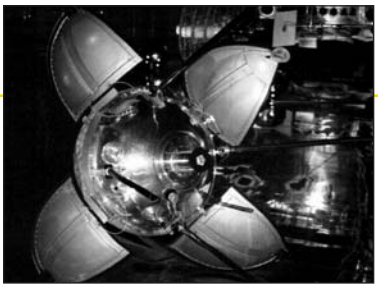
"What was our mission? We were defining it as much as we were being told what it was," Golomb recalls.

The science behind the group's achievements boiled down to two essential concepts. One was the idea of coding with shift-register sequences, developed by Golomb and further refined by himself, Viterbi



1962

NASA's Mariner 2 carries solar-powered instrument package past Venus. First successful planetary flyby.



1966

Soviet Luna 9 achieves soft landing on the moon.

and Welch. A shift register of n slots (n can be any whole number) is a device that takes an incoming stream of binary bits — ones and zeros — and, as each bit progresses from one slot to the next in the register, alters the message according to a predetermined formula. As each bit comes out of the register, it is fed back into the other side a certain number of times. The end result is a much bigger stream of bits with two advantages: it is coded to prevent jamming, and because it is redundant, with every original bit expressed multiple times, it is highly resistant to interference. Even if noise wipes out many bits in the stream, enough copies will be left to reconstruct the message. At the receiving end, a decoder inverts the coding formula and returns the original binary stream.

Another key technological building block was that of phase-lock loops, developed by Rechtin, Viterbi and Lindsey. The idea of a phase-lock loop is no different than every child's favorite bath hobby: making the water slosh higher and higher until it splashes out of the tub. An oscillator on the receiver tunes itself to resonate at the same frequency as the incoming signal. Resonance is a natural amplifier, helping to pull the signal out of deep noise. "Phase-lock" refers to the need for the oscillator and the signal to be in phase and to stay that way.

"Phase-coherent communications and tracking is key to modern digital communications," says Lindsey, who should know. While at JPL he worked secretly on the side for the U.S. intelligence community, monitoring Soviet communications. To his astonishment, he discovered that the other side was using phase-incoherent transmission — cheap, but very inefficient and not secure.

All these advances, though developed for communications in space, turned out to be vital for wireless transmission in a commercial airspace saturated with conflicting signals.

"I can say, without boasting at all, that we were the foundation of the global communications that we now have," Rechtin says. Lincoln Laboratories, run by the Massachusetts Institute of Technology, also contributed important advances, as did Purdue and Stanford. The legendary Bell Laboratories was a bastion of research but, according to Golomb, focused heavily on the land-based telephone system.

For years, no one in the group grasped the significance of their research. "It was just interesting work," says Welch. "I'm amazed, you see. We were basically in the digital communications era when nobody else was. Then as time goes on it's found a use in commercial applications. They were using all the theory that we had developed back in the fifties and sixties."

Years later, while consulting on the side, Lindsey was often asked how the group came together.

"I think God made this group," he replied.

After God came Zohrab Kaprielian, who did his best to live up to his predecessor. Revered, scorned, loved, feared (he was all four at once); Kaprielian re-assembled the JPL group at USC. Nominally Kaprielian's title was chair of the engineering department, but everyone knew he was much more.

EBERHARDT RECHTIN

THOMAS KAILATH

ANDREW VITERBI

IRVING REED

Golomb recalls that at one point around 1970, there were five levels of administration between himself and the president of the university, "and all of them were Zohrab Kaprielian."

"At that time we operated on the principle of one man, one vote," Golomb says, "and Kaprielian was the one man who had the one vote."

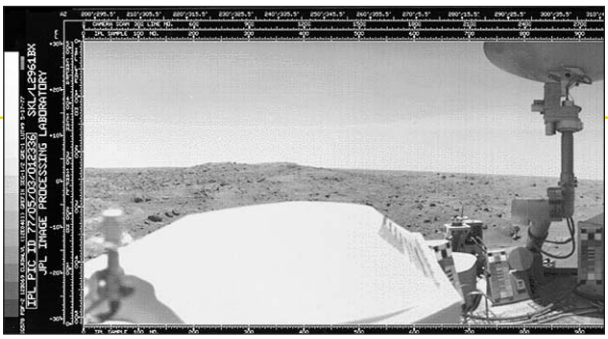
In matters of science Kaprielian used his vote brilliantly. Instead of trying to compete head to head with bigger universities, he focused on

continued on next page

"I CAN SAY, WITHOUT BOASTING AT ALL, THAT WE WERE THE FOUNDATION OF THE GLOBAL COMMUNICATIONS THAT WE NOW HAVE," RECHTIN SAYS.

1973

Pioneer 10 reaches Jupiter, and then continues on outside the solar system.

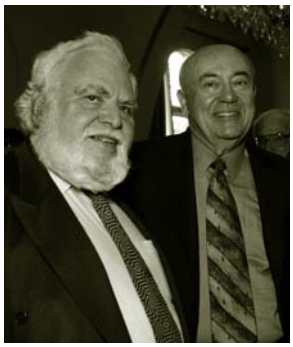


1976

Viking lander sets down on Mars.

hot new fields where he knew USC could move faster than its stodgie rivals. Digital communications was one of those fields.

In 1963, on Viterbi's advice, Kaprielian recruited Golomb from JPL. Golomb's presence attracted others in the group: Welch and Lindsey, and later Rechtin and Viterbi (who had done his Ph.D. at USC because it was the only institution that would allow him to study while working at JPL). But Golomb's eye for talent went beyond JPL. Also in 1963, he persuaded Kaprielian to hire Irving Reed, a gifted computer scientist then at RAND Corporation. Reed was best known for having built the first computer on the west coast, a desk-sized machine that humbled eastern rivals ten times its size.



SOL GOLOMB AND ANDREW VITERBI AT THE SCHOOL NAMING CEREMONY LAST SPRING.

What was more intriguing to Golomb was Reed's research on error correction codes. Working with a collaborator, the late Gustave Solomon, Reed had shown that his algorithm for error correction was optimal, that is, unbeatable. At the time their finding was only of theoretical interest.

"Error correction coding was brand new," Reed remembers.

Reed-Solomon codes became considerably less theoretical on the *Voyager* spacecraft. JPL launched *Voyager* in 1977 to explore the outer solar system. As historian Peter Westwick explains in his forthcoming book, *Into the Black: A History of the Jet Propulsion Lab, 1976-2004* (Yale University Press, 2005), older error correction codes began to fail as the spacecraft sailed towards Uranus and Neptune. The *Voyager* project team then switched to Reed-Solomon codes, in combination with Viterbi decoding. The results were stunning: crystal clear photographs of the outer planets invaluable to scientists and inspirational to the public. Norm Haynes, the *Voyager* project manager, called this telecommunications success "the finest technological achievement of *Voyager*: being able to get images back from three billion miles away."

Reed-Solomon/Viterbi decoding — and the underlying Golomb codes — have been standard on every spacecraft since *Voyager,* including the recent *Mars Rovers* and *Cassini.* And for billions of people, Reed-Solomon codes are part of everyday life. They are inscribed into every single compact disc and DVD sold in the world. (A real-world tip from Reed's graduate student Gregory Dubney: when you clean your CDs, don't wipe in a circle, as that will erase the Reed-Solomon codes over time and actually make the skipping worse. Clean the CDs by wiping towards the center.)

Together, these six pioneers — Golomb, Lindsey, Rechtin, Reed, Viterbi, and Welch — put USC on the map for information science and contributed to the USC Viterbi School's ascent into the top tier of engineering schools. Golomb, Reed and Welch won the prestigious Shannon Award, named for Claude Shannon, the first formulator of information theory. All six belong to the country's most select engineering society, the National Academy of Engineering. Golomb, Viterbi and Stanford's Kailath are also members of the National Academy of Sciences.

Despite their many achievements over the last four decades, members of the old JPL group look back on those days with a special fondness.

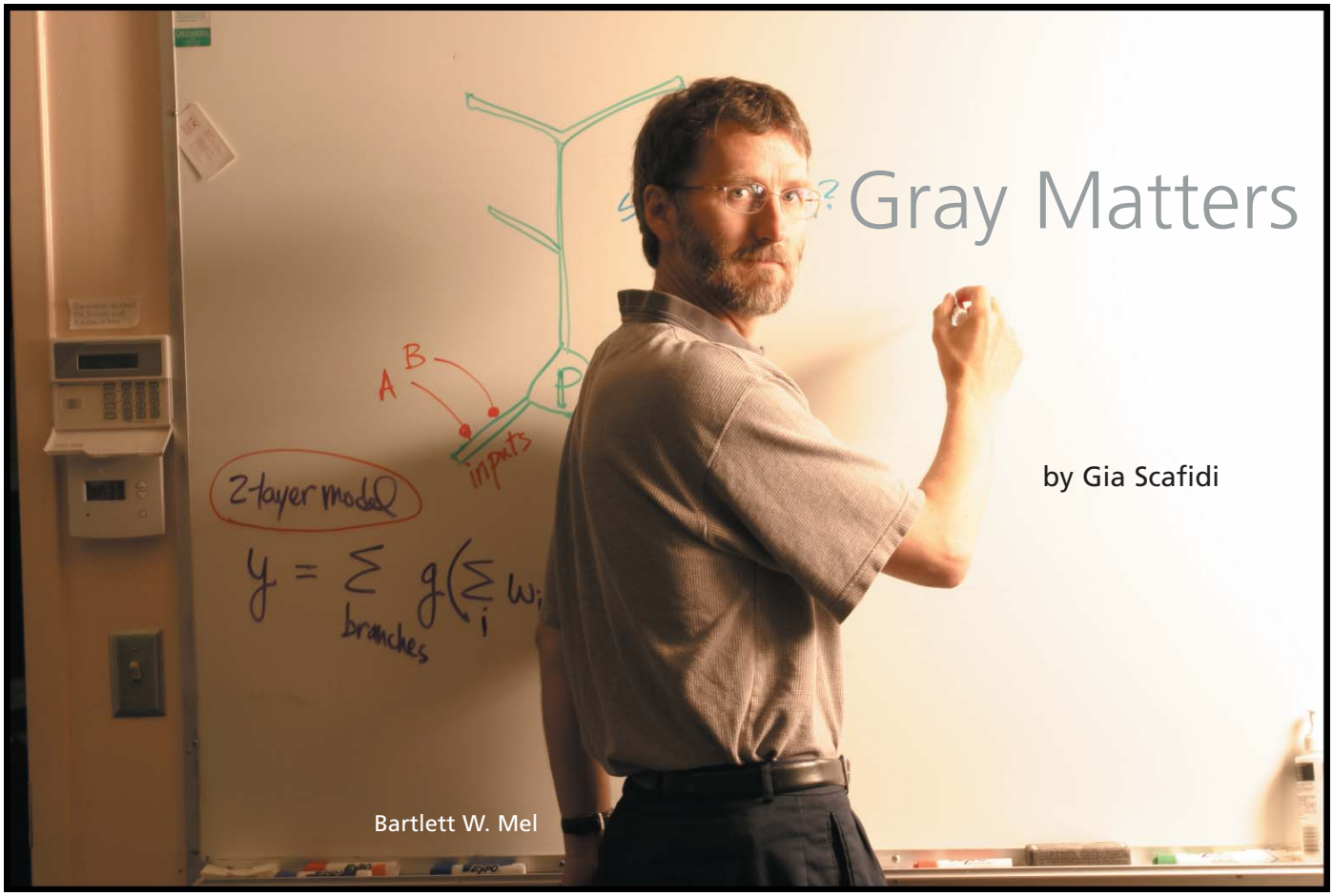
"It was the finest adventure we ever had, that exceeded anything I've done since," says Rechtin. "I don't think we could have done it singly, none of us could."

Says Lindsey: "So much work, so many things, so many areas started right in that Division 33, Section 331. We didn't know where we were headed. A cluster of the key guys in digital communications came together and worked together closely as friends, as colleagues.

