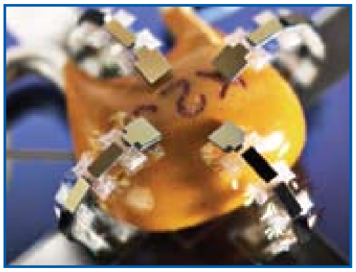
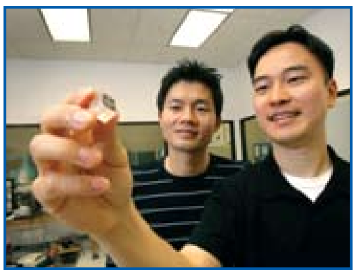
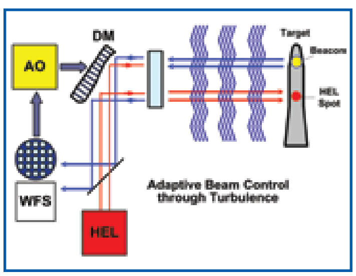
Henry Samueli School of Engineering & Applied Science

# Mechanical & Aerospace Engineering Department

## 2006-2007








## Research Highlights

New Nanomedicine Center

Guided Surgery Tool

Control of Laser Beams

No Slip Overcome by Nanotechnology

Algae and Hydrogen Production

Practical Fusion Energy

World's Smallest Microhand

UCLA

2006-2007
*From the Department Chair*

*Adrienne Lavine*

The process of putting together this annual report has been an opportunity for me to reflect back on the past academic year and see the great accomplishments of our faculty, students, staff, and alumni. I feel fortunate to be among this active and dynamic group that constitutes the UCLA Mechanical and Aerospace Engineering Department. This year we have welcomed a new faculty member into this mix, Christopher Lynch. You can read about him and his work on page 9.

My colleagues are working on a broad range of exciting research topics. In these pages you can read about some: the new Center for Cell Control, an NIH Nanomedicine Development Center; tools for guided surgery; control of laser beams; an ultra-slippery nano-engineered surface; a photobiological system that uses algae to consume carbon dioxide and produce hydrogen; fusion energy developments; and a robotic microhand for biological applications.

You will also see in the awards section that our faculty have won many accolades. Of particular note, assistant professor Jeff Eldredge won the National Science Foundation's CAREER award for his project on Numerical Investigations of Biological and Bio-inspired Locomotion. He joins Laurent Pilon, who received a CAREER award in 2005. Furthermore, as this report went to press, it was announced that assistant professor H. Pirouz Kavehpour had won the prestigious Young Investigator Award from the U.S. Army to support his work on interfacial tension and contact angle of ionic liquids.

In the 2006-07 academic year, our faculty had $25 million available to support research. In terms of research expenditures per faculty member, based on 2005-06 data from the American Society of Engineering Education, our department ranked fifth nationally among mechanical engineering and among aerospace engineering departments (considering the top 20 rated departments in each field based on the US News and World Report rankings of graduate programs).

We welcomed a new "crop" of approximately 100 graduate students this past year, for a total graduate enrollment of around 250. Our graduate students gather from around the world to learn from our renowned faculty and each other, deepening their understanding of mechanical and aerospace engineering and conducting original, cutting-edge research in faculty laboratories. In the 2006-07 academic year, our department granted 24 Ph.D. and 69 M.S. degrees.

We are proud to serve the citizens of California and beyond by providing a world-class education to our undergraduate students, as well. Our undergraduates have excelled in high school and come to us prepared to take advantage of the challenging educational environment we provide. Last year, we awarded 123 B.S. degrees. Congratulations to our newest alumni! You can read about some of the student society projects they undertook on pages 17-19.

Our high-quality staff members make possible our research and educational programs. We are also fortunate to have strong connections with alumni, industrial affiliates and advisory board, and other friends. They provide guidance, crucial financial support, partnerships on technology initiatives, and jobs for our graduates. We appreciate all of these contributions greatly.

I recently had the opportunity to attend an inspiring workshop entitled, "Leading Through Diversity," for department chairs in science, engineering, and mathematics within the southern campuses of the University of California. The keynote speaker was our new chancellor, Gene Block; he spoke with passion about the importance of diversity to university communities and of his commitment to achieving greater diversity on our campus. In the MAE Department, I am very proud to say that more than half of our faculty are involved in programs whose aim is to attract and retain female and traditionally underrepresented minority students in engineering. Two such efforts are described on page 16.

I hope you enjoy this glimpse of UCLA's vibrant Mechanical and Aerospace Engineering Department.

*Microhand cover photo credits: Jeffrey Tseng (microhand detail); Reed Hutchinson (Professor CJ Kim and PhD student Wook Choi).*

## Chih-Ming Ho wins new NIH Nanomedicine Development Center

### *Researchers to Analyze and Control Body's Critical Nanoscale Cellular Molecules to Aid in Curing Disease*

*Chih-Ming Ho*

An interdisciplinary team of scientists from the UCLA Henry Samueli School of Engineering and Applied Science, the David Geffen School of Medicine at UCLA, and UC Berkeley's College of Engineering has been awarded a prestigious federal grant from the National Institutes of Health Roadmap for Medical Research initiative aimed at improving nanomedical research. Their discoveries could facilitate the advances of regenerative medicine, curing diseases like cancer and viral infections at the molecular scale.

This multimillion dollar nanomedicine grant supports the new NIH Nanomedicine Development Center for Cell Control (CCC), led by UCLA Engineering Professor Chih-Ming Ho. The center will apply advanced engineering techniques and life science knowledge to control and investigate how the human body works at the molecular level. "I am delighted to have the opportunity to lead this important multidisciplinary and multi-campus effort. This center boasts a collaborative team with key strengths in both engineering and medicine — a critical combination in nanomedicine," said Ho, who is a member of the National Academy of Engineering and holder of the Ben Rich-Lockheed Martin endowed chair. "By taking the unorthodox approach of directly controlling the molecular circuitries in cells, we hope to make critical changes in the treatment of disease." The center's research will move with a fast pace toward clinical applications. Researchers have developed an efficient search algorithm to determine the optimal drug cocktail to better manage disease development; this approach will be used in animal and clinical tests in the near future.

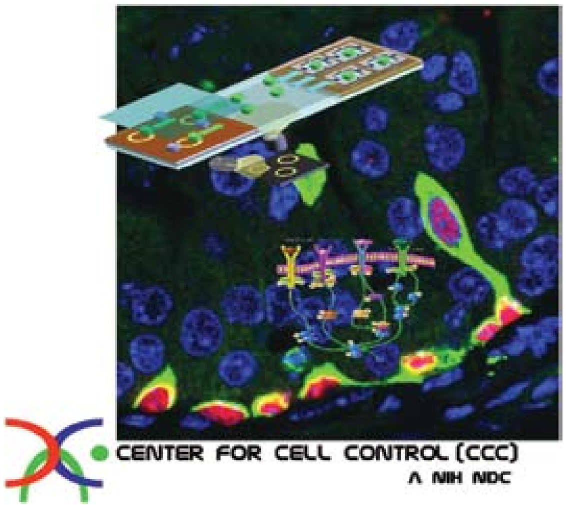
Besides Ho, a specialist in the use of nanotechnology to analyze and control biological complex systems, members of the research team at the David Geffen School of Medicine at UCLA include Hong Wu, MD, PhD, professor of molecular and medical pharmacology and a specialist in stem cells; Michael Teitell, MD, PhD, associate professor of pathology and laboratory medicine, chief of pediatric and developmental pathology and a cancer specialist; and Genhong Cheng, PhD, professor of microbiology, immunology, and molecular genetics and an expert in studying host defense against infectious diseases. From UC Berkeley, members include Ming Wu, professor of electrical engineering and co-director of the Berkeley Sensor and Actuator Center, and Xiang Zhang, Chancellor's Professor in mechanical engineering and Director of the Center for Scalable and Integrated Nano Manufacturing (SINAM). The group of investigators has developed a strong track record of interdisciplinary research collaboration over the past decade. The team will work with other NIH nanomedicine development centers toward world-class advancements in nanomedical research.

"This grant puts UCLA and UC Berkeley among an elite group of universities that are recognized as leaders in nanomedicine research," said UCLA engineering dean Vijay K. Dhir. "We expect this new center will build upon UCLA Engineering's research and education capabilities and further expand collaborative efforts with medicine to achieve exciting advances in nanomedicine."

To learn more, visit the Nanomedicine Development Center for Cell Control at:

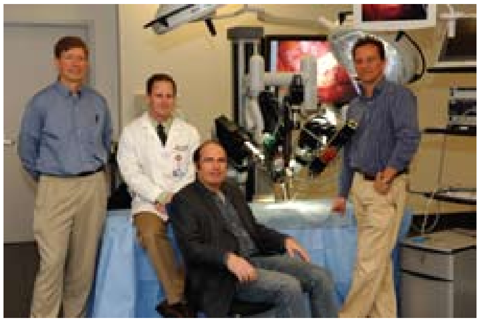
http://CenterForCellControl.org.

-Melissa Abraham



## Greg Carman helps develop guided surgery tool

Researchers at the UCLA Henry Samueli School of Engineering and Applied Science, working with laparoscopic surgeons, have developed a new method of guided surgery that will permit experienced surgeons to guide surgeries in remote locations, such as battlefield hospitals.



*(Left to right) Professor Greg Carman, Dr. Eric Dutson, computer science Professor Petros Faloutsos, and MAE graduate researcher Vasile Nistor.*

"Laparoscopic surgery is a specialized field that requires a lot of practice," noted Greg Carman, professor of mechanical and aerospace engineering. "To develop a way in which the best surgeon in the world can assist with a surgery remotely holds the potential to revolutionize the field."

Laparoscopic surgery is a minimally invasive procedure in which surgeons use a video camera to view the area in which they are working. The two-dimensional field of vision and limited range of movement make it a more difficult type of surgery.

The new telementoring system developed by the UCLA Engineering researchers allows highly trained surgeons to aid battlefield surgeons with laparoscopic procedures using video conferencing tools to provide live guidance.

"Our system replaces robotic surgery tools, which pose challenges associated with power supplies, ease of use, space constraints, and cost," said mechanical engineering graduate student researcher Vasile "Lică" Nistor. "Using this new method, a highly qualified surgeon could provide guidance from a remote location to an on-site generalist at a much lower cost."

Because of the considerable variation from operation to operation, it's critical to have an expert surgeon available who can offer guidance and advice in real time. A modified video conferencing system offers a way to present information to the on-site surgeon in a useful way that does not interrupt the surgery.

"We've found that because laparoscopic surgery is 2-D and not 3-D, it's analogous to playing video games," said computer science graduate student Brian Allen. "We'd like to find a way to use the graphic technologies that enhance video games to enhance the surgical procedure."

The system developed at UCLA also can be used to train residents and new surgeons in laparoscopic surgery.

To create practice simulations for medical residents, the team has developed a program to track the movement of the surgical tools that have been modified with a set of seamlessly integrated motion tracking sensors. The sensors measure rotation, position of the instruments, and other movement. By tracking both the expert and the novice, they can see where someone learning might have difficulties, or need more training during the simulations.

"We have been working closely with UCLA surgeon Dr. Erik Dutson, an expert in laparoscopic surgery," said computer science professor Petros Faloutsos. "By recording his movements, we have an expert benchmark that we can use for training."

*Dr. Eric Dutson and Professor Greg Carman*

The system tracks motion over time, showing both movement and steadiness in the hand that is not in use.

"It's very difficult to not move the off-hand," said Allen, "but critical since a wrong movement can accidentally cause a cut in the surrounding tissue out of sight of the camera, creating a chance of infection."

To counter what is statistically the major cause of failure for this type of surgery, the group has added a kinesthetic force feedback component to the system that will help constrain accidental movement outside areas designated by an expert surgeon. A surgeon would feel resistance if he or she accidentally moved their off-hand into a critical area, for instance, the liver to one side of a gall bladder.

