USC Engineering NEWS

A newsletter published by the University of Southern California School of Engineering

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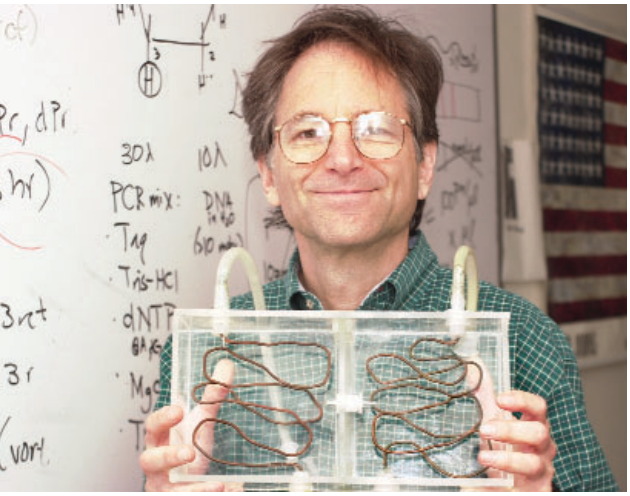

Professor Adleman with his deceptively simple looking DNA computer.

DNA COMPUTING

A DNA-based computer created by USC computer science professor **Leonard Adleman** has solved a logic problem that no person could complete by hand, setting a new milestone for this nascent technology, which could someday surpass the electronic digital computer in certain areas.

The results of this research were first published in the online version of the journal *Science* on March 14 and then ran in the print edition.

Adleman, a member of the National Academy of Engineering, previously made headlines in 1994 by demonstrating that DNA—the spiraling molecule that holds life's genetic code—could be used to carry out computations.

Adleman's idea was to use a strand of DNA to represent a math or logic problem, then generate trillions of other unique DNA strands, each representing one possible solution. Exploiting the way DNA strands bind to each other, the computer weeded out invalid solutions until only the strand that solved the problem remained. A person could have solved Adleman's 1994 problem with a pencil and paper. Adleman's latest experiment solves a problem requiring the evaluation of more than a million possible solutions—too complex for anyone to solve without the aid of a computer. It required a set of 20 values that satisfy a complex tangle of relationships.

Although they are still nowhere near primetime, "DNA computers do have several attractive features," said Adleman. "They are massively parallel, compute with extremely high energy efficiency, and store enormous quantities of information."

"In the past century we've become really good at controlling electrons," he said. "It would take a breakthrough in the technology of working with large biomolecules like DNA for molecular computers to beat their silicon-based electronic counterparts."

Still, even if no one finds a way to beat electronic computers on very complex problems, he said, DNA computers might find applications in other areas.

"It's possible that we could use DNA computers to control chemical and biological systems in a way that's analogous to the way we use electronic computers to control electrical and mechanical systems," he said.

Adleman suggested, for example, that such systems might someday be engineered into living cells, allowing them to run precise digital programs that would interact with their natural biochemical processes.

Nothing Succeeds Like Success

Dean C.L. Max Nikias

My first year as dean has come to a close. Our accomplishments in the past 12 months have been exceptional.

Several senior faculty produced research breakthroughs, from the creation of a DNA-based computer to GRID computing to advances in neuroengineering and nanotechnology. Our junior faculty won an astonishing seven Early Career Development Awards from the National Science Foundation. At the 2002 commencement, the valedictorian and one of the salutatorians were graduates of the Biomedical Engineering Department, which speaks to the strength of our graduates and our School.

A significant naming gift from our distinguished alumnus, Daniel J. Epstein, now provides the resources to push our Industrial and Systems Engineering Department into the ranks of the nation's elite. We will be seeking key additions to the department in the next four years. Our significant appointments in the School this year include Professor Norberto Grzywacz and Assistant Professor Tzung Hsiai in Biomedical Engineering; Associate Professors Leana Golubchik, Milind Tambe, and Ramesh Govindan in Computer Science; Professor Cauligi Raghavendra in Electrical Engineering/Systems; and Assistant Professor Elaine Chew in ISE. Joining our Biomedical Engineering Department in recent weeks is Professor Kirk Shung, who brings with him an ultrasound research institute and its staff. These additions, and those to follow throughout the coming year, position our School to climb higher, and grow stronger.