"We sorted out the problems and solved them and someone started using the results. Almost anything we solved we could write this paper and it would be published, because it was that new."

That heady time may have come and gone in digital communications, but it repeats itself in emerging fields such as biotechnology, nanotechnology, bioinformatics and quantum information theory. Under Dean Nikias, the USC Viterbi School of Engineering has continued Kaprielian's legacy by seeking out the brightest minds in the newest areas. In less than three years, the number of tenure-track faculty has increased from 140 to 170, while the school as a whole now ranks sixth, tied with Caltech, according to *U.S. News & World Report.*

Many scientists over the ages have built new industries. The men of Section 331 can also say they helped to build an institution, the USC Viterbi School of Engineering.



Gray Matters

by Gia Scafidi

INVESTIGATING NEURAL ARITHMETIC

Researchers from the USC Viterbi School of Engineering and the Technion Medical School in Israel have uncovered new clues about how the brain's ultra-complicated cells, known as neurons, work.

Their findings — appearing in a recent issue of the journal *Nature Neuroscience* — contradict a widely accepted idea regarding the "arithmetic" neurons used to process information.

"It's amazing that after a hundred years of modern neuroscience research, we still don't know the basic information processing functions of a neuron," says Bartlett W. Mel, associate professor of biomedical engineering, and a contributing author of the journal's article. "Historically, it has most often been assumed that a brain cell sums up its excitatory inputs linearly, meaning that the excitation caused by two inputs A and B activated together equals the sum of excitations caused by A and B presented separately."

"We show that the cell significantly violates that rule," Mel says. The research team found that the summation of information within an individual neuron depends on where the inputs occur on the surface of the cell. To understand the team's work and the significance of its findings, it helps to know a little more about a brain cell.

All of the information processing that takes place in the brain is managed by a web of neurons. These living cells come in a variety of shapes and sizes, often resembling trees or bushes. A neuron receives input from other neurons at thousands of sites — called synapses — scattered across its surface. Each synapse generates a small local voltage response when it is activated. According to the classical view of the neuron, synaptic responses flow down the cell's branch-like dendrites, which act like electrical cables and accumulate at the cell body. The prevailing theory was that if the overall voltage response at that location was sufficient, an electrical spike would fire, carrying down the cell's axon and communicating to hundreds or thousands of other neurons.

"Recent evidence suggests the story is not quite that simple, though," says Mel. "The input signals may interact with each other in the dendrites and may be profoundly transformed on their way to the cell body."

"In particular," Mel adds, "individual branches of the dendritic tree can, under

Bartlett Mel photo by Max S. Gerber

"THAT OLD REAL ESTATE PHRASE 'LOCATION, LOCATION, LOCATION' HOLDS TRUE FOR NEURONS AS WELL."

certain circumstances, generate local spikes that greatly amplify synaptic responses locally within the dendritic tree."

The team set out to establish the "arithmetic" used by the neuron to combine its many synaptic inputs, focusing on the pyramid-shaped neurons that make up the bulk of the brain's cortical gray matter.

The actual experiments were conducted in Haifa, Israel by Alon Polsky, a graduate student at Technion and lead author of the paper; and Jackie Schiller, contributing author and co-principal investigator. Using slices of cortical brain tissue from rats, Polsky and Schiller located individual pyramidal neurons, filled them with dye for visualization purposes (cells are otherwise transparent), and using extra cellular electrodes, stimulated the cells very close to their dendritic branches. While recording the voltage at the cell body, the team would deliver shocks through one or two stimulating electrodes directed to different locations in the dendritic tree, for example, to the same or different dendritic branches. They would then compare the voltage response at the cell body as the two inputs were activated, first separately and then together.

"The powerful thing about [Schiller's] method is that you can see where you're stimulating because the dye grows a little brighter wherever synapses are activated," says Mel, who working with the team remotely from USC, collaborated on the experiment design and data analysis.

"You can direct the stimuli to very specific spatial locations on the cell and start to look at what a difference location makes. That old real estate phrase 'location, location, location' holds true for neurons as well."

The data showed that three different scenarios could occur when two electrodes, A and B, were used to stimulate the same dendritic branch:

- If the total response to the two inputs (electrodes A and B) falls below the branch's local firing threshold, the summation looks linear — A plus B.
- If the two inputs are just strong enough that together they cross the local threshold, the summation looks superlinear — more than A plus B.
- If each individual input is strong enough to cross the local threshold by itself, the summation is sublinear — less than A plus B.

Mel explains the last point in this way: "If two people are trying to build a fire together and they each have a match, the fire isn't going burn twice as bright or twice as hot thanks to the second match, once it's already been started with the first. The second match is irrelevant."

WHILE THE RESULTS ARE PROMISING, THE TEAM IS CERTAIN THIS IS NOT THE FINAL WORD ON THE PYRAMIDAL NEURON.

In contrast to summation of inputs delivered to the same branch, the researchers found that summation of inputs on different dendritic branches always looked linear — like lighting two separate fires. The findings support a 2003 modeling study carried out in Mel's lab, in which he and graduate student Panayiota Poirazi predicted that pyramidal neurons would behave in this way. This was the first experimental test of those predictions.

"So, we now think of the neuron in terms of a two-layer model," Mel says. "The first layer of processing occurs within separate dendritic branches. Each branch independently adds up the inputs to that branch and then applies its own local thresholding non-linearity."

"In the second layer of processing," Mel adds, "the results from all the different branches are added together linearly at the cell body, where they help to determine the cell's overall firing rate."

While the results are promising, the team is certain this is not the final word on the pyramidal neuron.

"Undoubtedly, this is still too simple a model," Mel says. "But the two-layer model is a better description, it seems, than to assume that the neuron is simply combining everything linearly from everywhere. That's clearly not what these data show."

According to Mel, one additional complexity that must eventually be dealt with is that synaptic inputs arriving at the most remote part of the neuron — called the apical tuft — may interact in subtle ways with inputs arriving on the basal dendrites, closer to the cell body.

"We'd now like to see if we need to extend the two-layer model into a three-layer model," Mel says. "It may be that the basal and apical dendrites each behave as we've been saying, but when they interact with each other there's an additional nonlinear interaction that occurs between them."

Mel emphasizes that the "arithmetic" rules he and his colleagues found in pyramidal neurons may not apply to all neurons in the brain.

"There are other neurons that have different shapes, inputs, morphologies and ion channels," he says. "There might be a dozen different answers to the question depending on what neuron you're looking at."

While much more work lays ahead, new imaging techniques, lifelike models and modern laboratory procedures are making the task of understanding the brain's complicated neurons a whole lot easier. In the end, Mel says, the lessons learned from individual neurons will be crucial to advance researchers' understanding of the brain as a whole.

"We tend to view the brain as a computer," he says. "If we want to figure out how this computer works, we must first know how its separate parts function."

Postcards from Paris

Compiled by Bob Calverley

Some very lucky USC Viterbi School undergraduates traveled to Paris this past summer for a six-week study abroad program. They had a chance to fulfill academic requirements while experiencing the French lifestyle. Studying overseas gives students an opportunity to take an accelerated program of upper division courses while gaining some insight into cultural differences that they may face someday as working engineers. The hours were long, the study intense, but there was always time for some fun. While they were in France, many of them saw the Tour de France, and most sent back postcards from Paris about their experience.

USC Viterbi students at the Arc de Triumph, forming lifelong friendships. Clockwise, starting at top center are Joel Cicchella, Lino Manansala, Laura Brown, Tyler Cesar, Steven Funasaki, Carlos Espinoza, Todd Royce, Rockton Hill, Holly Chico and Kimberly Mendonca.

The following "postcards" are some of our students' highlights.

The Moulin Rouge Is Nothing Like the Movies

It was Rockton Hill's first time in Europe and he had not anticipated going to the Moulin Rouge on his first night in Paris. But his girlfriend and her family just happened to be in Paris at the same time and they wanted to go. The show was "AMAZING, nothing like what I'd expected," he said. The women were beautiful and the lights, music and people were dazzling.

"The group of students here is great; we all get along really well," Laura Brown decided early on. "It makes exploring Paris a lot more fun!"

A group of them went to the Eiffel Tower and took the stairs. "Cheaper," explained Laura. "We watched the Olympic torch being run under the Eiffel Tower, up the Eiffel Tower, and then taken down a zipline." Later the entire tower was lit up in fireworks.

That first week, some students went to see the gothic cathedral at Chartres. A tour guide showed them the smaller details in the stained glass and sculptures. Knowing how the positions of the statues had been determined and the reason for their depiction helped Kimberly Mendonca appreciate the beauty of the artwork. She climbed to the top of the north bell tower imagining how people in the Middle Ages had climbed the same tower with only a torch for light. At the top she could see the gargoyles and the flying buttresses. Later, the students sampled a large variety of French meats and cheeses in an open-air market in the village.

Sara Khan, a USC sophomore studying communications, and Rockton Hill, a junior electrical engineering major.

"The market environment that is so unique to the French is very much unlike the market environment in the States," said Kimberly. "It was also interesting to see the different types of food that are specific to French cuisine".

Sunset at 10, Dinner at 11

Todd Royce found the Parisian lifestyle heavily influenced by the northern latitude's long daylight hours. "It is common to saunter into the town well past 11 p.m. and find the majority of Parisians just sitting down to dinner," he wrote. "On several occasions I have tried to run a quick errand in the early afternoon but been unable to complete the task because stores are generally closed for an hour or two in the middle of the day."

But he soon grew to love the more relaxed Parisian lifestyle. No one ever rushed through a meal and supermarket checkers effortlessly moved people with no sense of haste. You could sit in a café for an hour or two with a single drink. And you always had to ask for the check.

The French take their soccer seriously. Several USC students went to a city hall to watch the EuroCup soccer game when Greece ended up defeating France 1-0. Soon a large rowdy French group was singing songs and then lighting road flares in the hotel courtyard. "You don't really see this kind of intensity and wildness in the U.S. after sporting events," observed Steve Funasaki.

Two weeks into his classes in Paris, Sam Bagwell had learned that the biggest challenge was finding time to enjoy France while still keeping up with class work. Putting the two together was the best solution.

"When we went to Versailles," he said, "we knew not only the facts about the chateau, but also a historical interpretation of why it was important. It was not only the residence of Louis XIV, but also a tool for him to control the nobility while staying away from any political strife in Paris. Context like this lends powerful meaning to what would otherwise be normal sightseeing."

Pleasant Surprises

"More often than not, we can get overwhelmed and miss the little surprises worth seeing and feeling," said Adrian Lim. While walking through the vibrant Bastille district listening to Parisian chatter, a gentle breeze wafting scents of freshly baked bread, Lim and her friends made a fortunate discovery. They saw a recessed opening in the solid row of buildings leading to a quaint uneven cobblestone alley where luscious green vines dangled from balconies, all of it hidden from the bustling city. They paused, drinking in the experience. "Paris has so many things to offer above and beneath the surface," she said.

Holly Chico had come to Paris primarily to complete two courses, but the experience soon dictated a different lifestyle. She spent hours in a small section of the Louvre, walked through the Picasso Museum, saw the Arc de Triomphe and traveled to the palace and gardens at Versailles. There was little time for sleep and thoughts of papers due and homework assignments often gnawed at the back of her mind. "Being in a different continent doesn't lessen the stress of school work but makes it more bearable with this amazing opportunity to see things," she said. "Life as an American in Paris means immersing yourself in a different culture from what you eat, to the Metro face you put on when you take the train, to how you speak in public. Two weeks of eating Nutella and baguettes, walking everywhere and anywhere, and perfecting my Pardons and Excusez-moi has certainly turned my life around."

Katie Rehdin had successfully avoided public transportation for most of her very suburban American life. "It was the second day here when I took the plunge," she said. Soon she loved being on the 14 Express home after a long day of the Metro. "Sure, sometimes it's hard to find a place to stand, but as a systems engineering major, I love watching and seeing how it all works. No place in the city is more then a few blocks from a station and thus everywhere is accessible in very little time.