The guided laparoscopic surgery project is funded by the U.S. Army's Telemedicine and Advanced Technologies Research Center. The UCLA Engineering researchers are collaborating with members of UCLA's Center for Advanced Surgical and Interventional Technology (CASIT). The facility includes a da Vinci surgical robotic surgery system, a human patient simulator, and laparoscopic surgical simulators and tools.

– Maryls Amundsen | Images Don Liebig

## Control of laser beams

*http://beamcontrol.seas.ucla.edu*

*Steven Gibson*

UCLA's department of Mechanical and Aerospace Engineering has established a comprehensive research program in high-performance control of laser beams in directed energy systems and laser communications. Professors Gibson and Tsao, along with post-doctoral scholars and graduate students, have developed novel adaptive filtering and control methods for wave front prediction and correction and precise pointing of laser beams. These methods are needed to compensate for the effects of atmospheric turbulence, platform vibration, target motion, and sensor noise, all of which degrade the performance of laser weapons and free-space optical communications systems. Other areas where precise control of laser beams is important include laser etching in manufacturing and laser surgery. The new beam control methods correct both higher order wave front errors and tilt jitter to levels not achievable by classical methods for adaptive optics and beam steering.

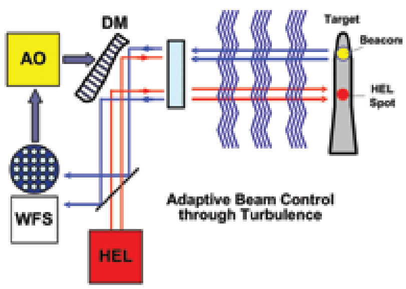
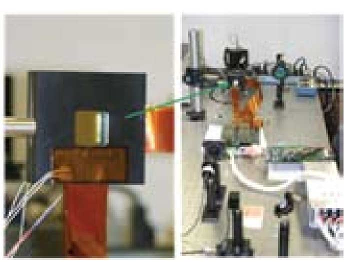



*Diagram of a directed energy system with high energy laser (HEL). Key components: adaptive optics algorithm (AO), deformable mirror (DM), wave front sensor (WFS).*

UCLA's contributions to control of laser beams fall into two main categories: adaptive control and filtering for correction of higher-order wave front errors, and adaptive control of tilt jitter. The two problem categories are closely related and are both present in adaptive optics systems. Adaptive control of higher-order wave front errors usually involves control loops with many, often hundreds, of channels corresponding to spatially distributed wave front sensor measurements and deformable mirror actuators; adaptive control of tilt jitter involves two control channels and two or more sensor signals, but usually much higher temporal orders of the adaptive filter.



*Left: Teledyne's prototype liquid crystal device. Right: UCLA beam control experiment with the liquid crystal device used as the control actuator. Control sample and hold rate = 3125 Hz.*

*Tsu-Chin Tsao*

High-fidelity wave optics simulations of directed energy systems have shown significant performance improvements with the new adaptive control scheme. These simulations have been performed not only by UCLA but by MZA Associates of Albuquerque, NM, a leading defense contractor for modeling of high energy laser systems. Also, recent laboratory experiments on adaptive optics at the Starfire Optical Range at the Air Force Research Laboratory, Kirtland Air Force Base, have demonstrated enhanced performance produced by UCLA's new adaptive control schemes.

UCLA's beam control research has enjoyed substantial extramural funding. For the past five years, UCLA has been the lead institution (Professor Steve Gibson, PI, and Professor T.C. Tsao, Co-PI) on a recent Multidisciplinary Research Project (MRI) titled "Atmospheric Propagation of High Energy Lasers: Modeling, Simulation, Tracking, and Control" with research partners Georgia Tech, Michigan Tech, MZA Associates Corp., Tempest Technologies and Trex Enterprises. Also, UCLA is the lead institution (Professor Steve Gibson, PI, and Professor T.C. Tsao, Co-PI) on a new MRI titled "Tactical HEL Weapon Alignment System Architecture Efficiencies" with research partners MZA Associates Corp., Air Force Institute of Technology and Naval Post Graduate School.

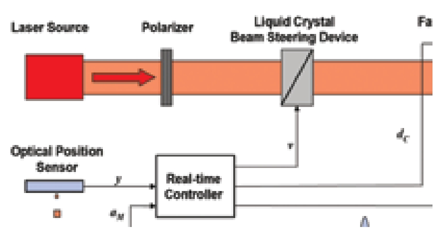
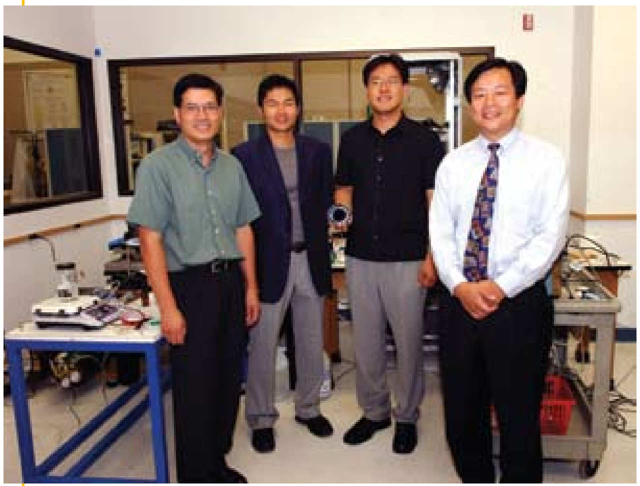



*Diagram of UCLA beam control experiment with Teledyne's liquid crystal beam steering device.*

An essential feature of UCLA's research in beam control is collaboration with the aerospace industry and the Air Force research laboratory. A prime example is UCLA's collaboration with Teledyne Scientific Co. of Thousand Oaks, CA, to apply feedback and adaptive feedforward control to Teledyne's new liquid crystal beam steering devices. Compared to standard mirrors used for beam control, the liquid crystal devices have the advantages of low power consumption and no moving parts.

## Researchers discover no-slip condition can be overcome by nanotechnology

*New Surface Benefits Microfluidic Applications and Cell Studies*



*Professor Ben Wu, Professor CJ Kim, Chang-Hwan Choi, and Professor James Dunn*

UCLA engineers working on the development of a new ultra-slippery nano-engineered surface have challenged a long-held concept in fluid dynamics-the no-slip condition. Mechanical and aerospace engineering professor CJ Kim and graduate student Chang-Hwan Choi have proven that their nano-architectured surface in effect defeats the fundamental notion of no-slip by a considerable margin, even in practical flow conditions.

The no-slip condition states that fluids stick to surfaces past which they flow, and there is no movement where a fluid touches the surface of a solid. Most challenges to this condition thus far have come from scientific interests because the amount of measurable slip has been too small to be useful. The advent of micro and nano technologies, however, has refocused attention on slip flows and the need to measure slip accurately because microfluidic applications can be affected by even a relatively small slip.

Since the amount of drag reduction caused by the internal slip surface of a pipe is determined by pipe size and flow conditions as well as the surface itself, a rather complex scientific value called slip length should be used to objectively describe the slip as a pure surface property, according to Kim.

Until recently, most of the reported slip lengths were less than one micrometer and prone to measurement errors. Kim and Choi expected to measure tens of micrometers of slip length on their new surface, and so considered a slip of less than one micrometer as no slip. "We started with the no-slip assumption on a flat surface in testing our slip length," said Choi, "and in most instances it remains true."

Consider, for instance, water droplets moving along a glass surface and along a Teflon surface. Compared to the relatively sticky (i.e., hydrophilic) glass surface, water beads and moves more easily on non-stick (i.e., hydrophobic) surface, such as Teflon. Droplets, which move mostly by a rolling motion, are unaffected by surface slip, although they move more easily along a more hydrophobic surface.

The primary question, however, is the movement of liquid in continuous flows, where it must slip on a surface to flow more easily. To determine if surface wettability would make a difference to continuous flow in microchannels, Choi measured the slip length on a planar hydrophobic surface while at Brown University, and found it to be about 20-30 nanometers, or thousands of times smaller than the width of a human hair.

The nano-engineered material Kim and Choi have created at UCLA has a dense forest of sharply tipped nanoposts, which greatly limits contact between a liquid and the surface of the solid. The height of the posts, their shape, and the large number in a small space combine to create a thick layer of air beneath the liquid and to keep it from filling the gaps between the posts

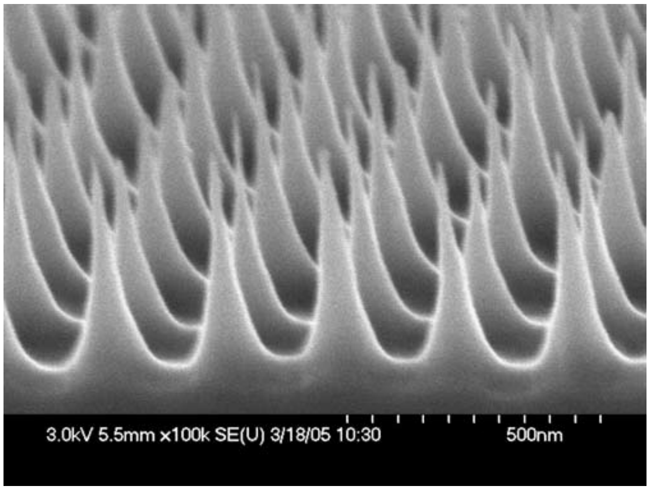
"We're using surface tension to keep the liquid out of the gaps, and in most practical flow conditions (e.g., pressurized flows) those gaps need to be very, very small," explained Kim. "So we've created a surface with a high density of sharp-tipped posts - submicron density - and then treated them to be hydrophobic."

At the suggestion of their colleague, UCLA mechanical and aerospace engineering professor Pirouz Kavehpour, Choi used a rheometer-a commercial tool used to measure viscosity-to track slip length along their surfaces. Although reliable and accurate, the rheometer lacks the precision to measure conventional miniscule slip lengths. But it may work for the very large slip Kim and Choi have on the nano-architectured surface.

"The rheometer gave us repeatable results, very quickly," said Kim. "And it showed that the nano-engineered surface had a 20-30 micrometer slip length, a thousand times larger than on a conventional hydrophobic surface. We were expecting the results in this range based on our analysis and others', but were still surprised and very pleased to see it validated in testing."

When the UCLA Henry Samueli School of Engineering and Applied Science researchers published their results in Physical Review Letters earlier this year, they received considerable response from the physics community.

"Fluid dynamics is a classical field, and while our results do not change a long-held belief about the behavior of moving liquids where they touch solids, we have worked around the assumption by creating a surface with a minimal liquid-solid contact," noted Kim. "The slip length along the new surface is far more than what was previously assumed possible for flows under pressure. This degree of slip is now large enough to be useful for engineering applications and not just limited to the microscale."




In addition to developing a low-friction surface for use in fluidic applications such as underwater vehicles and tools for DNA analysis and real-time, on-site testing and monitoring for early detection of hazardous materials, UCLA researchers are exploring new uses for the innovative surface.

Kim and Choi are working with bioengineering professors Ben Wu and James Dunn on the fabrication of new surfaces for cell growth.

"We know cells grow well under certain conditions, but at the nanoscale most of the changes to date have been in the chemical conditions; little attention has been paid to the physical conditions," said Kim. "We're approaching it from a new direction and fabricating different surfaces. We're able to make the surface as elaborate as needed, which is basically a new capability at the nanoscale."

In addition to addressing basic scientific questions about the physical manipulation of cell growth at the nanoscale, Dunn and Wu hope to use the process for advances in medicine.

"There are many potential applications for this work," explained Dunn, "one is tissue engineering. If we're able to change the cells' orientation using the nano-textured surface, we can make the cells line up in a particular way to form the shape and structure of the tissues that we need."

Added Wu, "We are currently investigating the molecular basis of the cells' interactions on different nanostructures. If we are successful, we can use this knowledge to control the surfaces to regulate cell behavior. Our research in this area is really just the tip of the iceberg."