Our dramatic rise from 11th to 8th in the *U.S. News & World Report* rankings of graduate

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USC INFORMATION SCIENCES INSTITUTE SCORES A DIRECT HIT WITH THE MARINES

Marine Corps generals responsible for aviation gave high marks in April to a product of the School of Engineering's Information Sciences Institute (ISI) CAMERA (Coordination and Management Environments for Responsive Agents) R&D project, following a briefing and demonstration given to them at the request of Lieutenant General William L. Nyland, Deputy Commandant of the Marine Corps for Aviation. Nyland had previously been briefed on a software suite that included an aviation application of the CAMERA project, called SNAP, and decided that he wanted all his senior officers to receive the same briefing.

Under development since 1999, CAMERA is a software framework that manages "win-win" negotiations between independently running software modules. SNAP, an experimental application of CAMERA to Harrier aircraft mission scheduling, has been under development at a Marine air station in Yuma, AZ, since 2000.

In SNAP, each software module represents the concerns of an individual stakeholder in the scheduling process. The system negotiates a balance between organization-wide goals, technical and policy constraints, and individual stakeholder requirements. Balancing such a complex mix of factors had been extremely time-consuming for officers, requiring them to juggle issues such as executing required assignments, maximizing readiness for future operations, balancing flying time equally among the pilots, fatigue factors, route limitations, timing and environmental considerations, squadron-level combat readiness plans, pilots' needs for training to maintain and increase skills, aircraft condition, and downtime needed for routine and unscheduled aircraft maintenance. SNAP quickly and accurately produces flight schedules that balance thousands of considerations, enabling officers to perform their complex task extremely rapidly—a capability the Marines regard as essential to their commitment to be ready for anything. One commander called for expanding the system beyond its current applications, while several others called for adoption of the current system "immediately." Robert Neches and Pedro Szekely are the co-primary investigators of CAMERA.

Lord Foundation Grant for Distance Education

A proposal prepared in collaboration with researchers at the Information Sciences Institute (ISI) and personnel at the School's Distance Education Network has resulted in the award of a $350,000 grant from the Lord Foundation to the School's Distance Education Network (DEN). The grant will support DEN's effort to expand Internet-based instructional programs and improve their content.

The grant enables DEN to extend its work to develop a portable classroom technology called "webcast-in-a-box." This technology would provide a way to transmit lectures held in ordinary classrooms over the Internet, while retaining the capability for teacher-student interactions that are a hallmark of DEN instruction.

Webcast-in-a-box will free DEN from the need to maintain expensive studio classrooms. The requirement for such studios places severe limitations on the number of courses USC—or any university—can provide over the web.

A second phase planned for the portable webcast system would enable instructors to create simple and straightforward digital (non-video) course content and materials for web instruction.

Kelly Goulis, the executive director of the Distance Education Network, says that the new capabilities under development represent the early phase of an effort to materialize a goal assigned by C.L. Max Nikias, the dean of the School. DEN will be incorporating advances in media and Internet technologies produced by the School's research into the instructional system. One example is a set of software tools called the "Digital Amphitheater" (DA) under development at ISI. DA will provide the ability to instruct large groups and allow both group discussions and private consultation in a wholly digital environment.

In turn, DEN would become a strong asset for USC information technology/communication research by serving as a unique testbed for new applications.

USC TRUSTEE AL MANN JOINS BIOMED AS RESEARCH PROFESSOR

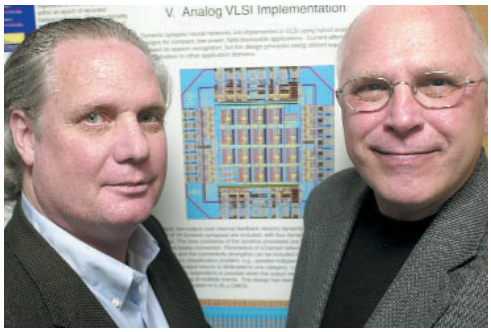
Al Mann, who started the Alfred E. Mann Institute for Biomedical Engineering at USC with a $112.5 million gift in 1998, is now a USC research professor in the Biomedical Engineering Department.

Mann is a respected and highly successful entrepreneur who has founded and led numerous companies in the field of medical technology. He is also a member of the National Academy of Engineering who has made significant engineering advances in medical devices, photovoltaic power conversion, illumination, radiometry, vacuum physics, thin-film optics and advanced methods of mathematical analysis. In 2001, USC conferred on him an honorary Ph.D.

Next-Generation Chip based on Human Neural Patterns

"Biologically inspired computing modules performing high-level pattern recognition will be a key aspect of future computing systems," said **John Granacki**, director of the Advanced Systems Division of the Information Sciences Institute (ISI) in the USC School of Engineering.