Laura, Kimberly and Katie discover a quaint, Parisian alley.

It is a beautiful system that makes me smile."

Paris 101

Shortly after arriving, Joel Cicchella was confident that he had learned everything that was important for surviving Paris and he writes:

- Don't have a sandwich; eat a baguette and a chunk of cheese for lunch.
- Parallel parking is an art form, but don't be afraid to give the car in front or behind you a little bump.
- Leashes are optional when walking your dog. And there is no need to curb your animal.
- When riding the Metro, always wear your "Metro face," meaning, don't smile and if you happen to make eye contact with another individual, look away immediately.
- A crepe can be eaten as a main course or a dessert, or even both in the same sitting.
- It is not necessary to wait for the little green men to light up when crossing the street.
- Mayonnaise is a sauce used for dipping your frites (French fries).
- Do not bother to bring out your umbrella even if you look out your window and see rain because it will be sunny before you get outside. But wait, and it will start again…so ignore that.
- Most important, don't forget to begin a conversation with "bonjour," and at some point throw in a "s'il vous plait" or "merci." And always give a nice big "au revoir" as you leave.

At first Eun Sook Han found it difficult to do her homework without the constant access to a computer and the Internet. In addition, the computers and connections at the Internet cafes were not as good as back home. "Being here has taught me to be less reliant on technology," said Eun. "Besides, we are here to enjoy the city and not spend all of our time with our computers.

Balancing the slower pace of Paris with the busy life of a USC student was not easy according to Erin Underwood. "I've started noticing the differences between people here and those back home," she wrote. "Life is more relaxed in France and people seem to enjoy it more. Getting that big job and making a lot of money doesn't feel as important here."

Tyler Cesar spent most of his time at the beginning of the week confined to his room or at the local Internet café, furiously trying to get his class work done before the approaching weekend. "The sixteen hours of sun per day takes getting used to," he said, noting that it would still be light at 9:30 or 10:00 p.m. But once Thursday rolled around, he and his friends began to focus on the approaching weekend because there were no classes on Friday. By early Thursday afternoon, assignments done, they were heading out for excursions to places like Chartres or Versailles or Que Pasa.

Nice, Normandy, Brittany and Omaha Beach

Katie Rhedin headed for Nice on her first free weekend. She remembered in high school that she had an antique travel poster for the city and always wanted to visit. "Old Town Nice was so beautiful and peaceful. It was how one would picture a Mediterranean village. Each section of the old buildings was painted another bright color on a palette ranging from terracotta to jade. Huge market places reigned by day while at night, little restaurants with provincial food opened. One even served rabbit," she said.

For Christine Mamuad, France was partly a homecoming. Her family had lived in the French town of Ferney-Voltaire for three years. But she was still in awe of being in a country so rich with culture and beauty and most memorable was a weekend excursion to the fortress/port city St. Malo and the Abbey of Mont-Saint-Michel.

"It's important to note the remarkable difference in St. Malo's tides, which fill and refill natural swimming pools, as well as hide and reveal bridges linking nearby islands to St. Malo," she said. "The bridge to the Ile du Grand-Be, an island which hosts the tomb of writer Francois-Rene de Chateaubriand, appears only when the tide is low." As the tide went out she and a group of students rock-hopped their way to one of the tidal bridges that was only partially exposed. They shed their socks and shoes and crossed the partly submerged stone path. "The reward for crossing the bridge and climbing up the hill to the writer's tomb was the stunning view of the fortress city of St. Malo, boasting medieval towers topped by wind-livened flags and the surrounding coastline, no less impressive with its strange juxtaposition of castles and buildings and boats."

Carlos Espinoza, Rockton Hill, Kimberly Mendonca, and Erin Underwood sitting at the top of a hill at St. Malo.

Todd Royce and several others visited Brittany and Normandy, taking in the Caen memorial Peace Museum and the cemetery at Omaha Beach. "The portion of land directly above Omaha Beach was given to the U.S. in recognition of the thousands of Americans who gave their lives fighting on the beaches of Normandy," he said. "It was nice to once again set foot on U.S. soil."

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Francisco Tolmasky said Omaha Beach and the cemetery was "by far the most moving place we've been to thus far. It reminded me of the sacrifice our ancestors went through, and made me feel somewhat connected with the French."

Bicycles are EVERYWHERE in Amsterdam

Even though they had barely begun to discover Paris, Brad Tallon and Adrian Lopez headed for Amsterdam. Tallon observed that everyone rides a bike around Amsterdam. "Amsterdam has even developed its own bike traffic system, creating lanes separate from foot and street traffic specifically for bike use," he said. "These lanes even have their own stoplight system." Determined to find one of the picturesque Dutch windmills, Tallon rode about 25 kilometers into the countryside until he found one.

Brad Tallon rode 25 kilometers just to find this picturesque Dutch windmill.

"I have noticed that Parisians have a defiant streak," wrote Adrian Lim. He decided that the most unusual manifestation of stubborn Parisian eccentricity was the Paris Plage. Plage is French for beach. Instead of encouraging everyone to make the trip to the sunny coastal regions of southern France, a few years ago the French decided to bring the spirit of the beach to Paris. So for several days, lining the banks of the Seine were truckloads of sand, beach chairs, huge, potted palm trees and Parisians lounging about in bathing suits, tanning and making sand castles. Lim, a native of Hawaii, was somewhat taken aback. "I also developed a sense of admiration for the Parisian spirit. The mere thought of bringing the beach to the city deserves recognition for originality and audacity. Making it an annual festivity is just crazy."

With an ethics paper due in her writing class, Lisa Schilken chose to focus on safety concerns, especially the Indy car racing league. What better way to do research than to try out a full-blown Formula One racing simulator? The Champs-Elysees not only has the Arc de Triomphe but also a number of car galleries including several displays of Formula One cars. One is a mock-up connected to a race simulator. An attendant helps you into the car, adjusts the pedals and bolts in the steering wheel.

"You get to pick any track you want and then do three laps on it. The racing is awesome, complete with feedback so the wheel will jerk if you go over any bumps — or go completely off the track and onto the grass like I did!" she said. "Adrian and Holly both tried it out too. Don't get me wrong, the Arc was fantastic, but give me a racecar any day!"

One weekend, Eun Sook Han and friends took an early morning train trip to London. They packed two days with frenetic sightseeing, noting that they would now be able to read the signs everywhere. They capped the trip by taking in a performance of Les Miserables and in stark contrast to French cuisine they had become accustomed to, a meal of greasy fish and chips.

Lisa Schilken tackles a Formula One racecar simulator by the Arc de Triumph.

"I think the longer we are here, the more we are realizing the interconnectedness with our work as engineers and the actual world," said Todd Royce. "Students have found inspiration … from anything between the Bastille Day fireworks show to the engineering behind food preservation in France. Assignments like this encourage us to recognize our role as engineers as well as the significant applications of engineering in everyday life."

Steve Funasaki expected to meet many French people, and he did. But more important, he established lifelong connections with his USC Viterbi colleagues. "Anytime there is an assignment, I see people working together and helping each other out. This trip has been an invaluable experience to make friends with both students as well as the professors."

Bon Voyage Crème Brûlée and Gelato

Eventually, and sadly, the six-week summer program in Paris drew to a close

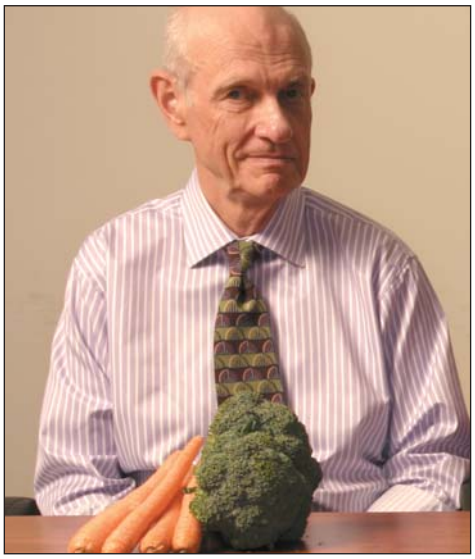
"I tried to squeeze in as many activities as my time would allow," said Lino Manansala. "Averaging about three to four hours of sleep for the whole week, I do not know how I mustered the energy for so many outings and so much work."

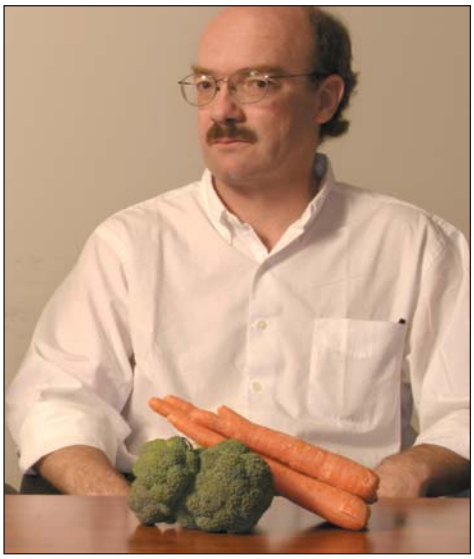
It is after 10:00 p.m. in Paris, the sun hasn't quite set and Parisians are beginning to think about dinner.

"Not only am I completing two engineering courses, but I am also visiting all the sites I've only heard about or seen in pictures," said Holly Chico. "Climbing towers, riding the Metro, eating the best crème brûlée and gelato, and roaming the many famous museums have been some of the highlights of my trip."

On the plane ride home, Christine Mamuad decided it had just about been the best six weeks of her life at USC. And while she was going to miss exploring Paris, France and Europe, and the baguettes and the pastries, she was going miss the close companionship of her fellow Trojans more. Polite acquaintances had become close friends, and for this branch of the Trojan Family, the Spirit of Troy would forever have a French accent.

The complete postcards can be found at http://viterbi.usc.edu/news/news/2004/2004_06_28_paris.htm





Peter Clarke, Susan Evans and Eduard Hovy

Thought for Food

Computer Science Provides a Surprisingly Effective Boost for Better Nutrition

by Eric Mankin

An unlikely collaboration of USC computer scientists and nutrition experts triggered by a "Eureka moment" is bringing better, more nutritious meals to the 24 million Americans who depend on community pantries.

Eduard Hovy and Andrew Philpot of the Information Sciences Institute (ISI) at the USC Viterbi School of Engineering, partnered with Susan Evans and Peter Clarke, directors of the highly honored "Wholesalers to the Hungry" program. They created an instant, individualized menu and recipe planner for low-income seniors and families who receive the fresh produce the program supplies to local food projects around the nation.

In preliminary tests, the system called "Quick! Help for Meals," has shown dramatic results in boosting pantry clients' use of fresh produce, "a critical element in improving their nutrition," says Evans, a research scientist at the USC Keck School of Medicine's Institute for Prevention Research.

"Hundreds of studies show that fresh produce in the diet helps people avoid or reduce obesity, which is linked to heart disease, diabetes and many other illnesses, as well as early death and increased costs of health care," says Clarke, director of the Center for Health & Medical Communication at USC's Annenberg School for Communication.

"Fewer than one out of four persons on average currently meet the recommended minimum five servings per day of fruits and vegetables. Low-income people score even lower.

"The stores where they must shop do not carry much produce, and price it expensively when they do. Many of the working poor have little time available for cooking and often have not learned culinary skills at a parent's knee. They lead stressful lives. Only well-designed and individualized recipes and nutrition tips will help break a dependence on convenience foods that are high in fats, salt and sugar," Clarke explains.

Supported by ISI, the National Science Foundation and Kraft Foods, "Quick! Help for Meals" will receive further testing this fall. If results on immediate consumption of fresh produce continue to be as positive as they have been, field trials will be expanded to determine if "Quick! Help" improves long-term dietary habits in households that receive the service.