To create the well-regulated nano-engineered surfaces, Kim and Choi use interference lithography to etch the pattern on a silicon substrate, followed by deep reactive ion etching. To make sharp tips on the posts, they heat the silicon, creating silicon oxide, which is then removed.

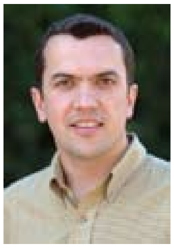
The current method of manufacturing is practical for small area applications, but the UCLA researchers are exploring polymer as an alternative material to decrease costs for large volume area applications, as on the surface of a torpedo. They also are exploring applications for the silicon material in field emission displays and tips for atomic force microscopes.

For more information on research in Kim's lab, please visit http://cjmems.seas.ucla.edu/.

- Marlys Amundson

Photos: Don Liebig, UCLA Photography

## Algae and sunlight for carbon capture and hydrogen production



*Laurent Pilon*

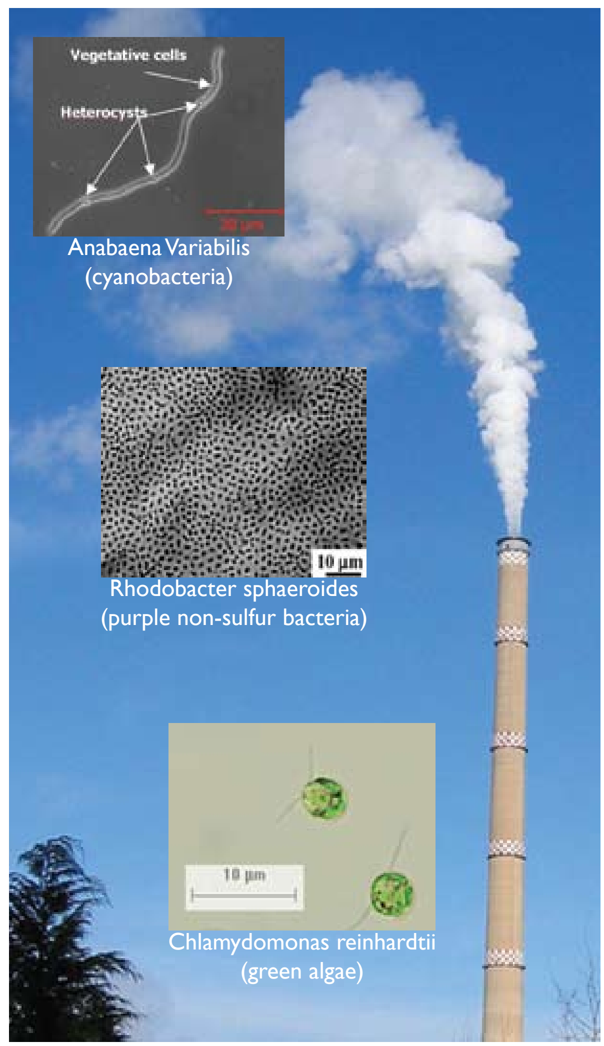
Fossil fuels are finite resources that currently supply more than 98% of the world's energy needs. Their combustion results in significant carbon dioxide emissions blamed for global warming and climate change. The world is currently facing an unprecedented combination of economic, political, and environmental challenges as it tries to meet expanding energy needs without further impacting climate and the environment. The solution lies in greater reliance on a combination of fossil fuel-free energy sources and on new technologies for capturing and converting carbon dioxide.

Fuel cell technology is one of the most promising environmentally friendly and energy efficient conversion systems. Fuel cells are being developed for use in transportation and power generation systems. In particular, hydrogen powered proton exchange membrane fuel cells do not produce carbon dioxide. In fact, they convert hydrogen and oxygen into electricity and water. However, 96% of the hydrogen currently produced is from fossil fuels. Thus, to ensure the long term sustainability of the future hydrogen economy, renewable resources must be employed for hydrogen production instead of fossil fuels.

In this framework, Prof. Laurent Pilon and his students are working on a photobiological system using algae to both consume carbon dioxide and produce hydrogen.

Algae are the fastest-growing plants in the world. To grow rapidly, they consume carbon dioxide and harness sunlight through photosynthesis. The generated biomass can then be used to produce liquid fuels (ethanol, butanol, biodiesel) or gas fuel such as methane. Some algae can even produce hydrogen by further harnessing sunlight in the absence of oxygen.

Prof. Pilon and his team study ways to improve the energy efficiency of various algae in converting sunlight into biomass and hydrogen. Their objective is to make the technology reliable and economically viable in order to address some of the world's most challenging problems in a sustainable manner. More specifically, they investigate how sunlight is absorbed and scattered by various $CO_2$ consuming and $H_2$ producing microorganisms. Prof. Pilon and his PhD student Halil Berberoglu were the first to assess the effect of genetic engineering on the optical properties of the green algae Chlamydomonas reinhardtii genetically "designed" with different pigment concentrations by Prof. Anastasio Melis' team at UC Berkeley. Genetic engineering offers the prospect of bottom-up design of microorganisms with the desired properties and performances. Other research projects include the development of better light delivery solutions in photobioreactors and improved growth medium compositions. One of Pilon's goals is to build an engineering prototype to consume the carbon dioxide emitted by the UCLA co-generation power plant. This interdisciplinary effort is performed in collaboration with Prof. Jennifer Jay from the UCLA Civil and Environment Engineering Department and with Prof. Anastasio Melis from UC Berkeley, Plant and Microbial Biology Department.

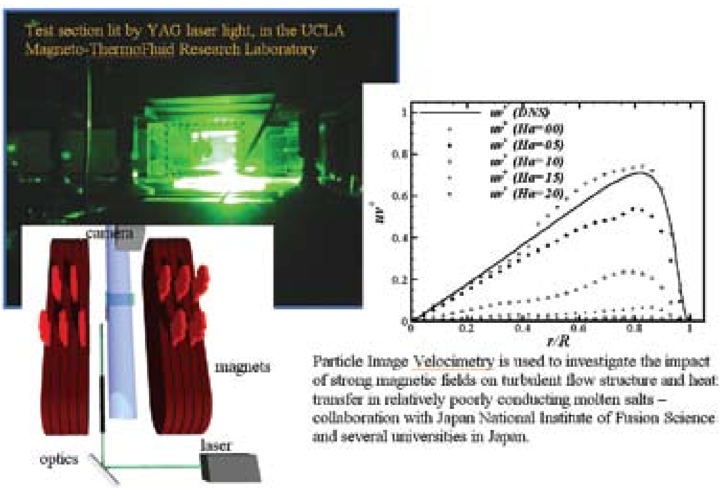



*Smokestack photo by Sworm from flickr.com Creative Commons.*

## Research toward practical utilization of fusion energy

*Mohamed Abdou*

Fusion, where light nuclei fuse together and give off extraordinary amounts of energy, is the process that drives the stars and has the potential to provide essentially limitless amounts of energy here on earth. The pursuit of fusion energy is itself an extraordinary scientific challenge that has been the dream and work of physicists and engineers around the world for decades, including some here at UCLA. Mechanical and Aerospace Engineering Professor Mohamed Abdou, and the Fusion Science and Technology Center in the UCLA Henry Samueli School of Engineering and Applied Science, have been leading the quest in the US to unlock the complicated phenomena occurring in the plasma chamber components that surround the burning plasma where fusion occurs. Many research projects, including experimental research, development of sophisticated physical models and simulations codes, and advanced design with unique materials, are currently being pursued – a few of which are described below.

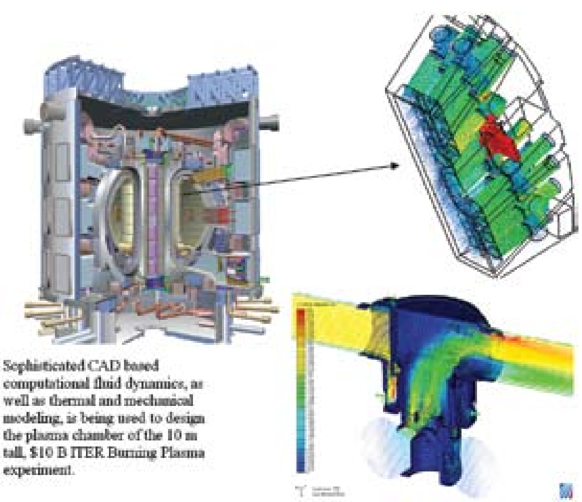



Particle Image Velocimetry is used to investigate the impact of strong magnetic fields on turbulent flow structure and heat transfer in relatively poorly conducting molten salts – collaboration with Japan National Institute of Fusion Science and several universities in Japan.

The fundamental fluid mechanical behavior of electrically-conducting liquids interacting with strong magnetic fields is a key area of research. Fusion blanket systems must contain lithium in order to "breed" tritium – one of the essential fuels to keep the fusion fire burning. This lithium can be introduced into the blanket as a coolant in the form of a liquid metal or a molten salt. But the same strong magnetic fields that are used to control and confine the fusion plasma also interact with the moving liquid metals, triggering magnetohydrodynamic (MHD) phenomena. These MHD effects can exceed viscous and inertial forces by 5 or more orders of magnitude – dominating the flow behavior and stability, and therefore controlling the ultimate operating temperature, pressure, stress fields, and transport properties in the plasma chamber. Hence, developing an understanding of liquid metal non-linear MHD phenomena in the presence of spatially varying nuclear and electromagnetic fields is important to developing innovative methods to control the flow of induced electric currents and their resultant forces.

*Neil Morley*

Professor Abdou and his researchers are also engaged in analyzing and designing nuclear components for the new International Thermonuclear Experimental Reactor, or ITER, plasma device whose mission is to demonstrate and study the fundamental questions of plasma physics and technology for fusion energy development. This experimental reactor will be built in France by a consortium of 7 parties. UCLA Fusion Science and Technology researchers are providing thermofluid analysis and design support for the base plasma chamber systems (in collaboration with Oak Ridge and Sandia National Laboratories). UCLA is also leading the US effort to develop Test Module experiments to deploy in ITER, where full plasma chamber functions including tritium breeding will be explored and studied in a true multi-field fusion environment.



Sophisticated CAD based computational fluid dynamics, as well as thermal and mechanical modeling, is being used to design the plasma chamber of the 10 m tall, $10 B ITER Burning Plasma experiment.

# CJ Kim creates the world's smallest robotic microhand for biological applications

*Chang-Jin Kim*

The four tiny "fingers" gently open and close, like a Venus flytrap collapsing around its prey. The "bones" are shiny pieces of silicon; the "muscles," polymer balloons connected by narrow channels through which air is pumped in or out, allowing researchers to control the diminutive fist, only one millimeter wide, by regulating the air pressure. This "microhand" is a deft manipulator of tiny objects and one day may be an invaluable tool in microsurgery.

For now, though, the dexterity of the microhand, the brainchild of Chang-Jin (CJ) Kim, professor of mechanical and aerospace engineering at the Henry Samueli School of Engineering and Applied Science, has been demonstrated on — of all things — sushi.

The tiny roe of smelt mimic other objects in biological environments, and the microhand has proven very adept at delicately capturing and removing a single egg from the rest of the gooey pack. "When you work in microscale, stickiness is an issue," Kim says. "And you're dealing with a liquid environment that is very viscous, like honey. Our hand is able to grab a soft and delicate object and mold itself around it. Yet it's very strong."

Kim laughs when he recalls the origins of his research. "When I started grad school, MEMS (micro-electro-mechanical systems) was a new field," he says. "I wanted a micro-robot that could do everything a human could do if the human were miniaturized," Kim recalls. Yet he soon realized that "the technology just wasn't available. So the goal got smaller and smaller — from a micro-robot, to a microhand, to a pair of micro-tweezers."

When he joined UCLA in 1993, Kim maintained his "hobby" project. As MEMS science matured, however, Kim enlisted the help of Ph.D. student Yen-Wen Lu — now an assistant professor at Rutgers University — to build the current generation of hands.