Granacki and **Theodore Berger**, professor of biomedical engineering and director of the USC Center for Neural Engineering, will receive $2 million in grants from the new Biological Information Technology and Systems program of the National Science Foundation (NSF) and from ISI.



Left to right: Professor Theodore Berger and John Granacki

For several years, Berger has been studying the faint electrical signals of individual neurons and networks of neurons. The group's research has led to mathematical models that represent the changes produced by a single neuron and by increasingly larger groups of neurons. The models were developed with **Professor Vasilis Marmarelis** of biomedical engineering, who is a co-investigator on the grants; Granacki has been building silicon computer chips that mimic Berger's mathematical neuron models.

"We want to imitate neural procedures on silicon because the brain is a superior computational device in many ways," said Berger. For instance, when confronted with the death of several thousand neurons from the consumption of a single alcoholic drink, neural circuits reconfigure themselves and continue to work. Granacki thinks this is something he and Berger can exploit to build a more reliable computer chip.

Unlike modern digital computer chips, the brain is analog and runs much slower. Granacki's early prototypes have also been analog, but his next chip will be digital in order to pack more neuron models into less space. It will also run as fast as the best silicon chips made today while still functioning more like neurons.

"So far, computers have been all math and logic," said Granacki. "We're inspired by biology to create a hybrid that will be a superior computing device."

Nothing Succeeds Like Success

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engineering schools is in part due to our innovative communications efforts, which have made the excellence of our School known. To maintain the new higher ranking of the School, we must elevate the rankings of individual departments. We will do this first by adding the finest faculty members and researchers we can to grow the departments, and then follow up by making members of the academic and corporate communities, as well as the general public, aware of our successes.

Fulfilling our ambition to elevate the School will require the continuing and growing involvement of our alumni and friends. Now more than ever, we must harness our higher level of energy and momentum, which will ultimately lead to our inclusion in the nation's elite engineering schools.

LANDMARK TECHNOLOGY GIVES GLIMPSE OF INTERNET FUTURE

In a landmark event in the evolution of Internet applications, in May researchers at the Integrated Media Systems Center (IMSC), which is a National Science Foundation engineering research center at USC, demonstrated breakthrough Internet technology for high-resolution, big-screen video and audio.

The demonstration was covered by *The New York Times*, three Los Angeles television stations (KNBC, KTLA, and Fox), and other media.

"Our new integrated technology provided a glimpse of the future of the Internet," said C.L. Max Nikias, Dean of the School of Engineering. He added that the new technology should serve as an important incentive to immediately accelerate the deployment of broadband, high-speed Internet transmission capacity.

Professor Ulrich Neumann, IMSC's Director, said, "In addition to home entertainment, our new Internet technology will also have a major impact on how the Internet will be used in the future in commerce, education, medicine, research, personal communication, and many other areas."

The IMSC researchers used the high-speed capabilities of the Internet to transmit multiple streams of picture and sound across the nation from the School's Information Sciences Institute/East, in Arlington, VA, for a big-screen presentation that dramatically surpassed the quality of high-definition broadcast television.

IMSC's new technology, termed Remote Media Immersion (RMI), integrates the Center's streaming video technology with its unique audio technology, which overcomes the limitations of today's stereo and surround sound. The audio technology, called Immersive Audio, generates a true three-dimensional sound field by using multichannel signal processing to localize and maneuver sound in space to create the illusion of movement.

The 24th Annual Engineering Awards Luncheon

In April the 24th Annual Engineering Awards Luncheon was held in the Crystal Ballroom of the Millennium Biltmore Hotel in recognition of engineering achievements, as a celebration of recent successes, and as a sobering examination of the nation's war on terrorism.

The audience was treated to "Engineering the Future," an engaging eight-minute video outlining Dean C.L. Max Nikias' plan to make the USC School of Engineering one of the nation's elite schools.

USC President Steven B. Sample, who is a member of the electrical engineering faculty, noted that seven assistant professors in the School had received National Science Foundation Early Career Awards. "Seven Career Awards at one university in one year is almost unheard of, even for a highly ranked engineering school such as ours," he said.

Jen-Hsun Huang, co-founder, president, and CEO of NVIDIA, the Santa Clara semiconductor giant, received the Daniel J. Epstein Engineering Management Award. Huang, who had toured the School with the dean, remarked that "if Max Nikias' vision of the Internet comes true, NVIDIA won't be able to make microprocessors fast enough."

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The management award also honored **Daniel J. Epstein** in that beginning this year, the award bears his name. The San Diego real estate entrepreneur and alumnus recently gave the School the largest-ever gift to name a USC academic department, which happens to be the same one from which he graduated in 1962.