Here is how the system works at the "Wholesalers to the Hungry" program:

While clients are waiting in line, volunteers collect information from them and enter it into a computer. Recipients are queried about their cooking skills (beginner? advanced?), available kitchen utensils (steamer? microwave?), household composition (children? seniors?), food preferences (garlic?).

By the time the recipients have gone through the line and picked up their food, a detailed document is waiting for each of them with illustrated recipes tailored to their specific, individual needs, in English or Spanish.

More than 7,000 community pantries nationwide could eventually become outlets for teaching people how to prepare simple and tasty meals. Just creating a big catchall compendium — or even several different editions — didn't work. "What we found was if people didn't find what they needed immediately, they assumed it wasn't there and tossed the flyer away."

Compounding the problem, charitable food pantries themselves got only a few hours notice about which fresh foods would be available that day. And if all they get that day is broccoli, or carrots, suitable recipes would have to be found. "We needed to invent an information tool that would adapt immediately to ever-changing supplies of food," says Evans.

The bottom line: not one or two different types of flyers, but flyers that could

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Photos by Max S. Gerber

be individually produced, on the spot, to whatever needs and interests the food recipients expressed.

"We knew what type of information product we needed, but we didn't know how to do it," says Evans. "Then we attended a presentation by Eduard Hovy in 2002."

Hovy, an expert on computer-based language translation, text summarization and web searches, was one of a number of scientists presenting talks to Keck School faculty on activities at the USC Viterbi School's Information Sciences Institute located in Marina del Rey. Hovy described computer software that could produce customized output on a variety of topics, tailored to the information needed, the situation, and the user.

"We looked at each other and said, 'Eureka,' Evans recalls. The team sat down with Hovy, and began to explore various designs, with research associate Andrew Philpot working on the programming. Within six months Philpot had produced a draft version of "Quick! Help."

"Even though the technology is tried and true," says Philpot, "the engineering requirements were tougher in a sense. A system which works great when I demo it in the lab takes lots of loving care to work reliably for a coordinator in the field." Quick! Help's layout involves not just text but graphics, and includes a number of features that recognizes the low literacy of many users:

- A customized cover, with the name of the recipient, and an illustration such as a snapshot of the recipient and his or her children, or a religious figure.
- Pictures of finished servings or key steps in their preparation. Recipes also highlight useful hints about whether items make good leftovers, can be frozen, may be made in advance, are "kid friendly," and more.

Clarke and Evans are pleased with the early results testing the system's effectiveness. For example, a recent study included three groups of recipients, all of whom received free produce. One group (control group) received no information about food preparation; one group (generic group) received all recipes in the Quick! Help database. The final group (tailored group) got the individualized Quick! Help flyers.

At the last field trial, a volunteer collects information that will be used to prepare the customized Quick!Help brochure that a pantry client will receive along with food at Share Our Food in Costa Mesa.

"In interviews five days after receiving food, recipients of the individually-tailored Quick! Help recipes said that they had not only used a recipe, but had used many or all the recipes, one after another. A much larger percentage (90 percent, versus 60 percent) read the customized flyer than read the generic one.

Twice as many recipients of the customized flyers were able to recall a recipe from it. Individualized versions of Quick! Help motivated household cooks to try different preparations, important for stimulating people's interests in a food, and to use the perishable foods quickly, before they could spoil.

"We found no differences in use of fresh produce between the control and the generic groups," says Clarke, "suggesting that giving typical flyers and giving nothing lead to the same results."

"We called our food recipients again — six weeks after they had gotten flyers," says Evans. "We didn't expect this, but we found that many of them still had and were still using the individualized Quick! Help material printed out for them. Households given the generic Quick! Help had discarded it."

The Quick! Help technology is fairly simple at heart, says Hovy. The most complex step in building a tailored menu is developing the models of the possible users, and associating each text fragment with just the appropriate reader characteristics. Once this has been done, the software can stitch together hundreds or even thousands of variants of the basic recipe.

This technology, which was first developed by Hovy and colleagues at the Universities of Toronto and Waterloo in Canada, has been patented, and is the basis of a small company in Canada which sold a version of the system to a company supporting people who stop smoking.

"Just as for Quick! Help recipes, individualized daily or weekly letters to encourage people to stick with their non-smoking regimens are significantly more effective than generic one-size-fits-all reminders," says Hovy.

"It would be elementary to extend Quick! Help to allow people at supermarkets to request individualized recipes while they wait in checkout lines. In fact, this technology is the logical next step, from broadcast to narrowcast to individualized pointcasting of information. You might one day receive ads that were made exactly and specifically for you, created by a Quick! Help system of the future," Hovy says.

The USC Office of the Provost, which encourages interdisciplinary work, recently rewarded this project with a stipend for an undergraduate research assistant.

"What we are exploring now," says Evans, "is the possibility that if we can offer a broad enough range of customized choices, we can help people change their diets in a healthier direction."

Much remains to be done. "This summer, in July 2004, we rolled out the tablet PC-based system, with the capability to take digital pictures of the client (or their children) and insert them into the output brochure," says Philpot.

"We also need fast, high quality print capability — lasers are too fragile and expensive, inkjets too slow. We'd like to have wireless communication between the tablets and the printers. We also need to add many more food items, and another area of work will be an extension for additional languages — Mandarin Chinese, Russian, Armenian, Tagalog and whatever other languages are useful in the deployment neighborhoods."

But Philpot is glad to have a chance to work on the problems. "Underlying it all, the idea that technology can make a real difference in the lives of food pantry clients continues to serve as a strong motivation for involvement," he says.

Albert A. Dorman, MSCE '62 *Civil Engineering's Renaissance Man*

Albert A. Dorman may be one of the most illustrious and intriguing civil engineers in America. The rapidly ascending trajectory of his half-century career spans work as an engineering consultant; CEO of one of the first multidisciplinary architecture/engineering firms to practice worldwide; and chair of one of the 200 largest private companies in America. Along the way, he has worked on all seven continents, including Antarctica, and has been registered as a professional engineer in eight states and as an architect in both California and Oregon.

Albert A. Dorman

His honors are equally exceptional. Dorman has been elected to the National Academy of Engineering, and is an Honorary Member of the American Society of Civil Engineers (ASCE), as well as a Fellow of the American Institute of Architects (FAIA) — the only individual ever to have simultaneously achieved this dual distinction. He has served as president of the Consulting Engineers Association of California and the Los Angeles Section of ASCE, and has authored dozens of papers on an impressive range of subjects. In 2000, Dorman received the ASCE's inaugural OPAL Award for Outstanding Lifetime Achievement in Leadership.

Yet his many accomplishments and accolades hide an even more remarkable story of a strikingly modest man who has always encouraged others to stand in the spotlight, while he worked to make the world a better place.

"I grew up in a small Eastern town, which taught me about ethics and morality, and gave me a strong love of nature," Dorman explains. "My father owned a country store where I helped behind the counter. I learned that everybody you meet — from the president of the bank to the man who pumps your gas — has something to teach you, if you're willing to listen."

Dorman was a good listener — and a good student, too. He served as student body president and yearbook editor at the New Jersey Institute of Technology, graduating first in his class with a B.S. degree in mechanical engineering. "While I've also always loved the 'liberal arts,' I chose to pursue engineering because I wanted to make use of my mathematical, analytical and scientific abilities," Dorman says.

After graduation, he served in the Army Corps of Engineers at the end of World War II. He soon realized that mechanical and industrial engineering wasn't a good fit for him. "It was all "things" related, and I needed to deal with society and interact with people," Dorman says. "Plus, I wanted to work outdoors. I knew that if I switched to civil engineering, I'd be working on highways, dams, structures and other outdoor projects."

Dorman saw California as an enticing new frontier, and moved after completing his military service. He worked for the California State Division of Highways (Caltrans) on the Santa Ana Freeway, and then for the City of Los Angeles Department of Building and Safety. "The latter in particular was a marvelous place to work after the war," he says. "Construction was booming, and I had an opportunity to plan-check the work of the best architects and structural engineers on some of the more important buildings in Los Angeles, and to learn from their calculations, designs and details. Many of Southern California's top structural engineers went through the department at that time."

Dorman also took the opportunity to enroll in USC's civil engineering program. He retains particularly fond memories of Professor David Wilson: "Professor Wilson was revered by the people who studied structures. He was influential and warm and I made a point of taking his courses. I later became a member of the David Wilson Associates at USC and still stay in touch with former students I met there." It should be noted that Dorman maintained a perfect 4.0 average throughout his engineering studies at USC.

The USC engineering school honored Dorman with its Distinguished Alumnus Award in 1976. He has stayed involved with the University by serving on the boards of councilors for Performing Arts and the School of Policy, Planning and Development (formerly Urban & Regional Planning). He just recently accepted Dean Nikias' invitation to serve on the Viterbi School's board of councilors and will make an impressive addition.

"I should have graduated from USC in 1951," Dorman recalls, "but I was one course short of my [master's] degree when I moved to the San Joaquin Valley with my wife, whom I met when she was a graduate student at UCLA. It wasn't until a decade later that I finally decided to commute to Los Angeles for one semester, to complete my degree."

Joan and Albert Dorman raised their three children, Laura, Kenneth and Richard, in Hanford, a town of then 10,000 residents in Central California. There, Dorman founded a one-man civil engineering firm and was later joined by USC architecture alumnus Lawrence Alexander, to form an additional firm, Alexander & Dorman, Architect/Engineer.

A quiet and rather small-town modesty surrounds Dorman's life and professional career. In 1954, he was invited to work on a new theme park that was to be built in Anaheim. Walt Disney had hired electrical engineer J. S. Hamel, "the best lighting engineer in America," as consulting engineer on the groundbreaking Disneyland project. Hamel told Disney that he would need to work with a civil engineer in order to design the park's grading railroad, streets and other infrastructure. Hamel recommended Dorman, but cautioned Disney that "he's only 28." To which Disney reportedly replied, "I was 26 when I introduced Mickey Mouse." And so Hamel & Dorman was formed.

"It was an immense undertaking," Dorman recalls. "The project was scheduled to

continued on page 44

A.V. Balakrishnan, MSEE '50, Ph.D. Mathematics '54

When A.V. Balakrishnan came to the United States in 1947, he wanted to become a Hollywood sound engineer. The film industry was at its peak, nearly a decade after the rise of sound film production, and was releasing profitable wartime favorites one after another. But Hollywood was closed to anyone who was not a member of the guild.

"It was nearly impossible to get a job, so I switched to electrical engineering because it was very close to sound engineering," says Balakrishnan, who earned his first USC master's degree in cinema in 1949. Then he turned to electrical engineering, hooked up with USC Professor R. Meigs, and got a job as a laboratory assistant, earning about $200 a month. It paid the bills, and in 1950, he had earned a second master's degree, this time in electrical engineering.

"I would have gone into a Ph.D. program in electrical engineering from there, but USC didn't have one, so I enrolled in a doctoral program in mathematics," Balakrishnan says. One of his professors, R. S. Phillips, an internationally acclaimed mathematician from MIT, recognized Balakrishnan's mathematical abilities and encouraged him to stay in the field.

"Bal was so gifted in mathematics," says his wife Sophia, a Russian-born linguist who works as an academic translator, "but like most theoreticians, he's always creating and destroying his ideas. He'll come up with an equation to explain 'air flutter' at 50,000 feet, and then tell me 30 minutes later why it won't work. Then he's on to a new way of solving the problem."

Balakrishnan considers himself an applied mathematician, interested in pure research for research's sake. A professor of mathematics and electrical engineering at UCLA, and director of the NASA-UCLA Flight Systems Research Center, he specializes in problems of aerodynamic stability and control. Much of his theoretical work forms the basis of computer models, which are used to test the control of unmanned aircraft flying through turbulent conditions.

From cinema to aerodynamics

He never imagined he would wind up in aerodynamics. Growing up in Chennai (Madras) on the southeast coast of India, he entered the University of Madras in the early 1940s and won a scholarship competition from the Indian government to study in the United States and learn to produce documentaries.