The project attracted the attention of R&D company Intelligent Optical Systems, Inc. (IOS), in Torrance, Calif., and government funding has followed. Kim's current Ph.D. student, Wook Choi, is working on a larger hand that will accommodate applications IOS has developed, such as removing foreign objects from a child's throat.

"Dreaming is not enough," Kim says. "You have to put money into it. We're using taxpayers' money, so we can't just do it for fun. But this has been a lot of fun. I feel guilty!"

-- Wendy Soderburg, UCLA Magazine

The microhand was covered by news media and was selected as the coverpage of the journal Applied Physics Letters (*Applied Physics Letters* 89, 164101, 16 October 2006).

News Coverage:

* Newsweek, *The Tiny Fingers*.
* MIT Technology Review, *A Tiny Robotic Hand*.
* Forbes.com, In Pictures, *13 Amazing New Nanotechnologies*.
* SciFiTech, *Tiny Robot Hand to Make Subtle Surgery Easier*.
* Nature (UK), *Tiny Hand With Tight Grip*.
* Yahoo! News, *Microscopic Robot Lends Helping Hand*.
* Fox News, *Microscopic Robot Hand Could Have Wide Application*.
* Livescience.com, *Tiny Helping Hand*.
* Crunch Gear, RIYL: *Tiny Robotic Science Stuff*.
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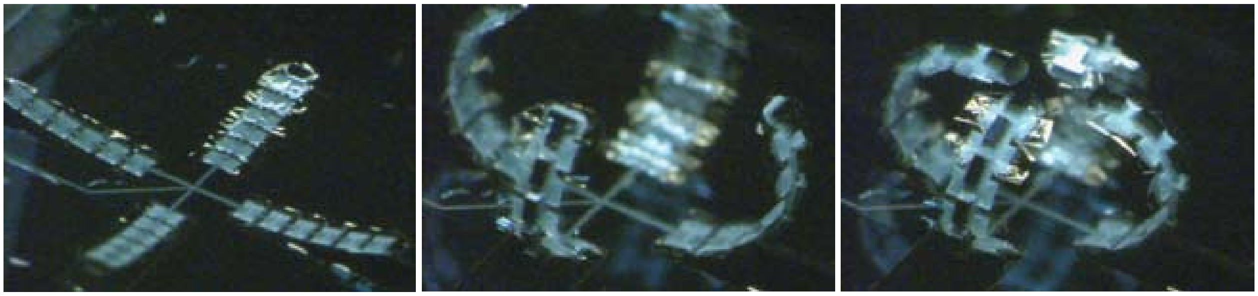
* Physics News Update, *A Superhydrophobic Surface*.

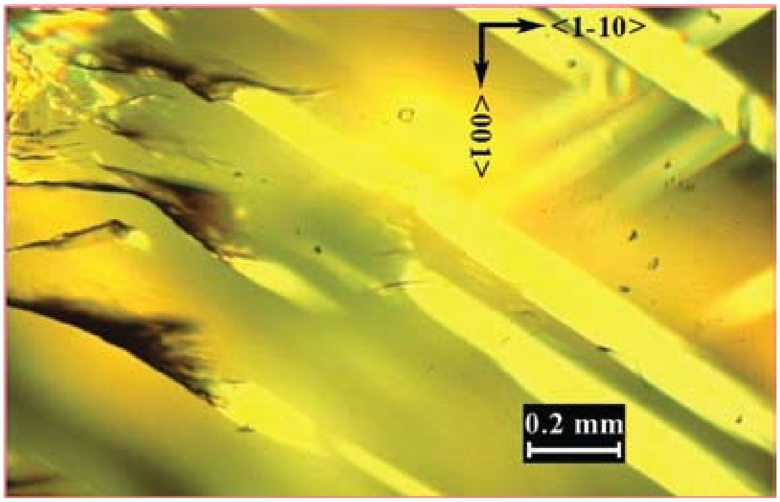


## Meet Christopher Lynch

*Christopher Lynch*

Professor Lynch served on the faculty of the Woodruff School of Mechanical Engineering from September, 1995 through September 2007 at which point he joined the faculty of the University of California, Los Angeles as a professor of Mechanical and Aerospace Engineering. As an assistant professor in the Woodruff School he spent nine months at Georgia Tech Lorraine where he developed research collaborations with French and German colleagues that continue to be productive. He was promoted to Associate Professor in 2000 and accepted the responsibilities as associate chair of administration of the Woodruff School in 2002. His accomplishments include the development of a new international conference, serving as chair of the American Society of Mechanical Engineers Technical Committee on Adaptive Structures and Materials Systems, and being honored with the receipt of an NSF CAREER award, an ONR Young Investigator award, an ASEE educator award, as a Fellow of ASME, and being nominated by his students and subsequently awarded the "Faculty Award for Excellence in Teaching," one of two such awards given annually at Georgia Tech.

Professor Lynch's research has branched into several areas related to ferroelectric materials including field coupled fracture mechanics, micro-electro-mechanics, and ferroelectric device development. Ferroelectric oxides, like muscle, change shape when a voltage is applied. A key difference between muscle and a ferroelectric oxide is the stiffness. Muscle undergoes large shape changes but produces only a small force. Ferroelectric oxides produce small shape changes but very large forces. Ferroelectric oxide materials were initially developed for use in sonar systems (barium titanate and later lead zirconate titanate). In recent years applications have grown to include medical ultrasound, active vibration control, nano-positioning devices, ultrasonic motors, unimorphs and bimorphs, lithotripters (for non-invasively breaking up kidney stones), fuel injectors, ultrasonic scalpels, and many others. Over the past decade or so the development of adaptive structures applications has resulted in a strong push to produce significantly higher strain output from these materials while simultaneously reducing cost. High drive fields can lead to field induced cracking. An example of electric field induced microcracks interacting with domains in a single crystal of PMN-PT is shown below. Actuators are typically constructed from stacked parallel plate capacitors (stacked flat plates with metal electrodes). Drive voltages are proportional to layer thickness. The push toward low cost manufacturing has led to the adoption of co-firing the electrodes with the stacks as is done in the manufacturing of low cost ceramic multilayer capacitors. This approach results in an inhomogeneity of the electric field around the edge of the internal electrode. In a capacitor this does not matter much, but in a ferroelectric there is a strain that is proportional to the electric field. This has led to the need for the development of electric field coupled fracture mechanics (experimental, analytical, and computational). Implementation of the analytical and computational fracture mechanics concepts has required a detailed model of the multiaxial non-linear and hysteretic constitutive behavior. This had to first be measured for a number of compositions and then modeled in a manner suitable for implementation in a finite element code. Professor Lynch's current research program continues to focus on constitutive law development and finite element implementation in support of numerous sensing and actuation applications.



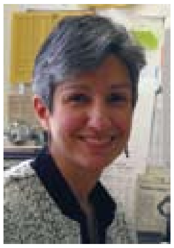

*Interaction of microcracks with domains in a single crystal of PMN-PT.*

## Northrop Grumman check presented to Greg Carman

*(l to r) Donny Wang, Northrop Grumman; Allen Lockyer, Northrop Grumman; Mechanical and Aerospace Engineering Professor Gregory Carman; Associate Dean, Research and Physical Resources, Gregory J. Pottie; Mechanical and Aerospace Engineering Chair Adrienne Lavine.*

Prof. Greg Carman accepted a check in support of his research from Northrop Grumman's Allen Lockyer. The funds will support the development of a compact mechanical energy harvesting system that converts mechanical energy into electrical energy for powering wireless sensor networks. The purpose of the system is to augment battery power so that the batteries do not require replacement over the life of the sensor network. The system is fabricated using MEMS technology and utilizes the unique properties of piezoelectric materials. The anticipated power output from the device is on the order of mW. The approach developed at UCLA has been submitted as a patent through the UCLA Office of Intellectual Property.

## Ann Karagozian gives invited talks on aerospace engineering



*Ann Karagozian*

Mechanical and aerospace engineering professor Ann Karagozian gave the Minta Martin Distinguished Lecture at the Department of Aerospace Engineering at the University of Maryland in March. In April, Karagozian gave a talk as part of the 125th Anniversary Distinguished Lecture Series at the Department of Mechanical Engineering at Ohio State University.

Prof. Karagozian was also one of nine invited alumni speakers for the Caltech Mechanical Engineering Centennial Celebration. Karagozian talked about "Fundamental Research and the Future of Energy and Propulsion Systems." She also recently gave the I.T. Distinguished Seminar in the Department of Aerospace Engineering at the University of Minnesota, and an invited lecture in the Pratt & Whitney/Rocketdyne Knowledge Management Distinguished Seminar Series.

On September 13, 2006, Professor Ann Karagozian testified on behalf of UCLA's aerospace engineering programs and outreach at a hearing held by the California State Assembly's Select Committee on Aerospace. Her presentation, entitled "UCLA's Contributions to California's Aerospace Workforce for the 21st Century", was given at the invitation of the committee chair, Assemblyman Ted Lieu (53rd District, El Segundo).

## KAIST-UCLA MAE Joint Workshop

The 4th Annual KAIST-UCLA MAE Joint Workshop was held on Feb. 21st – 23rd, 2007 in UCLA's MAE Department. This year the workshop was entirely student-run and organized and consisted solely of student presentations. Participating in the workshop were 24 student speakers and 3 faculty from KAIST and 17 student speakers and 11 faculty from UCLA. This ongoing series of workshops has been aimed at developing collaborations between the two universities and the exchange of information and experimental techniques to allow both universities to better develop their respective programs. Because of this year's format, more interaction between students was encouraged which will hopefully increase the transfer of technology even more. For many of the students from KAIST, this was also an opportunity to visit the US for the first time. The presentations and discussion sessions covered a variety of research areas such as: Heating & Fluidic Systems, Composite Enhancements and Fabrication, FEA/Structural Analysis, Systems & Controls, Micro-Devices, and Nano-Materials.

## Rajit Gadh interviewed by ZD-Net's Editor-in-Chief; also quoted on "Wireless Wonder Chip"

Rajit Gadh

Rajit Gadh, Professor of Mechanical and Aerospace Engineering at UCLA, Director of WINMEC (Wireless Internet for the Mobile Enterprise Consortium) and an expert in RFID, provided a succinct overview of what is going on with RFID, in a five-minute interview, conducted with him by ZD-Net's Editor-in-Chief Dan Farber. The video can be found at zdnet.com.

Professor Gadh was also quoted on RFID in the July 20, 2006 issue of MIT's *Technology Review*:

"It's hard to predict a killer app until it's released in the marketplace," says Gadh. But he's encouraged by the capabilities of the HP chip and expects that one of its most exciting applications will be for storing and sharing digital media. "I think this is a very positive development for the field of RFID," he says, "with the possibility of creating new markets, such as media streaming content over passive RFID."

## Abdou and Morley establish TITAN, a new 6-year collaborative program

Mohamed Abdou

Professors Mohamed Abdou and Neil Morley of the MAE Department have established a new 6-year collaborative program between UCLA Fusion Science and Technology Center, and the Japanese National Institute of Fusion Science. This new collaboration, called TITAN, comes with $1.2M of new funding to do in-depth experiments on the magnetohydrodynamic flow control and thermofluid behavior of liquid metals in fusion-relevant geometries and flow parameter ranges. These experiments will be performed in the Fusion Center's Magneto-Thermofluid Omnibus Research (MTOR) Laboratory on the first floor of Engineering-IV, which was identified by the Japanese as a unique US facility. Collaborative teams of professors, researchers, and graduate students from both the UCLA Fusion Center and Japanese Universities will participate in the performance and interpretation of this work.

Neil Morley

# In Memoriam

### Dr. Joseph Miller

*(1937-2007)*

Joseph Miller, an adjunct professor in the Mechanical and Aerospace Engineering Department, and a former vice president and general manager at TRW Applied Technology Group, died on July 5 in a bicycling accident. He was 70.