"That department has been named the Daniel J. Epstein Department of Industrial and Systems Engineering," said Nikias. "Dan is also a distinguished leader in management and a highly successful CEO. The addition of his name to our Engineering Management Award adds to its distinction."

The Distinguished Alumni Award went to **Simon Cao**, co-founder and chief technology officer of Avanex Corporation. Cao earned Master's and Ph.D. degrees in electrical engineering and in physics at USC.

Alice Gast, who recently became vice president for research and associate provost of the Massachusetts Institute of Technology and who is also the Robert T. Haslam Professor of Chemical Engineering there, received the Distinguished Alumni in Academia Award. The 1980 chemical engineering graduate becomes the first recipient of that award.

The featured speaker at the luncheon was NBC correspondent and MSNBC anchor **Forrest Sawyer**, who presented an incisive talk on "The War on Terrorism and the New Balance of Power." Sawyer, who is chairman of Sawyer Media Inc., is also a member of the School of Engineering's Board of Councilors. Speaking for 30 minutes, he described last year's 9/11 attack, the resulting war on terrorism, and the ongoing Israeli-Palestinian conflict from the widely differing perspectives of the various participants.

Nikias restated his passionate belief, first enunciated when he was a candidate for the job of dean, that the USC School of Engineering "is on the verge of becoming a great school. "And while the future is bright," he said at the luncheon, "the present is certainly far from dim."

Left to right: Xiaofan "Simon" Cao, Founder and CTO of AVANEX; Dean C.L. Max Nikias; Prof. Alice P. Gast, VP for Research and Associate Provost, MIT; and Jen-Hsun Huang, Co-Founder, President, and CEO, NVIDIA.

Dean C.L. Max Nikias and USC President Steven B. Sample (standing) greet USC Trustees Malcolm Currie and Gordon Marshall.

School of Engineering Board of Councilors (BOC) member and USC Trustee Mark Stevens (left) speaks with MSNBC journalist, BOC member, and guest speaker Forrest Sawyer.

SoE Faculty Earn Seven NSF Early Career Awards

Seven School of Engineering assistant professors have won National Science Foundation (NSF) Early Career Development awards, reflecting the School's rapidly growing strength in the areas of computer science and electrical engineering.

The awards provide between $300,000 and $500,000 each for research, teaching, and outreach activities during the next five years.

The purpose of Early Career awards is to identify future academic leaders and help them establish their research and teaching careers.

"Seven NSF career awards in a single year is an outstanding accomplishment for any large university, but it is absolutely astonishing for an engineering school," said C.L. Max Nikias, dean of the USC School of Engineering.

Four of the recipients, Mathieu Desbrun, Ashish Goel, Christos Papadopoulos and Gaurav Sukhatme, are assistant professors of computer science. Ahmed Helmy, Chongwu Zhou, and Won Namgoong are assistant professors of electrical engineering. Desbrun, Papadopoulos and Sukhatme are also affiliated with USC's NSF-funded Integrated Media Systems Center.

Mendel Honored by IEEE

Dr. Jerry Mendel, professor of electrical engineering/ systems, and his two former Ph.D. students, Nilesh Karnik and Qilian Liang, have been awarded the 2002 Institute of Electrical and Electronics Engineers (IEEE) Outstanding Paper Award from the IEEE Neural Networks Society, for the paper "Type-2 Fuzzy Logic Systems."

The paper, which was published in December 1999, is of fundamental importance because it adds a new mathematical dimension to fuzzy logic that will allow many sources of uncertainty to be handled within the fuzzy logic framework.

Mendel has previously received two other best-paper awards, one in geophysical signal processing and one in statistical signal processing.

Golombfest 70

Dr. Solomon Golomb, a USC University Professor who is renowned worldwide for his work in communications theory, recently received a Distinguished Alumnus Award from Johns Hopkins University in Baltimore.

Also, early this summer a 70th birthday celebration was held in Dr. Golomb's honor. Dubbed Golombfest 70, the two-day event included presentation of nearly 20 papers.

Golomb earned a Bachelor's degree from Johns Hopkins in 1951, before earning a Master's and Ph.D. in mathematics from Harvard University.

His theories led to a communications technique that was used to detect a radar signal bounced off Venus, the first successful human contact with another planet. His research has been used in applications ranging from radar to cell phones to cryptography.

He has held joint appointments at USC as professor of electrical engineering and mathematics since 1963, and he was the first USC faculty member elected to the National Academy of Engineering, as well as one of the youngest ever elected to the Academy. He is the holder of the Andrew and Erna Viterbi Chair of Communications in Electrical Engineering.