"The problem was that the job they had waiting for me at the Indian Institute of Science just didn't measure up to the opportunities I knew I would have with a Ph.D. in the U.S.," he says. "So I stayed."

After earning his Ph.D. in 1954, he went to the east coast and worked in radar at RCA for two years. "That was a hotbed of activity at the time, but I didn't want to stay in Camden because it was known only for Campbell's soup," he laughs. "Instead, I joined the wagon going west, like so many other engineers did."

He became a visiting assistant professor in USC's mathematics department in 1956. A year later, he took a job at Space Technology Laboratories. Then in 1961, his ship came in; he accepted a job as an associate professor of electrical engineering at UCLA. One of the first people he hired was Andrew Viterbi (Ph.D. EE '62), namesake of USC's engineering school.

"Andy was very good at spread spectrum loops for transmitting satellite signals, so we worked together," he says. "Until that time, most of the work in this field was concentrated on the east coast, at MIT and Bell Labs. Control theory was evolving into guidance and communications systems for spacecraft. We were the pioneers of that era on the west coast."

In 1965 he became a full professor of mathematics at UCLA, and in 1969 he became founding chairman of UCLA's department of system science. In 1986, he was named director of the NASA-UCLA Flight Systems Research Center. While he was making a name for himself, Balakrishnan's son, David, was doing the same in music. A talented violinist, David attended The Juilliard School in New York City, then founded a jazz group, the Turtle Island String Quartet, which has earned several Grammy nominations. "Usually when someone knows my name, they think it's David, not me," Balakrishnan quips.

His four other children are just as accomplished. Jerry is a professor of psychology at Purdue University; Sally is a computer scientist; Kenneth has a Ph.D. in linguistics from Yale University; and Robert works in the seafood industry in Los Angeles.

A.V. Balakrishnan

Flight tests at Dryden

Balakrishnan pulls out a Christmas card with a picture of his two grandchildren on the front. "They're about as American as they come," he jokes. He does not have much time to see them, not with his teaching, research and frequent trips to the NASA-Dryden Flight Research Center in Lancaster, California. He and his colleagues at UCLA collaborate with the NASA center on research in computation fluid dynamics, which addresses problems of air flow, velocity, turbulence and wing flutter. The pressure is on to flight test dozens of next-generation aircraft coming online in every shape, size and weight imaginable.

The defense industry, which allocated $2 billion this year to develop and buy more unmanned aircraft, has taken a special interest in this testing. Just recently, the Pentagon boldly announced its vision to replace a third

continued on page 45

Arthur P. Adamson, BSME '41

Once the first jet airliners became reality, Arthur Adamson was thrust into the development of advanced jet engines at General Electric Corporation. Much of the frenzy centered on high-thrust jet engines — called turbofans — for commercial aircraft that would be larger than any ever built.

The TF39 turbofan, designed by GE for large military transport planes, had demonstrated that bypass six turbofans could be built in large sizes and with very high fuel efficiency. They outperformed every jet engine of the day and provided the basis for GE's new commercial transport engines.

"The TF39 engine could deliver the power and fuel efficiency needed for intercontinental transport of passengers and freight," Adamson explains from his home in Cincinnati, Ohio. "But it required numerous modifications for commercial use. My job was to coordinate the technical teams as they applied the military's know-how in engine design to commercial aircraft."

Before anyone knew it, the industry had given birth to a new transport plane — the jumbo jet.

"It shrank the world from seven days to seven hours for a transatlantic crossing," Adamson says.

GE's first large commercial turbofan was used on the new McDonnell Douglas DC-10 turbofan jumbo jets; Boeing followed suit with its spacious 747s and Air Bus A300, the first twin-engine, wide-body airliner in the world. Within a few years, intercontinental travel had skyrocketed and Adamson had earned his wings in the race to establish turbofans as the dominant engine type in commercial aviation.

Engines and machinery had always been part of Adamson's life, clear back to his boyhood on a farm in Coffeyville, Kansas. He said he never had a doubt that he would become a mechanical engineer.

"Farm boys always know a lot about machinery," he says. "I liked airplanes in particular. The engines are more fun than anything else."

It didn't take long before Adamson succumbed to the call. After high school, he spent two years at a junior college in Coffeyville before packing his bags in 1939 and heading for Los Angeles. He moved in with his aunt and enrolled in USC's mechanical engineering program, supporting himself with summer aircraft plant jobs and a part-time job in the engineering school's mechanical engineering lab. Sydney Duncan became his favorite professor; Thomas "Pop" Taylor Eyre, then chair of the mechanical engineering department, was his inspiration.

He joined GE a month after graduation. There he spent his early years working on rocket and jet engine programs in Philadelphia and then Schenectady, New York. While working, he enrolled in GE's advanced technical training program, which allowed him to move into technical leadership positions.

In 1955, he moved to Evendale, Ohio, a suburb of Cincinnati, to oversee rocket engine development. In 1959, while the country scrambled to catch up with *Sputnik*-era launch capabilities, Adamson became chief engineer of a high-profile rocket engine program, which resulted in the first manmade satellite into an Earth-orbiting trajectory.

"His creative genius led to several aircraft engine programs," says USC classmate and fellow GE engineer Robert Hoffman (BSME '41), a resident of Redwood City, California. "One of them was the XV-5A lift fan for vertical launch, high-speed helicopters. That was a very rewarding program and a great vehicle to see take off."

In Lynn, Ohio, Adamson moved on to the GE 12 small turboshaft demonstrator, which became the very successful T700/CT7 engine family and helped him win GE's Steinmetz Award for "concepts in developing electric motors, guided missile autopilots, electronic controls, rocket propulsion systems and the CF6, T700 and CF34 jet engines." He also helped develop the TF 34 family of turbofan engines used in the Navy's anti-submarine aircraft, the Warthog, and in regional commercial passenger jets.

Through the years, Adamson acquired some of the most prestigious aviation industry awards around. He is the recipient of GE's Perry T. Egbert, Jr. Memorial Award "for outstanding creativity in the development of the CF6-50 Commercial Jet Engine," and the Franklin Kolk SAE award for service to aviation. He is also in GE's Propulsion Hall of Fame and was elected to the National Academy of Engineering.

Arthur P. Adamson in his younger days at General Electric.

Adamson and his wife, Florence, on their way to a game of tennis in 2001.

Staying busy even in retirement, Adamson is a longtime wood carver. He also plays tennis every day, likes to do computer programming "just for fun," and is hooked on pre-1960 movies. But most of all, he loves hopping on a plane for the east coast to be near his two children, five grandchildren and two great grandchildren. That plus the fact he just can't stay away from the drone of those ultra high-speed turbofans!

Aimee Lopez, BSCE '99

Cromwell Field at USC won't look any different when it reopens in March 2005 for the Trojan Invitational Track Meet, but what lies beneath the green carpet of newly planted grass will be brand new, and cool.

Ask Aimee Lopez, the Turner Construction project manager for a new 3-million gallon water storage tank built 40 feet below the field. The new thermal energy storage (TES) system brought her back to USC five years after her own graduation and has given her an opportunity to "thank USC" for her undergraduate education and early career success.

"This is my mark on the world," says the quick-spoken, petite Latina woman, beaming like a mother with her newborn child. "This is the culmination of all my education and training in engineering, something that will last forever and reflects the latest techniques in civil engineering. It's a landmark and I'm very happy that I was able to work on the project."

Unbeknownst to spectators in the 3,000-seat stadium, or to the athletes racing across its eight, 42-inch Rekortan surfaced lanes, the invisible water storage tank will be doing its thing: circulating chilled water to all of the air conditioning systems on campus, says Richard Snouffer, director of Energy Services in USC's facilities management office. TES is expected to save USC about 4,500 megawatt-hours of electricity a year and roughly $400,000 annually in electricity costs.

USC's new thermal energy storage system under construction in Cromwell Field.

"Once this tank is buried, we never want to see it again," Snouffer says.

"This tank is designed to last forever," Lopez adds.

Measuring 123 feet in diameter and extending 40 feet underground, TES incorporates the latest construction materials and state-of-the-art design for water storage tanks. It was built with 2,310 cubic yards of pre-stressed concrete and 484,000 pounds of steel reinforcements to safeguard it from cracks or damage incurred during an earthquake.

"The cold water will be circulated day and night to air conditioning systems all over campus, and used in some of the new buildings, such as Tutor Hall of Engineering and the new molecular biology building," Snouffer explains. "The project actually expands the capacity of the campus's existing chilled water system and reduces our utility costs in the long run."

TES consists of two components, according to Lopez: the chilled water storage tank under Cromwell Field and a new pump house in the basement of Grace Ford Salvatori Hall. Construction workers had to tunnel 17 feet underground to connect two 24-inch-diameter pipelines from the water tank to the pump house.

"The warmer water coming back through these pipes will have a chance to chill overnight before it is recirculated," Snouffer describes. "That allows us to shift a lot of our kilowatt-hour usage to off-peak hours — at night — when electricity is less expensive. That's the beauty of the system."

Sensors suspended in the tank will monitor water temperature and height. A computer energy control management system will alert facilities personnel if anything goes awry.

Lopez has been overseeing the project from a trailer next to Grace Ford Salvatori Hall since the start of the preconstruction phase last spring. Before the excavation could begin, construction crews had to build a bridge over the track for dump trucks, cranes and other heavy equipment moving on and off the field.

Aimee Lopez

"It would cost more than a million dollars to replace that track," Snouffer says. "The bridge, which is about 4 feet above the track, turned out to be the most viable way of protecting it."

Lopez isn't new to construction — she grew up with it. Her father, a migrant worker, built apartments in the small agricultural community of Huron, California, about 100 miles southwest of Fresno, when he was not out working in the fields.

"Since I was very small, I always wanted to be a builder of some type," she says. "At first, I was interested in architecture, but then, seeing my dad building apartments got me interested in construction. So I told him that one day I wanted to build the apartments for him. I wanted to make his dream come true."

Lopez liked science and math. In middle school, she was selected to enter an advanced summer school program — the Coalinga-Huron House for the Academically Talented Development Program — for children gifted in math and science. She spent six summers on the UC Berkeley campus, taking college-level advanced placement courses. She applied to a variety of college engineering schools, including "some of the state schools, Cal Polytechnic University in San Luis Obispo, UCLA, Berkeley and some of the other UC

continued on page 46

Asad M. Madni, President and COO, BEI Technologies, Inc.

When Trojan Dad Asad Madni ran into his distinguished old friend, George Bekey, on a flight in 2002 from San Francisco to Los Angeles, their chance reunion turned quickly to techno talk and a new partnership.

"I asked him to serve on my company's scientific advisory board, which he enthusiastically accepted," says Madni, president and chief operating officer of BEI Technologies, Inc., a leading manufacturer of

Asad M. Madni

precision sensors, motors and actuators for automotive stability control systems and commercial, industrial and aerospace industries. "Then I started to learn all about USC's engineering school and its progressive attitude toward reaching out to industry."

Before long, Madni had accepted a reciprocal offer from Professor Cauligi S. Raghavendra, chair of electrical engineering systems department and Bekey, emeritus professor of computer science, electrical engineering and biomedical engineering, and founder of USC's robotics research program, to join the advisory board of the Viterbi School's electrical engineering department. His paternal interests, with son Jamal, now entering his third year of computer engineering/computer science, and professional interests in wireless and embedded sensors fueled a desire to "help mold engineering curricula at USC that would have a direct impact on him."

The Perfect Match

Madni was a perfect match for USC's electrical engineering advisory board, bringing practicality and balance to decisions about the department's academic programs. His company — BEI Technologies, Inc. — is the world's largest independent supplier of yaw rate sensors for automotive stability control and is well known for its revolutionary MEMS-based quartz rate sensor, the GyroChip®. The miniature sensor is used by a wide variety of international car manufacturers, including General Motors, Ford, BMW, Mercedes, Volvo, Toyota and Honda, to increase stability and prevent rollovers. The same technology developed at BEI has been used to upgrade Boeing 737 airplanes, as well as to stabilize NASA's 1997 *Sojourner* rover while it traversed rocks and hills on the surface of Mars.