Miller was a triple graduate of UCLA Engineering, earning bachelor's, masters and PhD degrees ('57, '58 and '62). He had a distinguished career in spaceflight engineering, in high-energy laser research and as an executive at TRW. He returned to the School in 1997 where he taught an undergraduate course on engineering design.

In the 1960s, Miller was the chief development engineer for the Lunar Module Descent Engine. This powered the Apollo Lunar Excursion Modules as they descended to deliver the first humans to the Moon's surface. From 1971 to 1980, Miller served as the chief engineer and program director for TRW's high-energy laser projects. He would later become vice president and general manager for TRW's Applied Technology Group. In 1991, Miller was elected to the National Academy of Engineering, the highest professional honor for an American engineer, for his contributions to advanced high-power lasers and optical systems.

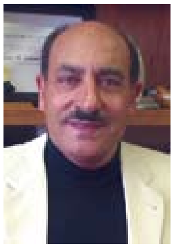
After he retired from TRW, Miller joined UCLA in 1997 as an adjunct professor, teaching a course he designed titled, "The Art of Engineering Endeavors." In this class, Miller covered the essence of engineering design, along with the moral, ethical and environmental aspects of engineering design and management. He also emphasized that great engineering accomplishments were the direct results of great collaboration. He taught the course twice a year until his death.

**Mohamed Abdou** was the Invited Keynote Speaker at TOFE-17, in Albuquerque, NM. He was an invited Fusion Nuclear Technology lecturer at the Institute of Plasma Research in Ahmedabad, India. He was also the Invited Keynote Speaker at the 13th International Conference on Emerging Nuclear Energy Systems (ICENES).

**Pei-Yu Chiou** was invited to participate in the National Academy of Engineering's 2007 U.S. Frontiers of Engineering Symposium.

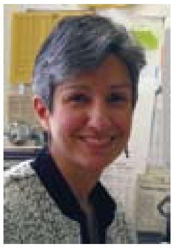
**Jeff Eldredge** received the National Science Foundation's CAREER Award for his project "Numerical Investigations of Biological and Bio-inspired Locomotion." It is a five year award with $419,043 in funding. Some excerpts from the project summary: The program will address a need for a high-fidelity, computationally efficient tool for simulating flows produced by bodies with moving, deforming surfaces. This tool will be applicable to a wide range of fluid dynamical problems of biological and technological interest, but focus in this program period will be devoted to studying the role of flexibility in biomorphic locomotion in fluids.

**Oddvar Bendiksen** was the World-Class Visiting Researcher at the Air Force Research Laboratory, Wright-Patterson Air Force Base, Dayton, OH, August and September, 2006.



**Nasr Ghoniem** was elected a Fellow of the American Society of Mechanical Engineers, with the following citation: "Professor Ghoniem is an educator, inventor, and R&D leader. After his Ph.D. from UW, he joined UCLA, where he is a University of California Distinguished Professor. During the first 15 years of his career, he invented a low-activation class of steels that is recognized as a breakthrough for structural applications in fission and fusion energy systems. He became one of the world leaders in R&D of radiation-resistant materials for energy and space applications. In the next 15 years, he established himself at the forefront of computational mechanics and multiscale modeling of materials, where he developed groundbreaking models of plasticity."

**Jiun-Shyan "J.S." Chen** , (joint Civil and Environmental Engineering and Mechanical and Aerospace Engineering Professor) was elected a Fellow of the International Association for Computational Mechanics (IACM). The Fellows of the IACM are elected worldwide biannually. Chen was elected along with eight other researchers from around the world. He has also been invited to serve as the Editor-in-Chief of a new Journal "Interaction and Multiscale Mechanics: an International Journal (IMMIJ)."



**Ann Karagozian** presented: the Pratt & Whitney/Rocketdyne Knowledge Management Distinguished Seminar; the I.T. Distinguished Seminar at the Department of Aerospace Engineering, University of Minnesota; the Minta Martin Distinguished Lecture at the Department of Aerospace Engineering, University of Maryland; the Special Invited Alumni Lecture at the Caltech Mechanical Engineering Centennial; and the 125th Anniversary Distinguished Lecture at the Department of Mechanical Engineering, Ohio State University.

**Pirouz Kavehpour** won the prestigious Gallery of Fluid Motion Exhibit at the annual meeting of the American Physical Society, Division of Fluid Dynamics in Tampa, Florida. The exhibit features award-winning photographs and videos illustrating both experimental and numerical investigations of a wide variety of flow phenomena. Judged by a panel of distinguished international referees, winning entries were selected based upon criteria of scientific merit, originality, and artistry/aesthetic appeal.

**Chang-Jin Kim** received the Guest Professor of Peking University Award from the President of Peking University, China for the period of Nov. 2005 and Nov. 2007. The award ceremony was in Dec. 2006.

**Bill Klug** received the 2006-2007 Susan and Henry Samueli MAE Teaching Award. from his colleagues in the MAE Dept. In addition, his recent paper "Failure of Viral Shells," which appeared in Physical Review Letters last December, was featured in the "News & Views" section of Nature Physics, in the article "Biophysics: Pushed to the limit."

**Daniel Yang** was elected a Fellow of the American Society of Mechanical Engineers, with the following citation: "Professor Daniel Yang has made significant contributions to the advances of manufacturing automation and mechanical design. His most outstanding accomplishments in research include the establishments of relationships between product freeform geometry and multi-axis machine tools; the development of parameter/time conversion for CNC tracking of parametric curves; the invention of a deviation function method for the design of new kinematic pairs; and the investigation on robot kinematics in workspace and dexterity."

**Webb Marner**, adjunct professor in MAE, received the Professional Development Award for Non-Senate Faculty to attend the 2007 ASME International Design Engineering Technical Conference.

**David Okrent**, professor emeritus of MAE, received the George C. Laurence Pioneering Award for Nuclear Safety. This is in recognition of his life-long career of major contributions in the areas of, among others, nuclear power plant safety, societal risks, and intergenerational equity pertaining to energy systems.

**Theodore Shugar**, lecturer in MAE, received the Professional Development Award for Non-Senate Faculty members from the Office of the Chancellor, Faculty Diversity, during AY2006-2007. The award offers funding to assist with professional development projects such as curriculum development, books, software, or other items. Dr. Shugar's proposal was entitled "Finite element teaching materials for use with commercial software."

# National Academy of Engineering Members

## Vijay Dhir

Vijay K. Dhir, Dean of the UCLA Henry Samueli School of Engineering and Applied Science and professor of mechanical and aerospace engineering, was elected into the National Academy of Engineering (NAE) in 2006. Honored for his work on boiling heat transfer and nuclear reactor thermal hydraulics and safety, Dhir joins five other UCLA mechanical and aerospace engineering faculty who are NAE members. Dhir has been a faculty member at UCLA since 1974, and leads the Boiling Heat Transfer Lab, which conducts pioneering work in fundamental and applied research in phase change heat transfer. A central concern of Dhir's program has been to understand boiling – one of the most complex processes providing an efficient means of cooling. In 2004, Dhir was named the recipient of the prestigious Max Jakob Memorial Award. Bestowed annually to recognize eminent achievement and distinguished service in the area of heat transfer, the award was established by the American Society of Mechanical Engineers and the American Society of Chemical Engineers to honor Max Jakob, a pioneer in the science of heat transfer.

## Chih-Ming Ho

Professor Chih-Ming Ho, director of the Center for Cell Control and director of the Institute for Cell Mimetic Space Exploration, was elected in 1997 for his contributions to the understanding and control of turbulent flows. He joined UCLA to lead research in microelectromechanical system (MEMS) in 1991, and served as the founding director of the Center for Micro Systems. UCLA's MEMS program has been recognized as one of the top three programs worldwide.

## Jason Speyer

Professor Speyer was elected to the National Academy of Engineering in 2005 for "the development and application of advanced techniques for optimal navigation and control of a wide range of aerospace vehicles." He has pioneered new optimal deterministic and stochastic control, team and differential game strategies, estimation, and model-based fault detection.

## Affiliated Professors

### Kuo-Nan Liou

Professor Kuo-Nan Liou, who holds a joint appointment in mechanical and aerospace engineering, was elected in 1999 for contributions in the theories of radiation transfer and light scattering, with applications to remote sensing technology and climate modeling.

### Joseph Miller (1937-2007)

Adjunct Professor Joseph Miller was elected to the NAE in 1991 in recognition of his record of personal technical contributions to the design and development of high power lasers and optical systems.

### Raymond Viskanta

Adjunct Professor Raymond Viskanta was elected in 1987 for pioneering contributions to thermal radiation transport and general heat transfer engineering.

# ENDOWED CHAIRS

## H. Thomas Hahn - Raytheon Company Manufacturing Engineering Chair

Professor H. Thomas Hahn holds the Raytheon Company Chair in Manufacturing Engineering, established to support a renewed focus on manufacturing engineering at UCLA, and to recognize excellence in research and education in this field. Hahn joined the UCLA faculty in 1992, coming from Pennsylvania State University where he was the Harry and Arlene Schell Professor. He also held a professorship at Washington University in St. Louis and research positions at the Lawrence Livermore National Laboratory and the Air Force Materials Laboratory. Hahn's research interests cover a wide spectrum of composites technology ranging from design and analysis to processing and manufacturing. Hahn served as chair of the UCLA Mechanical and Aerospace Engineering Department from 2002 to 2006.

## Chih-Ming Ho - Ben Rich Lockheed Martin Aeronautics Chair

Professor Chih-Ming Ho holds the Ben Rich-Lockheed Martin Chair in Aeronautics, which honors the late Ben R. Rich (MS '50), one of the world's leading aircraft engineering pioneers. The chair was established to recognize a faculty member conducting advanced research in aeronautics, including microelectromechanical systems. Ho is the Director of the NASA-funded Institute for Cell Mimetic Space Exploration at UCLA, an interdisciplinary center focused on identifying, developing, and commercializing nano-, bio-, and information technologies for space exploration. He is an internationally renowned researcher in bio-nano technology, micro/nano fluidics, and turbulence. Ho was elected a member of the National Academy of Engineering and an Academician of Academia Sinica which honors scholars of Chinese origin with exceptional achievements in liberal arts and sciences.

## John Kim - Rockwell International Engineering Chair

Professor J. John Kim holds the Rockwell International Chair in Engineering, which was established to support exceptional research and educational accomplishments in aerospace and aeronautical engineering. Kim's primary research interest is numerical simulation of transitional and turbulent flows, physics and control of turbulent flows, and numerical algorithms for computational science. He has been a pioneer in developing direct numerical simulations and large eddy simulations as a reliable and respected tool for studying physics of turbulence. Kim has been at the forefront of the application of a new cutting-edge approach to flow control. Kim is a Fellow of the American Physical Society, and received a NASA Medal for Exceptional Scientific Achievement in 1985, the H. Julien Allen Award from NASA Ames Research Center in 1994, the Otto Laporte Award from the American Physical Society in 2001, and the Ho-Am Prize in Engineering from the Ho-Am Foundation in 2002.

## SINAM: Exposing young minds to nanomanufacturing

The Center for Scalable and Integrated Nanomanufacturing (SINAM), funded by the National Science Foundation, is a Nanoscale Science and Engineering Center founded in 2003 to establish a new manufacturing paradigm that integrates an array of new nanomanufacturing technologies. SINAM boasts an exceptional team of scientists and engineers from UCLA, UC-Berkeley, UC San Diego, Stanford, University of North Carolina Charlotte, and HP Labs. Professor Adrienne Lavine, SINAM Associate Director of Education and Outreach, and KiMi Wilson, SINAM Education Coordinator, have created and implemented educational programs in conjunction with SINAM's research. "We believe that exposing pre-college students to engineering is essential to prepare a well educated diverse workforce for careers in engineering over the next 10–20 years," states Wilson.