Aerospace Engineering's SCrewball Flies High

The USC School of Engineering team competed successfully at the AIAA Design/Build/Fly competition held in Wichita, KS. The USC plane, nicknamed SCrewball, placed second in the competition out of a total of 38 planes entered from schools in the US, Canada, Italy, and Turkey. Twenty-eight of the 38 planes passed the technical inspection, and were deemed safe and allowed to fly. Of these, 21 posted scoring flights ranging from .59 points to 132 points. USC's team had a score of 115 points. The USC team scored a 92 out of 100 on the written report (the third-highest score).

The team members shown in the back row of the photo are from left to right: Tim Schoen (ME), Tim Bentley (AE), Nathan Palmer (AE, graduated in December '01), Charles Heintz (AE), Michael Mace (ME), Jake Evert (AE, graduated in December '01), Philippe Kassouf (AE) Stephane Gallet (AE), David Lazarra (AE), George Cano (AE). In the front row are Wyatt Sadler (graduated several years ago, but remains as our pilot), George Sechrist (ISE), Tai Merzel (AE), Jonathan Hartley (AE or ME), Doris Pease (AE), Jerry Chen (AE), and Tyler Golightly (ME). Several other students participated in the project, but were not able to make the trip to Wichita, including Andreas Figueroa, Christina Nichitean, Boris Gee, Brian Wetzel, Billy Kaplan, Stephanie Hunt and Lester Kang.

USC ARCS Scholars

The School honored its ARCS scholars on March 1 with a luncheon and a demonstration of advanced multimedia technologies at the Integrated Media Systems Center (IMSC).

ARCS, or Achievement Rewards for College Scientists, is a nonprofit organization that gives scholarships to outstanding college students majoring in science and engineering. ARCS was founded in 1958 following the launch of Sputnik and was dedicated to reestablishing U.S. technological superiority. The ARCS leaders who raise funds are all volunteers and all women.

Dean C.L. Max Nikias and Christopher Stoy, chief executive officer of the School's external relations, expressed their deep appreciation for this work to approximately a dozen ARCS leaders attending the luncheon. Before the luncheon, the ARCS scholars and leaders toured the IMSC laboratories and saw demonstrations of immersive audio, 3-D face capture, and GlobeAll Vision technologies.

The School's ARCS Scholars assembled at the California Club in November 2001. Back row, left to right: Alok Bachuwar, biomedical engineering; Ali Fakhari, chemical engineering; Matt Behrend, electrical engineering; Marisa Margaretich, environmental engineering; Eric Liu, mechanical engineering; David Silva, electrical engineering; Kris Kubow, biomedical engineering; Jon Mapel, electrical engineering.

Front row, left to right: Jodi Nagata, chemical engineering; Kristin Sahyouni, industrial and systems engineering; Dean C.L. Max Nikias; Meena Singh, biomedical engineering; Melissa Carrasco, computer engineering and computer science.

BOARD OF COUNCILORS GROWS STRONGER

To provide broader reach in the academic, governmental, and corporate arenas, Dean C.L. Max Nikias has made five key additions to the Board of Councilors.

Dr. Alice P. Gast, (BSc, Chemical Engineering 1980), the vice president for research and associate provost at the Massachusetts Institute of Technology. In addition to her administrative positions at MIT, Dr. Gast is MIT's Robert T. Haslam Professor of Chemical Engineering.

Professor Geraldine Knatz, (M.S. Environmental Engineering 1977, Ph.D. Biological Sciences, 1979). Dr. Knatz is the managing director of the Port of Long Beach. She also teaches graduate courses in Ecology and Environmental Compliance in the Department of Civil Engineering.

Thomas O. Gephart, (BSME 1962), founder and Chairman of Ventana Global. Mr. Gephart has led the successful global launch of five U.S. technology private equity funds, and Ventana has 70+ technology portfolio companies that have attracted over $3 billion in equity financing, including direct investments from Ventana's 84 multi-national investor-partners representing 20 countries.

YH Cho, a USC trustee, is chairman and CEO of Korean Air. Mr. Cho is also Chairman and CEO of Hanjin Information Systems and Telecommunications Company, Ltd. Mr. Cho received an MBA from USC in 1979. He has been on the USC Board of Trustees since 1997.

Kenneth R. Klein, COO and board member of Mercury Interactive. Mr. Klein is responsible for Mercury Interactive's worldwide operations, including sales, customer support, professional services, field marketing, and information technologies. He holds Bachelor's degrees in electrical engineering and biomedical engineering from the University of Southern California.

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