"We are striving to forge new partnerships with industry, so we were truly fortunate to have Dr. Madni join the board," says Bekey. "He is a technically sophisticated executive and gets very involved in helping us find solutions to our technical problems. It's an ideal connection for a research laboratory."

The Place to Be

Madni came to the United States in 1966 when he was a teenager because he believed that "this was the place where science and technology had its basis and its future." He attended UCLA, where he earned his B.S. and M.S. degrees in electrical engineering. At California Coast University he earned his Ph.D. in electrical engineering and he graduated from the MIT Sloan School of Management program for the senior executives. In 1975, he joined Systron Donner Corporation, where he held senior technical and executive positions for 18 years, eventually becoming chairman, president and CEO. Over the years, he saw the quickening pace of competition — with companies scrambling over each other to be first on the market with new technologies. He says it's not about to let up. "Students will need every advantage they can get to compete," the Trojan Dad says. "They'll be judged on the breadth and depth of knowledge they have in engineering, as well as on the experience they've gained working in industry."

But Madni isn't about to let up, either. To support USC, his company donated equipment to several departments in the School. In 2004, the Robotic Embedded Systems Lab (RESL) received a full inertial navigation system and angular rate sensors — "the best around," says lab director Gaurav Sukhatme — to develop a robotic helicopter and a new hopping, self-balancing robot.

Last fall, Madni's interests led to some company-sponsored research. After meeting with researchers to learn about their areas of specialization, he seized on some very promising work in the development of next-generation miniaturized silicon gyroscopes, and then decided to sponsor the work. "The faculty is accomplished and they work outside-of-the-box," Madni says. "I was very impressed with the research, because it's practical and down-to-earth, focusing on technologies that have an obvious impact on society."

New R&D Paradigm

Madni believes research and development will be driven by a new paradigm in years to come, one in which speed to commercialization becomes the hallmark of success. "Commercializing products in a timely and cost-effective way will be the key," he says. "Universities and industry will have to partner to stay competitive in the future." Fortunately, he says, Viterbi School faculty are "refreshingly open and conducive" to industry partnerships. That attitude will serve students well, "because they'll get some exposure to industry problems and issues rather than becoming isolated in their ivory towers."

He adds that parents of engineering students should get involved with Viterbi School events and networking opportunities, especially if they work in the industry, so that they can help support the school's goals. "We need to build many more partnerships with business and by doing that, we will be able to create more internships for our students, more opportunities for research collaboration, and more networking opportunities for students. We have the best of all worlds at USC to make that happen," he says. "Open-minded faculty, brilliant new faculty coming on board, very bright students and one of the most strategic locations in the world for technological innovation."

Dorman *continued from page 39*

be completed in 14 months, including land clearing, design and construction. Nothing like it had been attempted before. Rivers had to be created, a railway built. For example, it was the first time a paddle wheel steamboat had been mounted on a rail; no one had ever had to park that many cars before; and on and on. Everything was new and innovative. And the burden of professional responsibility was almost overwhelming — my seal and signature were on the plans!"

"My final inspection was one week before the park's official opening in July, 1955," Dorman recalls. "We made it — but it took ten years before I could bring myself to set foot there again, this time with my family."

Disneyland opened to enormous fanfare, and Dorman returned home. But he made the decision not to talk about his involvement with the project. "I just wanted to raise my kids in a small town," he explains. "I didn't want potential clients in the Central Valley to think their projects would be too small for me. As importantly, I wanted to be fully identified with the community and my neighbors." So he quietly resumed his private practice. He also served as city engineer for two of the three cities in Kings County, and designed projects that ranged from schools to subdivisions. In his spare time, he was a partner in farming 800 acres and was deeply involved in community activities.

"I've been a student of one sort or another all my life," Dorman says. "As an engineer working with architects, it appeared to me that they were the ones making the major design decisions, which the engineers then implemented. So I decided to train myself to be an architect, and became licensed in that field also. I then found out it was the owner who was making what I thought were the ultimate decisions, and I decided to learn what owners faced. I became involved as an owner in residential, commercial and industrial properties.

"After all that, I discovered that it was the lenders who made the decisions: the kinds of projects they would finance, and how much they would lend. I helped found a savings and loan association in Hanford and served as its chairman so I could learn about lenders' criteria. Incidentally, that S&L was acquired by one of the largest institutions in the U.S., and I was privileged to serve on its board of directors."

Dorman's professional career as an engineer has been equally astute. In 1965, Dorman's Hanford civil engineering firm, by then good-sized, was acquired by the architecture/engineering firm Daniel, Mann, Johnson & Mendenhall of Los Angeles, two of whose principals — Phil Daniel and Ken Johnson — were also USC alumni. Dorman was asked to serve as an engineering project director of DMJM, and within ten years he became chief operating officer, then president/CEO and finally chairman/CEO.

Dorman continued to run DMJM after it was acquired by Ashland Oil in 1984, and managed the resulting Ashland subsidiary, which soon acquired other engineering and architectural firms. Six years later, all these companies were bought back from Ashland, creating AECOM Technology Corporation, which went on to become the parent company of many of the nation's oldest and most distinguished engineering, architecture and program management firms.

Dorman's vision for AECOM was to create an almost invisible parent company, where each operating company would excel in its own field, under its own name, with independent staff that was given credit for their company's success. "I had never met a Marine who said, 'I'm a DOD guy,'" Dorman explains. "They were always a Marine. You can't truly identify with too large an entity."

It's a principle that has worked well: AECOM now ranks among the top five in the world in its fields. Its numerous major consulting firms, 100 subsidiaries and 18,000 employees currently generate more than $1.8 billion in revenue annually for its employee-owners. "I'm pleased that AECOM has been able to create some financially secure people," Dorman says with typical modesty.

He notes with pleasure that the late James H. Zumberge, USC's ninth president, served as a special consultant to one of the AECOM companies, which held a ten-year contract to support all U.S. scientific research facilities in Antarctica. "Jim was an internationally acclaimed geologist, and had important geologic features in Antarctica named after him," Doman explains. "A wonderful man, and we were glad to have him helping us." Dorman is also pleased that USC's current president is an engineer, adding that "Dr. [Steven] Sample and I were classmates in the National Academy of Engineering. He has done a simply outstanding job at USC."

Al Dorman carried the Olympic torch on its journey through Los Angeles for the 1984 Olympic Games. "In retrospect, it was symbolic of my efforts to 'pass the torch' to the next generation," he says.

Dorman voluntarily retired as chair and CEO of AECOM in 1992, after he turned 65. "I would have enjoyed being there forever," he muses. "But I don't believe that young, dynamic people in any organization should be left wondering what their future could be. I reminded myself what it would be like if I were a young Al Dorman, 40 or 50 years old, and the top person gave no indication of retiring. You have to create an upward draft, with opportunities for lots of people to grow, if you're going to be fair to your people and the company."

continued on next page

Dorman *continued from page 44*

"My successor — Richard G. Newman, a colleague for 14 years — has done wonderfully carrying the company forward," Dorman adds. "I believe he is largely responsible for AECOM's growth and success." The company continues to provide Dorman an office and support, in his role as founding chairman.

Dorman reflects thoughtfully on his long career. "I've practiced in California for one-third of the state's history," he notes. "It's been an exciting time. The population has tripled — from less than 10 million to more than 30 million — and civil engineers created much of California's infrastructure, building freeways, water supplies, airports and much else we take for granted. I think California owes a great deal to its civil engineers. Parenthetically, about half the state's civil engineers are in public employment. That's very significant for our profession, and for society, and I'd like to see civil engineers be recognized more widely for their contributions."

Dorman believes firmly that engineers should participate at all levels in a variety of activities, to make their particular expertise available not just within the profession, but throughout society. In his case, he has accepted leadership roles with numerous civic and non-profit institutions that range from the California Chamber of Commerce to the National Foundation for the Advancement of the Arts, and he has also served on the board of directors of three publicly traded companies.

Making a difference has always been a driving force for Dorman. "My family has a tradition of giving back to the community and sharing," he says. "Some environmentalists say we should 'leave no footprint behind.' I fully concur for wilderness areas. But I'd like to think that my life has been devoted to the opposite: creating 'footprints' that improve the quality of life through such tangibles as safe drinking water, waste disposal, better health care, economic development, education and safer transportation for us and our children."

Future generations are indeed very much on Dorman's mind. He endowed the Albert Dorman Honors College at the New Jersey Institute of Technology to enable bright but

continued on page 46

Balakrishnan *continued from page 40*

of the nation's military aircraft with pilotless planes by 2010.

So the testing goes on, but not without a disaster here or there. When that happens, Balakrishnan is usually one of the experts called upon to evaluate specific problems. He consulted with industry reps on some of the issues arising from the crash of a Helios prototype aircraft, a remotely piloted, propeller-driven winged aircraft that plunged into the Pacific Ocean in 2003 a few minutes after launch. The accident raised a lot of concern about flight safety and how aviation experts could make unmanned aircraft as safe to fly as piloted airplanes.

Balakrishnan has been working with the NASA-Dryden test facility since the 1970s to develop flight test data reduction techniques and to help bring NASA and the research community into closer collaboration. In 1986, his efforts were rewarded when he received NASA's Public Service Medal for his "exceptional continuous theoretical and administrative contributions in establishing the UCLA-NASA Flight Systems Research Center." In 2001, he received the Richard E. Bellman Control Heritage Award — the highest professional achievement award given to control systems engineers and scientists — for his contributions to the theory and application of automatic control. Last April, Balakrishnan received the USC Viterbi School's Distinguished Alumni Award in Academia.

If that is not enough, he keeps his hand in industry too, working as a consultant for Optimization Software, Inc. Among his professional memberships, Balakrishnan is a lifetime Fellow of IEEE and a member of the International Scientific Radio Union. He is also the author of ten books, more than 200 scientific papers and has earned dozens more awards. All the while, he never lets any of it interfere with his daily game of badminton — ever the lover of aerodynamics!

Balakrishnan monitors flight test data at the NASA-Dryden Flight Research Center in Lancaster, Calif.

Balakrishnan and his wife, Sophia, in his UCLA office.

Andrew Viterbi presented Balakrishnan with a distinguished alumnus award last spring.

Lopez *continued from page 42*

campuses up north." Then she attended a MESA (Mathematics, Engineering, Science Association) college orientation program, where she met Larry Lim, director of pre-college programs at the USC Viterbi School, and that clenched the deal.

"USC was right, I just knew it," Lopez asserts. "I didn't fit into the culture of some of the other schools, but I knew I would like USC. I knew that Los Angeles was going to be very diverse."

Aimee Lopez (center, seated on right) with her Latina sorority sisters.

She entered the USC civil engineering program in 1994 and moved into Fluor Tower, a campus dorm. Each floor of the dorm had a different cultural theme; Lopez lived on a Latino floor and wanted to create an extended family environment. She got involved with the Latino student assembly and co-founded a Latina sorority, Nuestra Alma Latina, which means "our Latin soul," during her freshman year. "That's one of the reasons I'm so excited to be back on campus," she says. "We are celebrating our 10th year this year."

Aimee Lopez at her 1999 graduation.

Lopez attributes much of her success in engineering to USC's diversity and nurturing environment. "I learned valuable leadership skills at USC and that's really important for women in this field," she says. "There aren't that many women who graduate in engineering and there are even fewer Latina women. They get lost. So we wanted to help everybody out and let them know that they weren't alone. We wanted to make everybody a leader."

And lead she did, "on two hours of sleep a night," she laughs. "I still have my class schedules, where I would write in my 15-minute naps between classes. It was non-stop."

Lopez interned at IBM during her second year at USC. Then Parsons, a large civil engineering firm based in Pasadena, California, recruited her and she worked nearly full-time while still taking classes. Her natural leadership qualities did not go unnoticed; she was awarded an El Centro Chicano Student Leadership award in both her junior and senior years, and was asked to speak at her own USC graduation ceremony in 1999.