*James Jenkins (Graduate Mentor) and Jmar Akai Montgomery (SINAM NMSA Participant)*

One of SINAM's educational programs is an exciting three-day on-site photolithography experiment conducted with middle and high school students. This experiment enables students to fabricate and test their very own circuit board. During the three-day collaborative experiment, students are guided through the process of photolithography by UCLA faculty and graduate students. The photolithography module built on the successful efforts of CNSI's Outreach Program, spearheaded by Sarah Tolbert. "The experiment is a wonderful hands-on project for students where they see that they really get to make something, which is the essence of engineering," states Lavine.

Another educational program is SINAM's Nanomanufacturing Summer Academy (NMSA), which provides undergraduates from various universities an opportunity to conduct research in nanomanufacturing for eight weeks with distinguished SINAM faculty. The primary goal of NMSA is to prepare, motivate, and encourage students to pursue graduate study in engineering. Hugo Chiquito, a 2007 NMSA participant and a Cal State L.A. senior mechanical engineering student states, "My research experience here at UCLA with the SINAM program was incredible. I love the faculty here; my mentor was accessible and supportive of my research ideas. It was a privilege being here."

For Fall 2007, SINAM plans to unveil its new program for middle and high school students called NanoXperience, where students will come to the UCLA campus and explore photolithography, meet faculty, and visit labs. Also, the SINAM scholars program will build on the work of NMSA by giving undergraduates an opportunity to conduct research with faculty during the academic school year. SINAM is poised to make an impact on increasing the diversity of engineering one student at a time.

## Tino Mingori reaches out to local schools

*Tino Mingori*

Mechanical and Aerospace Professor Emeritus D. Lewis (Tino) Mingori, the first in his family to attend college, is reaching out to students at his former high school and middle school.

A graduate of Hamilton High School in Los Angeles, Mingori was inspired by his upcoming 50th reunion to visit the campus.

He recalled, "My parents did not complete high school, but they always encouraged me to study hard. My teachers at Louis Pasteur Jr. High (now the Los Angeles Center for Enriched Studies) and at Hamilton High provided the knowledge and guidance that brought a university education within reach. That education began in 1956 when I enrolled as a freshman in engineering at UCLA."

Last fall, Mingori began tutoring students at Hamilton in math once per week, working with a few students on each visit. Soon after, he also began tutoring at the Los Angeles Center for Enriched Studies (LACES).

"In addition to working with the students on their math, I'm encouraging them to consider attending college and perhaps studying engineering or science," Mingori said. "It's very rewarding—I feel like I'm making a difference at a critical time in these students' lives. At the end of the semester, one of the students sent an email stating, 'You helped me accomplish my goal.'"

- Marlys Amundson | Photo: UCLA Photography

## Supermileage Vehicle team takes sixth

The UCLA Supermileage Vehicle team continued its goal of pushing the limits of fuel efficiency with its 2007 vehicle. Supermileage is a collegiate design project organized by the Society of Automotive Engineers. Teams design and build single person, highly fuel efficient vehicles and compete in a fuel-mileage-based competition. UCLA Supermileage, in its second year of existence, competed in the SAE Supermileage competition and the first ever Shell Eco-Marathon America.

While competing in the first Shell Eco-Marathon America in April, UCLA took 8th place, reaching 824 mpg. At the SAE Supermileage competition in June, UCLA took 6th place in mileage with 832 mpg. These performances represent an improvement of over 300% from the efficiency of the 2006 vehicle.

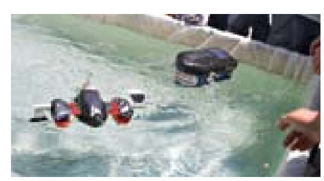

UCLA Supermileage founders and project managers Michael Raymond and Brian Wilhelm along with sub assembly leaders Ben Pagliuso and Ed Fong, became the first alumni of the team. Losing four of the team's seven core members (when they graduated in 2007) will surely be felt by next year's team which has already begun designing the team's third car. President Brett Rosenthal, Internal Vice President Jordan Chase, and External Vice President Alex Chapman hope to break 1000 mpg and recruit a new freshman class that will keep the team running for years to come.

– Brett Rosenthal


*(clockwise from top) UCLA Supermileage Vehicle team; #19 racing down the track; #19 takes 6th place; #19 with hood off; and being placed on.*

## Students learn real-world fluid mechanics in race

Every year, teams of students in Prof. Pirouz Kavehpour's Fluid Mechanics and Aerodynamics Laboratory (157A) design and build a boat to compete in a race at the end of the quarter. This year, teams were instructed to create boats with biologically-inspired propulsion systems. No propellers were allowed; instead, teams used fins, flippers, and tails to power their boats up and down the length of a 20' x 10' pool. In addition to the challenge of designing unconventional methods of locomotion, teams also had to contend with the difficulties that come when converting designs and theory into actual, working boats. Despite these obstacles, the students enthusiastically dove in and produced six swimming boats that were ready to compete by race day.



## UCLA Design/Build Fly team takes ninth

The Los Blue Angeles, UCLA's entry into the 2006-2007 Design/Build/Fly (DBF) competition, placed 9th of 36 teams at the fly-off in Tucson, Ariz., the weekend of April 20, 2007. The DBF, hosted by the American Institute of Aeronautics and Astronautics (AIAA), Cessna Corp., and Raytheon Missile Systems, is an annual contest that aims to provide undergraduates with the opportunity to engage a real-world design problem. Student teams from across the globe must design and manufacture a radio-control airplane to meet given performance specifications, as well as submit an accompanying 60-page design report.

Improved construction methods were instrumental to the UCLA team's 9th place ranking, the best finish a UCLA DBF team has ever had in the contest. Equally critical to the team's success was a much-improved design report score, which ranked 11th among the teams that participated in the April fly-off. At the 2005-2006 DBF, UCLA finished 24th overall with a report score ranked 20th of a field of 49.

Although high final ranking is a great achievement in itself, the DBF contest provides the additional benefit of challenging undergraduates to take the description of a desired product from design to manufacture to implementation. This introduces students to the difficulties of team building, resource management, and fundraising—problems that are less technical in nature, but are equally important. The contest rules, which change each year, also allow students to test for themselves the theoretical knowledge from their classes.

Certainly, senior members must draw upon lessons learned in MAE 154S (Flight Mechanics, Stability, and Control of Aircraft) to effectively size the aircraft's wing and empennage for the prescribed missions. To support the associated aerodynamic loads, other team members must then utilize their understanding of the behavior of various materials and structures. Knowledge gained from such classes as MAE 101 (Statics and Strength of Materials) and MAE 166A (Analysis of Flight Structures) allows both younger and older students to assist in the structural design of the wings and fuselage. Thus, the project enables undergraduates at different points in their college education to make useful contributions.

– Gerard Toribio

*The UCLA DBF contest aircraft completes the 360-degree loop required by the flight pattern.*

*UCLA DBF team members complete the fuselage skinning. From left to right, Kevin Archibald (junior, chief design engineer), Matt Wong (junior), and Eric Chrisman (sophomore, project manager).*

*UCLA DBF team members pose with the airplane after the contest in Arizona. Top (left to right): Tom Wiltse (soph), Jeff Jonokuchi (soph), Gaurav Bansal (frosh), Eric Chrisman (soph, project manager), Alex Kroll (junior), Matt Wong (junior), Ian Schultz (soph). Bottom (left to right): Viet Nguyen (junior), Alex Capecelatro (frosh), Jerry Huang (junior), Sara Wales (junior), Kevin Archibald (junior, chief design engineer), Gerard Toribio (junior).*

## UCLA's Mars Rover Challenge takes third at competition

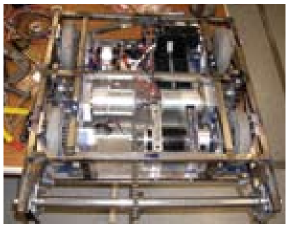
Andrew arrived at 3am Saturday, June 1st, and stayed up all night preparing the rover. Andrew and his brother rendezvoused with one of the judges at 7am, who led them from the hotel to the MDRS site. Upon arrival, Andrew's brother began a frantic setup operation of the equipment while Andrew did his best to prep and debug the communications and control systems. The competition time slot rolled around at 8am, and the rover met with mixed results. 45 minutes into the run, after the rover had been responding to all commands, the rover unexpectedly shut down.

There was one more event to compete in. After rebuilding the rover no fewer than 6 times, Andrew and his brother got it working in time to compete in a second run, which was successful. The day ended with the awards ceremony, where the judges awarded points for missions completed, as well as their impressions of the teams. Andrew was honored to receive a personal invitation to join the Mars Society's Engineering Team.

– Andrew Boggeri

## UCLA Battlebots

ASME has competed in Combat Robotics events for the last two years and grown dramatically as a result. In 2006, we sent one robot to ROBOGAMES in San Francisco, competing against many of the same robots that were famous on the original BattleBots TV show. In 2007, we competed with three:



Our featherweight (30lb) team was composed of engineers Mike Elbogen, Chris Coffman, and Tom Wiltse – none of whom had much, if any, experience in robotics. They designed and built a wedge-lifter that won its first fight at ROBOGAMES. The bot, "BruClaw", survived vicious hits by hammers and blades that ripped sections of Lexan armor off, but it returned from the event in complete running condition.

The lightweight (60lb) robot "UBRuined" was built by returning member Robert Glidden, and competed at COMBOTS. A shell-spinner with steel claws, it won its first fight by KO, delivering a single jarring blow that knocked its opponent's electronics loose. It subsequently lost to a flamethrower that shot a 6-foot flame into UBRuined's vulnerable underside.

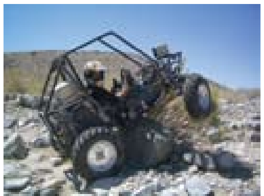
Returning from 2006 was ASME's flagship robot, the middleweight (120lb) "DracUCLA", designed by returning member Jeff O'Donohue. After a complete redesign from the 2006 version, the 2007 DracUCLA sported a front-mounted steel drum 50% larger and heavier than the previous year's one. DracUCLA took the most abuse in the arena by far, absorbing hits that flung it several feet in the air and coming back for more. Even a bent weapon axle did not prevent it from fighting, and it came back from ROBOGAMES in running condition.

-Rob Glidden

## UCLA Mini-Baja

Unlike many years in the past, UCLA's Society of Automotive Engineers experienced zero mechanical problems and finished their day with their car intact. Scores for the days events were: 57th for acceleration, 46th for hill climb, 43rd for maneuverability, and 39th for rock crawl. The competition concluded with the 4 hour endurance race. With 101 cars on the track all at once, the day proved exciting and unpredictable. The course featured many drop offs, jumps, downhill slaloms, and full speed straight-aways; it was not uncommon to see cars flying through the air, hitting tree branches, spinning off course, or landing on their roofs. The UCLA vehicle proved extremely reliable after the first hour and a half. After changing drivers, the car began having fuel delivery problems due to a torn o-ring in the gas line. After resolving some of these issues, the team also noticed some welds beginning to crack and some bolts becoming loose in the suspension systems. These were fixed quickly enough and the car was able to get back on the course. The final problem that ended the day proved to be a bit ambiguous: broken parts within the belt clutch prevented the car from climbing hills, but did not cause problems on flat ground. The problem wasn't diagnosed until the judges black flagged the team for having to be helped up hills too many times, and with that the day ended. UCLA SAE clocked about 2 and a half hours on the track, which was good enough for 46th place. All together they scored 496 out of a possible 1000 points, and placed 47th overall out of 101 entries.

-Nick Herron



## Audrey Pool O'Neal

*Audrey Pool O'Neal / Photo: UCLA Graduate Quarterly*

Audrey Pool O'Neal was just 14 when she built a truss out of balsa wood that held 80 pounds of bricks. Her I-beam design "wasn't the most aesthetically pleasing—the others were much prettier," she admits, "but my truss held the most bricks." As a result, she won first prize for her project in a Purdue University program for promising high school students. The rest—her college degree, a job at General Motors, a PhD in engineering at UCLA, and her work in a program much like the one in which she excelled—all of that became more or less inevitable.