After graduation, Parsons offered Lopez an opportunity to be a field engineer on a construction project at Merck's, a pharmaceutical company in Elkton, Virginia. She spent three months helping to upgrade some of the company's facilities.

Turner Construction, a leader in high-rise construction, caught her attention shortly thereafter and she moved into project management in California. Since joining Turner, she has been a project manager on an Internet-hosting facility in Marina Del Rey and worked on a baggage screening security system upgrade at Los Angeles International Airport.

"I think that all of my assignments all over the country and my background really helped me move up faster in engineering and construction at this firm," Lopez says, "but my leadership training at USC is probably the best thing that ever happened to me."

Dorman *continued from page 45*

disadvantaged students primarily from northern New Jersey's industrial neighborhoods to pursue rigorous yet nurturing engineering programs. "I talk to the students every year," Dorman says. "They share their dreams, and I share my experience. It always renews my faith in the future."

Dorman also serves as a longtime trustee of the J. David Gladstone Institutes, which for three decades has underwritten groundbreaking, life-saving biomedical research in affiliation with the University of California-San Francisco.

He recently completed what may become his most lasting legacy for all Americans. From 2001 to 2003, Dorman served as chair of a National Research Council Committee charged with reviewing policies and practices relating to all Federal Government facilities — 3.3 billion square feet of space worldwide, valued at more than $300 billion. Each year the government spends more than $25 billion in tax dollars maintaining, renovating and acquiring these facilities, many of which have become under-utilized or obsolete. Dorman's committee identified principles that best-practice organizations use to manage facilities. Their report, *Investments in Federal Facilities: Asset Management Strategies for the 21st Century,* offers what the U.S. Government Accountability Office calls "a comprehensive, integrated transformation strategy" for investing in and managing all federal facilities — a strategy that could potentially save billions of future tax dollars.

"It was intellectually perhaps the most complex program I've ever addressed," Dorman admits. "Although I have no illusions about the difficulties of reaching consensus and then implementing change in the political process, we have received some encouraging feedback. Perhaps unrelatedly, the President has issued an Executive Order that will advance some of our recommendations. If only a 5% improvement occurs, I will consider the committee's efforts to have been worthwhile."

Al Dorman's efforts throughout his career have not only been worthwhile, but they are worth praise, and they will no doubt leave their footprints on this world.

snapshots

USC Viterbi School of Engineering Events
Summer & Fall 2004

Craig Hodgetts explaining the Hollywood Bowl shell re-design.

Carole and Robert Ferguson speaking to other parents at the move-in day reception.

Trojan spirit was everywhere at FED EX Field for the Virginia Tech game.

An Evening at the Hollywood Bowl

On August 14 the Viterbi School hosted its second annual "Evening at the Hollywood Bowl." Seventy alumni and friends of the School gathered for a reception and dinner prior to the concert at the Bowl's Museum Garden. They were also treated to a fascinating presentation by Craig Hodgetts of Hodgetts & Fung, the architectural design firm responsible for the re-design of the famous Hollywood Bowl shell. Following the dinner, the group enjoyed the "Tchaikovsky Spectacular" with fireworks and a brief performance by the Trojan Marching Band.

Mary and George (BS '69) Crane at the Hollywood Bowl event.

Parent's Move-In Day Reception

The Viterbi School hosted a reception for incoming freshman parents on move-in day, Wednesday, August 18. Over 200 parents and family members attended to meet other parents and Dean Nikias. Along with the dean, current parents Carole and Robert Ferguson spoke about their experience as Viterbi School parents and offered advice on what students and parents could expect in the coming days, months and years.

BCA Classic Weekend

Dean Nikias traveled to the Washington, D.C. area for the Black Coaches Association (BCA) Classic on Saturday, August 28. More than 90,000 fans and a national audience watched USC defeat the Hokies of Virginia Tech, 24-13, at FedEx Field in Landover, MD. Highlights of the weekend for Viterbi alumni and friends included the Friday night pep rally at the Wardman Park Hotel and a dinner for alumni and friends hosted by the dean at the Cosmos Club.

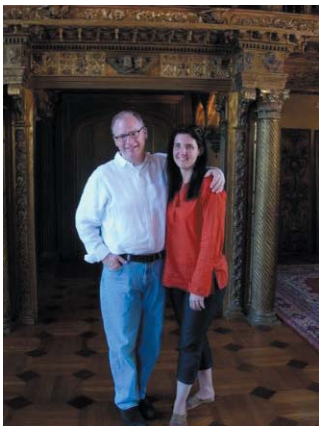
Stonebrook, a 1914 English Tudor manor, and site of the 2004 Viterbi weekender reception.

Chairholder Sheldon Ross and Trustee Dan Epstein with their "chairs" at the dedication.

Parents and students learning more about the Viterbi School a the Trojan Family Weekend reception.

Annual Weekender Reception

The Viterbi weekender reception was held on September 24, the evening before the USC vs. Stanford game which resulted in a suspenseful Trojan victory, 31-28, over the Cardinal. The Friday evening reception for alumni and friends was held at the historic home of Christina and Kelly Porter. Our generous hosts entertained guests with an impressive tour of Stonebrook, their newly restored, 1914 English Tudor manor. Dean Nikias gave remarks in the manor's 2,000 sq. ft. ballroom and presented Christina and Kelly with USC gifts for their children.



Kelly and Christina Porter in the historic ballroom at Stonebrook.

Daniel J. Epstein Chair Dedication

On October 6 the Daniel J. Epstein Department of Industrial and Systems Engineering installed Dr. Sheldon Ross as the first chair holder of the Epstein Endowed Chair in Industrial and Systems Engineering. The endowed chair is a generous gift by USC trustee and Viterbi School board of councilor member Dan Epstein (BSISE '62). The dedication and installation followed an intimate dinner at Hoose Library at USC, which featured remarks by President Steven B. Sample and Dean Nikias. At the end of the evening, Epstein was inducted into the Russian Academy of Science, a very special honor bestowed by Viterbi professor and alumnus, George Chilingar.

Dean Nikias, Sheldon Ross, Dan Epstein and President Sample at the Epstein Chair Dedication.

Trojan Family Weekend Breakfast Reception

On Friday, October 15 the Viterbi School hosted a breakfast reception held in conjunction with Trojan Family Weekend. Over 150 family members had an opportunity to meet with faculty and staff of the Viterbi School. In addition, Viterbi student ambassadors led parents though laboratory tours of the Integrated Media System Center, Dryden Wind Tunnel and the AMI Medical Devices Lab.

Alumni news & notes

Summer and Fall 2004

1985

Barry Tilton (BSEE) is preparing to leave the Air Force after 20 years. His last position was as the chief of Air and Space ISR Engineering for the National Geospatial Intelligence Agency. He expects to be taking a job in the Washington, D.C. area next summer.

1992

Keith Kelly (BSME) grew up in the inner city of Detroit, has traveled and lived all over the world and now works for the State Department.

1995

Alex Soriano (BSME) obtained an MBA from the University of Michigan in 2003 and then went on to work in marketing for Merck & Co. He has now accepted a manager position in marketing with St. Jude Medical.

1997

Christina Smolke (BSChE) joined the Caltech chemical engineering faculty in October 2003 as an assistant professor. She received her Ph.D. from UC Berkeley in 2001 and also served as a National Institute of Health postdoctoral fellow at Berkeley for two years.

2000

Erin Kettwig (BSEE) is working as a product manager for the firm Cypress Semiconductor.

2001

Lauren O. Baum (BSBE) recently resigned her position as a product designer at Sandel Medical Industries, L.L.C. and returned to USC to obtain her master's degree.

2003

Kevin Helm (BSAE) is working as a designer for the Northrop Grumman Corporation.

2004

Stanley Jones (CSCI) was recently hired by Microsoft as an associate consultant.

Faculty & Staff News

Christopher Stoy (MPA '73, Ph. D. '83), CEO of External Relations at the Viterbi School, and his wife **Cynthia** (BACAAS '91), celebrated the birth of their first child, Taliana Irene Stoy on Monday, September 20 at 12:15 p.m. They are "thrilled and overwhelmed" with their beautiful little girl, and the Viterbi School extends to them our warmest congratulations and a happy welcome to this new member of the Trojan Family.

Christopher with little Taliana Irene, minutes old.

Taliana Irene

Sylvia Adams is the new assistant in the office of corporate and foundations relations.

Rebecca Coleman has recently joined the Viterbi School as director of major gifts. She joins us from Whittier College, where she also served as a director of development.

Cynthia Harrison was recently promoted to executive assistant to Dean Nikias. She formerly served as an executive assistant in the external relations office at the Viterbi School.

Cami Lee-Shono (BACAAS '96), marketing specialist at DEN, gave birth to a baby girl on September 28. Her name is Madeline Mei Young Kimiko Shono. She was born 5 lbs, 18 inches.

Isadora Gullov-Singh was promoted to director of corporate and foundations relations effective July 1. She formally held the position of associate director in this area and served as interim director during a six-month search.

Kirstin Strickland has joined the Viterbi School as the new associate director of corporate and foundations relations. She was formerly with the USC Alumni Association.

Please keep us informed of your personal and professional progress, as well as changes in your contact information by visiting www.usc.edu/engineering and clicking on Alumni. Or by writing to the Alumni Relations Office at the USC Viterbi School of Engineering, Olin Hall 300, Los Angeles, California 90089-1454

New Board of Councilors Members

Kenneth Dahlberg (MSEE '69) is president and CEO of San Diego-based Science Applications International Corporation (SAIC), the world's largest employee-owned research and engineering company. He received a bachelor's degree in electrical engineering from Drexel University in Philadelphia in 1967, a master's degree in electrical engineering from USC in 1969 (studying under Engineering Dean Zohrab Kaprielian), and attended the University of California business school for advanced education for executives. He is a director of the National Defense Industrial Association, and a member of the Institute of Electrical and Electronic Engineers, the Surface Navy Association, the Association of the United States Army, and a lifetime member of the United States Navy League. *See complete profile on Ken Dahlberg in the Spring 2004 issue of USC Engineer.*

Vinod K. Dham is co-founder and managing member of NewPath Ventures LLC, a hybrid Indo-U.S. venture fund. Prior to this, Dham was the chairman, president and CEO of Silicon Spice Inc., a start up involved in developing VOIP solutions for the communications market. Silicon Spice was acquired by Broadcom Corporation, where Dham served as vice president and general manager. Acclaimed as the "father of the Pentium processor," Dham was vice president and general manager of the microprocessor products group at Intel Corporation where he managed the Pentium, 486 and 386 Microprocessors products, generating multi-billion dollar businesses. He has a bachelor's degree in electrical engineering from Delhi University in India and master's degree in electrical engineering from University of Cincinnati.

Albert A. Dorman (MSCE '62) is retired, founding chairman of AECOM, one of the world's largest architecture and engineering firms. *See complete profile of Albert A. Dorman on page 39 of this issue.*

John C. Johnson (MSSM '74) is the vice president of Sector Advanced Development Programs in the systems development and technology division for electronic systems at Northrop Grumman. His responsibilities include managing over 300 advanced technology programs and applying discriminating technologies and innovative system solutions across all Department of Defense mission applications. Johnson received both his undergraduate and graduate degrees from USC. He holds a master of science degree in engineering with an emphasis in systems management, and has conducted Ph.D. studies at USC as well. Johnson also attended Air Staff College and Industrial College of the Armed Forces.

Bonnie Optekman is the vice president of NBC News Production Systems in New York City. She handles the information technology services for NBC News operations worldwide and is responsible for ensuring computer technology meets news broadcast requirements in daily news coverage, special events planning and acquisitions. Optekman received her bachelor's degree from Hofstra University, graduating magna cum laude. She majored in journalism and served as the news editor for the "Hofstra Chronicle. She also holds a graduate certificate in computer programming from New York University.