Audrey went home to Inkster, Michigan, knowing what she wanted to be when she grew up. "The only thing that wavered was what kind of engineer I would be," she says. Ironically, perhaps, it was a teacher of English rather than science or mathematics who set Audrey on her course. Deciding that Audrey "should be an engineer," Martha Petroski not only arranged the Purdue opportunity but two summers later sent Audrey off to the University of Wisconsin for a similar but more intensive and longer program.

Audrey turned down a subsequent scholarship from Wisconsin to accept an offer from the General Motors Institute (now Kettering University), a small private college that provided plenty of face time with professors and was less than two hours from home. For five years, Audrey studied mechanical engineering for 12 weeks, then worked 12 weeks in GM's Powertrain division, which designs and manufactures engines and automatic transmissions for all GM products. Her thesis involved a simplified process for welding high carbon steel directly with low carbon steel to make a material that was both hard and flexible.

Where she grew up, just about everyone worked for one of the automakers. "Many, many family members [including her father] worked for Ford," she says, "so I was going to be the rebel and go to GM." Her father had his revenge, however. "To make sure I didn't forget where I came from," she says, "when I graduated from high school, he bought me a brand new Ford, which I had to drive to the GM lot every day."

After she got her bachelor's degree, Audrey continued working at GM for more than a decade. In 1996, GM sent Audrey to UCLA for a master's degree in Mechanical Engineering, specializing in fluid mechanics, preparing her to work on "the engine side" of its operations. Audrey didn't go back, however, but stayed on for doctoral studies.

In the next few months, she'll receive her PhD in mechanical engineering. Working in the Multifunctional Composites Lab, Audrey has developed a way to embed a nanocomposite barium titanate into the materials used to build machines that need capacitors to store and then release power. Barium titanate is a dielectric ceramic material, which does not conduct electricity but has the ability to support an electrostatic field while dissipating minimal energy in the form of heat. Structures built using her material won't need separate capacitors— "You could save the weight and embed that functionality into the skin of an aircraft, for example," she explains.

Engineering may be her oldest love. "I always liked taking things apart and putting them back together, even before I realized there was a field of engineering," she says. "Sometimes I'd get it right and sometimes not exactly."

Her newest love is teaching. There's "that light bulb moment," she says, "when you look at the face of a student and see that they get it. There's something about that I enjoy too much"—at least too much to go back to GM or any job in industry. Instead, she'd "like to help students become engineers." While she finishes her dissertation work, she's been getting some practice in that arena at UCLA's Center for Excellence in Engineering and Diversity (CEED), which offers a variety of pre-college programs to orient K-12 students toward engineering and computing, as well as undergraduate programs and services focused on the personal, academic, and career development of economically disadvantaged and underrepresented Engineering and Computer Science students at UCLA.

-- Jacqueline Tasch, UCLA Graduate Quarterly

## The Darfur stove

Brian Y. Tachibana (BS '03, mechanical engineering) has spent nearly three months in Khartoum, Sudan's capital, helping to develop fuel-efficient cooking stoves for the internally displaced people living in the refugee camps. As project engineer for an international volunteer collaborative effort, Tachibana is responsible for on-site production of the cook stoves.

"I feel very fortunate that I have the freedom, both financially and personally, to participate in a project like this, an extremely worthwhile cause," he said. "My first responsibility was to oversee the manufacturing and distribution of 50 metal cook stoves, which are currently being used and evaluated by some of the displaced people."


*Brian Y. Tachibana*

The Darfur conflict, an ongoing armed conflict in the Darfur region of western Sudan, has led to the deaths of more than 400,000 people, and more than 2.2 million people have been forced from their homes and now live in refugee camps.

These camps, scattered across Darfur, are in areas that have limited wood available for fuel. This shortage requires women and children in the camps to go farther and farther from camp to find wood for cooking, putting them at increased danger of attack.

Nearly all of the Darfur refugees cook on three-stone fires, which require twice as much firewood as the new metal stoves, according to the Lawrence Berkeley National Lab researchers. The more efficient metal stoves, which use the same fuel, pots, and cooking methods used by those in the camps, would reduce the amount of fuel needed, and also help ensure that refugee families would have less need to trade or sell limited food rations to purchase wood for fuel.


*Women living in refugee camps in Darfur are shown how to use the new metal cookstoves.*

Feedback from those using the stoves in the camps will allow the team to address any technical or usability issues before moving forward with production of 5,000 stoves early next year.

"I live and work in CHF International's compound, so my work day tends to run from when I wake up to when I go to sleep," explained Tachibana. "When I first arrived, my days were almost completely filled with hunting down materials and information, identifying appropriate workshops, coordinating manufacturing activities, etc. Evenings were spent processing the information, exchanging details with the team, and planning for the next day."

Following distribution of the first 50 stoves in the camps, Tachibana's focus has shifted to working on program details and managing the team's activities in Darfur.

"In the U.S. you can usually answer a question by hopping on Google, shooting off an e-mail, or placing a phone call," Tachibana said. "Khartoum is still a place where good, old-fashioned legwork reins supreme. Persistency is also important. On more than one occasion I've been told that certain things can't be done or certain things aren't available just to realize I was asking the wrong person or the wrong question."

Ken P Chow, engineering project manager for Engineers Without Borders - San Francisco Professionals, noted, "Brian's been doing a super job for the project. Everyone from our project leader - Ashok Gadgil - to the CHF-Sudan country director has been very impressed with him. The progress of the project has been exceptional once he arrived in Sudan."

Although the project takes most of Tachibana's time, he has found time for fun, as well. "NGO employees seem to be a pretty hard working bunch, but I have found myself involved in some unexpected leisure activities, including Salsa lessons from a Sudanese instructor who lived in Cuba, happy hours at the U.S. Embassy's Recreational Facility, and 'lawn' tennis on dirt courts."

UC Berkeley Professor Ashok Gadgil and Christina Galitsky, a principal research associate at Lawrence Berkeley National Lab, were the driving forces behind the project. The cook stove's design was further improved in a class taught by Gadgil, one similar to UCLA's mechanical project design course (162B). Engineers Without Borders - San Francisco later reworked the design for manufacturability in Sudan.

"This project fits into my vision for my engineering career," reflected Tachibana. "As much as I can control it, I'd like to continue working on projects that I have a personal connection to or that I feel are helping the world. I've noticed that I tend to draw the deepest satisfaction from situations like that."

The Darfur cook stoves project is sponsored by CHF International (http://www.chfhq.org/). Lawrence Berkeley National Lab and Engineers Without Borders-San Francisco Professionals are providing engineering and fundraising support in the States.

For more about the stoves and the project, please visit http://darfurstoves.lbl.gov/.

-- Marlys Amundson | Photos CHF International.

# Alumni and Student News

**Tak-Sing Wong**, a Ph.D. candidate in the Mechanical and Aerospace Engineering Department of UCLA, has been awarded a prestigious Intel Foundation Ph.D. Fellowship for the academic year 2007–08. The Intel Foundation Ph.D. Fellowship Program is a highly competitive program with approximately 40 fellowships awarded nationwide per annum. This year, there were 140 finalists from 23 participating universities and 30 students were selected from 14 universities.

The Program awards two-year fellowships to Ph.D. candidates pursuing leading-edge work in fields related to Intel's business and research interests. Fellowships are available at select U.S. universities, by invitation only, and focus on Ph.D. students who have completed at least one year of study.

**Kancy K. Lee** has been awarded the 2007 Harry Showman Prize from UCLA. The prize is awarded to "those who most effectively communicate the achievements, research, results or social significance of any aspect of Engineering to a student audience, the engineering professions, or the general public". Kancy has been working in Laurent Pilon's lab as an undergraduate student researcher. She is continuing for her PhD next academic year.

**Marianne So** is the first recipient of the MAE Spirit Award. This award was inspired by her exuberance and dedication to the students, faculty, and staff of MAE, and all her efforts to make MAE a community. Marianne graduated in June 2007. On behalf of the MAE Department and the Honors and Awards Committee, we congratulate Marianne So on being the first recipient of this award!

**A. Marm Kilpatrick** BS '95 had his paper, "Predicting the global spread of H5N1 avian influenza," published in the December 19, 2006 issue of PNAS. Because of his findings, he was interviewed on NPR and ABC News, and was featured in a New York Times article, "Scientists Criticize Bird Flu Search," in the December 4, 2006 issue.

Engineering student organizations for generations to come will benefit from the newly established **Richard Gay** Endowment Fund for Student Projects. The fund honors three-time alumnus Richard Gay (BS '73, MS '73, PhD '76), a tireless supporter of engineering student organizations at UCLA.

Each year, dozens of UCLA engineering groups receive financial support from the Alumni Fund for Student Projects. This new fund will provide much-needed supplementary support for engineering student activities and allow additional students to gain hands-on engineering experience through extracurricular activities.

"Our engineering student organizations offer a variety of ways for our students to gain real-world experience in design, project management, and teamwork," said UCLA Engineering Dean Vijay K. Dhir. "This endowment will provide critical support to our students."

The **Jonathan David Wolfe** Memorial Endowed Undergraduate Scholarship in Mechanical and Aerospace Engineering was established by the Wolfe family to honor Jonathan Wolfe, a three-time mechanical and aerospace engineering alumnus (BS '94, MS '94, PhD '01).

"His life was closely intertwined with UCLA – he was a part of the School for nearly half of his life," recalled his mother, Elaine Wolfe. "After he graduated, he worked in Professor Jason Speyer's lab as a researcher. He loved UCLA – and he really loved learning new things. We hope the scholarship will help students to pursue their dreams and continue despite any financial difficulty."

Three of Chih-Ming Ho's students were in the news. **Chien Sun** received the Best Ph.D. Award from the BME Dept. **Tak-Sing Wong** was a awarded a prestigious Intel Foundation Ph.D. Fellowship (see top left paragraph). **Robert Lam**, an undergraduate working in Prof. Ho's lab, received a 5-year scholarship from Northwestern University.

The student winners of the 2006-2007 HSSEAS Student Awards were **Kancy Kitshan Lee** (BS), **Elena Adriana Garcia** (BS), **Carlos Castrejon Jr** (BS), **Qian (Nataly) Chen** (BS), **Jian Gong** (PhD), **Efren Vasquez** (BS), **Hann-Shin Mao** (BS), **Takane Usui** (BS), **Juliett Davitian** (MS), **Kevin Christopher Chu** (MS), **Jason Robert Marden** (PhD), and **Ratnesh Kumar Shukla** (PhD).

## Industrial Advisory Board

MAE's Industrial Advisory Board met in the Rice Room on 5/25/07, to discuss MAE's plans for the next few years. Attending from industry were John Armenian (TechFinity), Rick Baker (Lockheed Martin), Gaurang Choksi (Intel), Natalie Crawford (RAND), Patrick Fitzgerald (Raytheon), Dan Goebel (JPL), Wayne Goodman (Aerospace Corporation), Jason Hatakeyama (The Boeing Company), Asad Madni (Crocker Capital), Roger Murry (Honeywell Engines, Systems & Services), Kevin Petersen (NASA Dryden Flight Research Center), Shawn Phillips (Air Force Research Laboratory/Propulsion Space Engine), and Munir Sindir (Pratt Whitney), Chair of the Board. Attending from UCLA were William Goodin (UNEX), Vijay Dhir (Dean of the School), Adrienne Lavine (Chair of the MAE Dept.), and Profs. Karagozian, M'Closkey, Zhong, and Carman of the MAE Dept. Student groups were also in attendance. Topics of discussion included: graduate and undergraduate programs; Industrial Affiliates program; student society projects; systems engineering; and faculty recruitment.