Darlene Solomon is vice president and director of Agilent Laboratories. Her responsibilities include developing the company's long-term technology strategy and overseeing the alignment of Agilent's objectives with its centralized research-and-development activities. Prior to Agilent, Solomon worked at Hewlett-Packard Laboratories as a member of the technical staff, subsequently holding a variety of research and management positions including R&D manager for the chemical and biological systems department. She received her bachelor's degree in chemistry from Stanford University and a doctorate in inorganic chemistry from the Massachusetts Institute of Technology.

Alumni Recognition

Michael B. Pursley (Ph.D. EE '74) received the Edward Howard Armstrong Achievement Award from the IEEE Communications Society for "seminal contributions to spread-spectrum communications and adaptive protocols for mobile wireless communications networks."

Michael received a bachelor's degree with highest distinction in 1967 and a master's in 1968, both in electrical engineering from Purdue University. He received a Ph.D. in electrical engineering from USC in 1974. He has several years of industrial experience, primarily with the Space and Communications Group of the Hughes Aircraft Company. While at USC, he was a Hughes doctoral fellow and a research assistant in the electrical engineering department. He also served on the faculty at the University of Illinois for almost 20 years, and he has held visiting faculty positions at UCLA and CalTech.

Michael is currently the Holcombe Professor of electrical and computer engineering at Clemson University in South Carolina. His research is in the general area of communications and information theory with emphasis on spread-spectrum communications, communication over fading channels, applications of error-control coding, protocols for packet radio networks and mobile communications systems and networks.

In Memoriam

Robert E. Kalaba

Professor of Biomedical Engineering and of Economics

Robert E. Kalaba, an applied mathematician associated with USC for almost half a century, renowned internationally for his analytical and computational solutions to problems in physics, engineering, operations analysis and biology, died September 29 following a brief illness. He was 78.

A professor of biomedical engineering, electrical engineering and of economics, Kalaba was an engineering lecturer at USC from 1956 to 1971. He became a research associate in biomathematics in 1966 and a visiting professor of electrical engineering in the biomedical engineering program in 1969. In 1974, he became a full professor at USC with appointments in biomedical engineering, electrical engineering and economics.

"Thus, he was truly one of the founding fathers of BME here," says Michael Khoo, professor and chair of the department of biomedical engineering. "Computational programs that he helped prepare are in use in coronary care units to aid in the optimization of drug regimens."

Before coming to USC, Kalaba was a mathematician at the RAND Corporation in Santa Monica from 1951 to 1969. He was a founding editor of *Applied Mathematics and Computation.* He was also a consultant at Hughes Aircraft Company, Esso Production Research Corporation, the Jet Propulsion Laboratory and the Service Bureau Corp.

Kalaba continued to work from his hospital until a few days before his death. In addition to his prolific research, he was known as an excellent teacher who could simplify complex mathematical problems for his students.

Born in Mount Vernon, New York, Kalaba earned his B.S. in 1948 and his Ph.D. in 1958 from New York University. He served as an electronics technician in the U.S. Navy at the end of World War II.

A resident of Pacific Palisades, California, he is survived by his wife Wilma, two daughters and two sons. Funeral services were held October 9 at the Corpus Christi Catholic Church in Pacific Palisades.

Lyman Handy

Former Chair of Petroleum Engineering, Passes Away at 85

Lyman Handy, emeritus professor of petroleum engineering who chaired the USC Viterbi School's department of petroleum engineering for over two decades, passed away September 14 in Fullerton, California. He was 85.

Handy joined the USC faculty in the late 1950's as a part-time lecturer and became chair of petroleum engineering in 1966. Under his leadership, the department became internationally known.

Handy was an influential contributor in the field of petroleum engineering and known worldwide as an experimentalist with an uncanny sense of the mechanics of flow in porous media. His papers continue to be cited and used today. Among the many honors he received was the Distinguished Service Award from the Society of Petroleum Engineers, an organization in which he served in several national level positions.

In 1942, Handy graduated from the University of Washington with a B.S. degree in Chemistry. He served in the U.S. Navy during World War II and was stationed off the coast of Italy. In 1950, he earned his Ph.D. in physical chemistry from the University of Washington and he worked at Chevron Oilfield Research in La Habra as a research chemist from 1952 to 1966.

Melvin Wheeler Jackson (BSCE '43) was born July 19, 1917, in Nashville, Tennessee, to Kathryn Nance and James Wat Jackson. He died on October 26, 2003 at the age of 86, surrounded by his beloved trees near his home.

The ninth of ten children, when Melvin was five years old his family moved to Los Angeles, California. He attended night school at USC, majoring in civil engineering. During his college years, he worked full-time and still managed to graduate in 1943 as valedictorian of his engineering class. He went on to complete his master's of science degree and Ph.D. from University of Illinois in 1946.

It was during this time that he met his beautiful wife, Mary Alice Pfeiffer, and they were married in 1946.

Melvin taught at the University of Illinois, the Georgia Institute of Technology in Atlanta and University of Colorado in Boulder, Colorado. He retired from Argonne West National Lab as senior plant engineer in 1983, and he held licenses as a registered professional engineer in 21 states.

Melvin had a full life, having gained the friendship of many during his extensive travels with his wife. His many endeavors included stamp collecting, rock hunting, collecting antique farm implements and attending auctions. Mel had a passion for history, particularly of the west and Native Americans. He had an artistic penchant and a special talent for creating folk art items. He always looked forward to his weekly appointment at the blacksmith. His greatest enjoyment was working among the many trees he planted. He strictly abided by the philosophy that "you are never too old to plant a tree." He is survived by his wife, Mary; sons, Stephen F. Jackson (Jeanie) and Thomas J. Jackson (Sherrie); and daughter Sarah C. Jackson (Jeff Hampsten); and many nieces and nephews. Memorials in Melvin's name may be given to Bannock County Historical Museum, P.O Box 253, Pocatello, Idaho 83204.

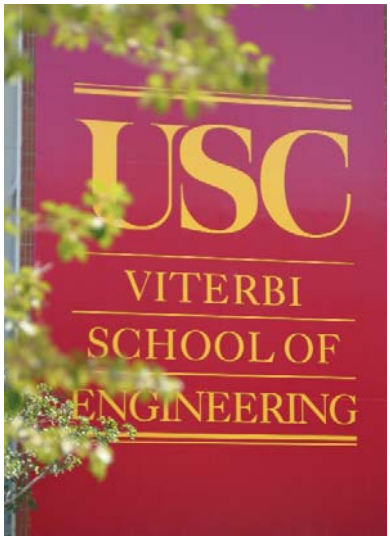
J. Alan Higgins (MSME '68) passed away on March 19, 1997 after a 19 year struggle with multiple sclerosis.

Sunnie Chung, a master's degree student in the USC Viterbi School department of computer science, died in a traffic accident on July 11 in a single-vehicle accident on the I-15 near Baker, California. Two other USC Viterbi School computer science students were injured in the same accident. They were Keun Lee, a doctoral student, and Kyung Hwan Yoo, a master's student.

A Brand New Name

A strong coherent visual identity is a critical component in establishing the USC Andrew and Erna Viterbi School of Engineering as one of the nation's pre-eminent engineering schools. Adding the prestigious Viterbi name was an important step in this journey, and a significant opportunity for the School to seize upon.

Recognizing the need to graphically convey the School's new stature, an internal branding group embarked on the process of selecting and hiring a firm to develop the new brand last April. Their mandate was to develop a visual brand and guidelines that would consistently communicate the many attributes of the USC Viterbi School of Engineering to audiences ranging from students, faculty and alumni, to the School's many supporters around the world. The new brand also had to fit into the university's extensive graphic identity system. "USC" is a strong brand that is already known worldwide.



After several months of internal research, the branding group selected Praxis Advertising and Design. Praxis is currently putting the finishing touches on a dynamic new visual identity for the School that will be formally unveiled in mid-December.

The new Viterbi branding system offers design templates, a vibrant color palette, a new signature and identifying mark, specifically designed with the flexibility to address the varied needs and complexities of the School, while providing a high degree of consistency. The system communicates important core Viterbi attributes such as innovation, a pioneering entrepreneurial spirit, global reach, nimbleness and dynamism.

When successfully implemented, the new brand will be consistently applied to all electronic and printed communications. Every piece will speak with a single clear voice and integrally reinforce the School's positioning to the pinnacle of America's foremost schools of engineering.

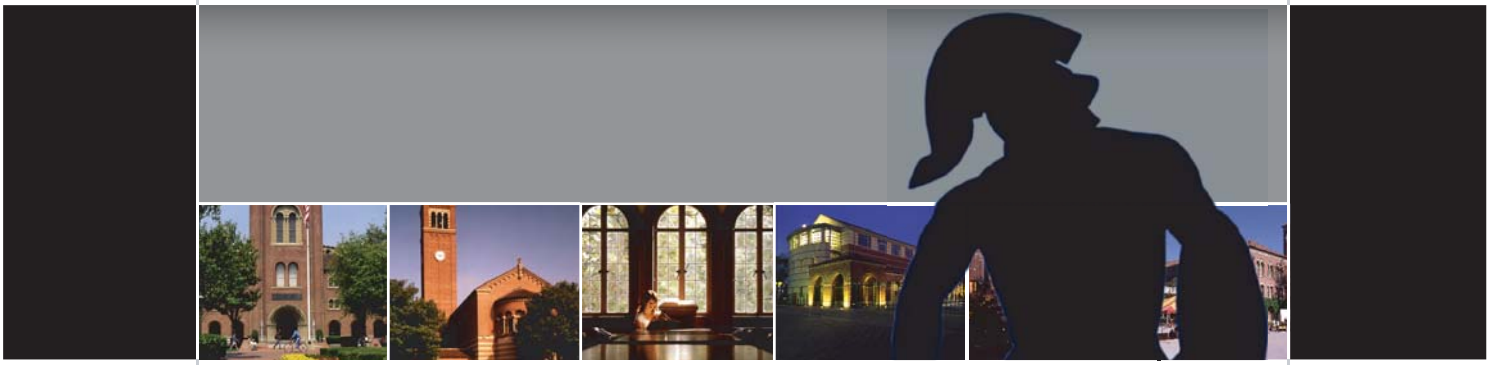
Look for the exciting new Viterbi brand on communications that you receive after the first of the year and in the next issue of *USC Engineer.*

Bob Calverley, executive director, communications, Dean Nikias, Praxis President David Schwartz (standing) and Praxis Vice President Craig Rettig, examine USC Viterbi brand designs.

Viterbi students celebrating the School's new name in March.

Photo of Viterbi banner by Brian Morri and student photo by Lee Salem

University of Southern California

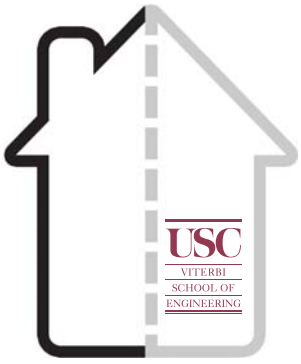


When You Move to Your New Home—Don't Volunteer to Pay Capital Gain Tax on the One You Leave Behind

You Really Don't Need To, You Know

If you are thinking of selling your home of many years—whether or not you plan to buy a new residence—a sizable portion of your increased value may be subject to federal and state capital gain tax, even after using your $250,000 or $500,000 exemption. It is easier than you think to avoid this tax, which can take as much as 25% of the increased value.

You may be able to eliminate a portion of this unwanted tax by transferring a percentage interest in your home—prior to sale—to a USC charitable remainder unitrust.



Not only might you avoid the tax, you will also get a charitable deduction for part of the value transferred (this can mean tax savings on your other income) and you receive a substantial yearly income for the rest of your life.

In addition to these financial and tax benefits, you may designate the remainder value of your trust to create a lasting legacy at the Viterbi School of Engineering.

To learn more about how this concept might be adapted to your personal situation, please contact Barbara Myers by e-mail at bmyers@usc.edu or by phone at (213) 740-2502.

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