### CURRENT PARTNERSHIPS

- Aerospace Corporation
- BEI Technologies
- Boeing
- Capstone Turbine
- Conoco Philips
- Crocker Capital
- Honeywell Engines
- Intel
- JPL
- Lockheed Martin
- NASA
- Northrop Grumman
- Pratt & Whitney
- RAND Corporation
- Raytheon
- TechFinity
- USAF

## Alumni Advisory Board

The MAE Alumni Advisory Board advises the department on curriculum and alumni issues. Since many of the board members are recent alumni, their comments on specific courses have been helpful to the chair and vice chair for undergraduate studies. They also provided feedback on the new on-line MS degree, with respect to how it may be relevant to their own careers, and their companies' support for it.

*June 6, 2007 meeting: First Row, Marianne So (Honeywell), Michelle Yi (Raytheon Space and Airborne Systems), Christine Garity (HDR Architecture, Inc.), Margaret Motagally (HDR Architecture, Inc.), Cathy Leong (Boeing); Second Row, Robert Glidden, Garett Chang (B&M Racing & Performance Products), William R. Goodin (Chair, Department Liaison, UCLA Engineering Alumni Association), James Sharp (SySense), Greg Glenn (SySense), Alex Diaz (Boeing), Nathan Kwok (C&D Zodiac), Prof. Bob M'Closkey, Eliza Sheppard (Northrop Grumman Space Technology), David Lee (Northrop Grumman Space Technology), Prof. Adrienne Lavine.*

*Not pictured: Enrique Baez, Jr. (Jet Propulsion Laboratory), Myles Baker (M-4 Engineering, Inc.), Karen Baumgartner (Raytheon Space and Airborne Systems), Jennifer Bursch (Boeing), Jeff DeFazio (Northrop Grumman Space Technology), Vincent Gau (GeneFluidics), Alfredo Lopez (Boeing), David H. Miller (General Motors Advanced Technology Center), Yuri Nosenko (ExxonMobil Refining and Supply), Charisse Pua (United Technologies), Kirk A. Williams (Accenture Financial Services).*

## DYNAMICS

### Oddvar O. Bendiksen

Classical and computational aeroelasticity, structural dynamics and unsteady aerodynamics.

Associate Fellow, AIAA, 1995

### Daniel C. H. Yang

Robotics and mechanisms; CAD/CAM systems, computer controlled machines.

Fellow, ASME, 2007

### James S. Gibson

Control and identification of dynamical systems. Optimal and adaptive control of distributed systems, including flexible structures and fluid flows. Adaptive filtering, identification, and noise cancellation.

## FLUID MECHANICS

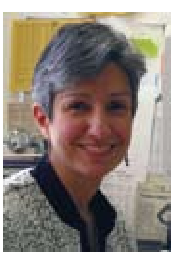
### Jeff. D Eldredge

Fluid mechanics and acoustics, interaction of fluid flow and sound, control of acoustically-driven instabilities, and fluid particle-based computational techniques.

### John Kim

Numerical simulation of transitional and turbulent flows, turbulence and heat-transfer control, numerical algorithms for computational physics.

Fellow, American Physical Society, 1989



### Ann R. Karagozian

Fluid mechanics of combustion systems, with emphasis on acoustically controlled reacting flows, detonation phenomena, high speed combustion systems, and microgravity combustion.

Fellow, AIAA, 2004

Fellow, American Physical Society, 2004

### Owen I. Smith

Combustion and combustion-generated air pollutants, hydrodynamics and chemical kinetics of combustion systems, semi-conductor chemical vapor deposition.

### H. Pirouz Kavehpour

Microfluidics and biofluidics, biofuel cells, cardiovascular flow, complex fluids, interfacial physics, micro-tribology, non-isothermal flows, drug delivery systems, and artificial organs.

### Xiaolin Zhong

Computational fluid dynamics, hypersonic flow, hypersonic boundary layer stability and transition, numerical simulation of transient hypersonic flow with nonequilibrium real gas effects, numerical simulation of micro two-phase flow, MHD control of hypersonic boundary layers, high-order numerical methods for flow simulation.

Associate Fellow, AIAA, 2004

# HEAT AND MASS TRANSFER

### Mohamed A. Abdou

Fusion, nuclear, and mechanical engineering design, testing, and system analysis; thermomechanics; thermal hydraulics; neutronics, plasma-material interactions; blankets and high heat flux components; experiments, modeling and analysis.

Fellow, American Nuclear Society, 1990
Associate Fellow, TWAS, 1989

### Ivan Catton

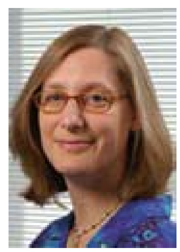
Heat transfer and fluid mechanics, transport phenomena in porous media, nucleonics heat transfer and thermal hydraulics, natural and forced convection, thermal/hydrodynamic stability, turbulence.

Fellow, ASME, 1989
Fellow, American Nuclear Society, 1999

### Vijay K Dhir

Two-phase heat transfer, boiling and condensation, thermal and hydrodynamic stability, thermal hydraulics of nuclear reactors, microgravity heat transfer, soil remediation.

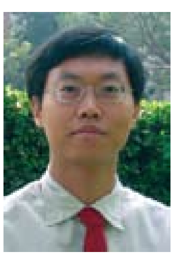
Member, National Academy of Engineering, 2006
Fellow, ASME, 1989
Fellow, American Nuclear Society, 1997



### Adrienne Lavine

Thermal control of nanoscale manufacturing, thermomechanical behavior of shape memory alloys, thermal aspects of manufacturing processes including machining and plasma thermal spray, natural and mixed convection heat transfer.

Fellow, ASME, 1999



### Y. Sungtaek Ju

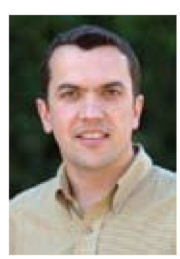
Micro- and nanoscale thermosciences, energy, bioMEMS/NEMS, nanofabrication.

### Anthony F. Mills

Convective heat and mass transfer, condensation heat transfer, turbulent flows, ablation and transpiration cooling, perforated plate heat exchangers.

### H. Pirouz Kavehpour

Microfluidics and biofluidics, biofuel cells, cardiovascular flow, complex fluids, interfacial physics, micro-tribology, non-isothermal flows, drug delivery systems, and artificial organs.



### Laurent G. Pilon

Radiation transfer, biomedical optics, photobiological hydrogen production, energy conversion, foam, nanoporous media.

# MANUFACTURING AND DESIGN

### Mohamed A. Abdou

Fusion, nuclear, and mechanical engineering design, testing, and system analysis; thermomechanics; thermal hydraulics; neutronics, plasma-material interactions; blankets and high heat flux components; experiments, modeling and analysis.

Fellow, American Nuclear Society, 1990
Associate Fellow, TWAS, 1989

### Gregory P. Carman

Electromagnetoelasticity models, piezoelectric ceramics, magnetostrictive composites, characterizing thin film shape memory alloys, fiber optic sensors, design of damage detection systems for structures.

Fellow, ASME, 2003

### Rajit Gadh

Radio frequency identification (RFID), middleware for RFID networks, wireless internet of artifacts, RFID in supply chain/logistics/manufacturing, reconfigurable wireless network sensors, wireless internet architectures for enterprise, wireless multimedia - video/imaging/graphics, digital rights management for multimedia content, CAD/visualization.

### Nasr M. Ghoniem

Damage and failure of materials in mechanical design; mechanics and physics of material defects (point defects, dislocations, voids and cracks); material degradation in severe environments (e.g. nuclear, fusion, rocket engines, etc.); plasma and laser processing; materials non-equilibrium, pattern formation and instability phenomena; radiation interaction with materials (neutrons, electrons, particles, laser & photons).

Fellow, American Nuclear Society, 1994
Fellow, ASME, 2006

### H. Thomas Hahn

Nanocomposites, multifunctional composites, nanomechanics, rapid prototyping, information systems, nanolithography, energy harvesting/storage structures.

Fellow, ASME, 1993
Fellow, American Society for Composites 1996

### Y. Sungtaek Ju

Micro- and nanoscale thermosciences, energy, bioMEMS/NEMS, nanofabrication.

### Daniel C. H. Yang

Robotics and mechanisms; CAD/CAM systems, computer controlled machines.

Fellow, ASME, 2007

### Tsu-Chin Tsao

Modeling and control of dynamic systems with applications in mechanical systems, manufacturing processes, automotive systems, and energy systems, digital control; repetitive and learning control, adaptive and optimal control, mechatronics.

## MEMS AND NANOTECHNOLOGY

### Gregory P. Carman

Electromagnetoelasticity models, piezoelectric ceramics, magnetostrictive composites, characterizing thin film shape memory alloys, fiber optic sensors, design of damage detection systems for structures.

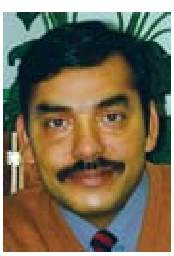
Fellow, ASME, 2003

### Yong Chen

Nanofabrication, nanoscale electronic materials and devices, micro-nano electronic/optical/bio/mechanical systems, ultra-scale spatial and temporal characterization.

### Pei-Yu Chiou

Biophotonics, nanophotonics, BioMEMS/NEMS, electrokinetics, microfluidics and biofluidics, guided self-assembly, high throughput single cell analysis.



### Vijay Gupta

Experimental mechanics, fracture of engineering solids, mechanics of thin films and interfaces, failure mechanisms and characterization of composite materials, ice mechanics.

Fellow, ASME, 2005

### Chih-Ming Ho

Molecular fluidic phenomena, nano/micro-electro-mechanical-systems, direct handling of macro molecules, bio-nano technologies, DNA based micro sensors.

Member, National Academy of Engineering, 1997

Fellow, American Physical Society, 1989

Fellow, AIAA, 1994

### Y. Sungtaek Ju

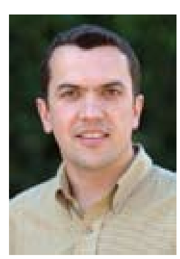
Micro- and nanoscale thermosciences, energy, bioMEMS/NEMS, nanofabrication.

### H. Pirouz Kavehpour

Microfluidics and biofluidics, biofuel cells, cardiovascular flow, complex fluids, interfacial physics, micro-tribology, non-isothermal flows, drug delivery systems, and artificial organs.

### Chang-Jin Kim

Microelectromechanical systems (MEMS), surface-tension-based microactuation, nanotechnology for surface control, microdevices including microfluidic applications, full spectrum of micromachining technologies.



### Laurent G. Pilon

Radiation transfer, biomedical optics, photobiological hydrogen production, energy conversion, foam, nanoporous media.

## STRUCTURAL AND SOLID MECHANICS

**Oddvar O. Bendiksen**

Classical and computational aeroelasticity, structural dynamics and unsteady aerodynamics.

Associate Fellow, AIAA, 1995

**H. Thomas Hahn**

Nanocomposites, multifunctional composites, nanomechanics, rapid prototyping, information systems, nanolithography, energy harvesting/storage structures.

Fellow, ASME, 1993

Fellow, American Society for Composites 1996

**Gregory P. Carman**

Electromagnetoelasticity models, piezoelectric ceramics, magnetostrictive composites, characterizing thin film shape memory alloys, fiber optic sensors, design of damage detection systems for structures.

Fellow, ASME, 2003

**William Klug**

Computational structural and solid mechanics, computational biomechanics, and micro/nanomechanics of biological systems.

**Nasr M. Ghoniem**

Damage and failure of naterials in mechanical design; mechanics and physics of material defects (point defects, dislocations, voids and cracks); material degradation in severe environments (e.g. nuclear, fusion, rocket engines, etc.); plasma and laser processing; materials non-equilibrium, pattern formation and instability phenomena; radiation interaction with materials (neutrons, electrons, particles, laser & photons).

Fellow, American Nuclear Society, 1994

Fellow, ASME, 2006

**Christopher Lynch**

Ferroelectric materials including experimental characterization of constitutive behavior under multiaxial loading.

**Vijay Gupta**

Experimental mechanics, fracture of engineering solids, mechanics of thin films and interfaces, failure mechanisms and characterization of composite materials, ice mechanics.

Fellow, ASME, 2005

**Ajit K. Mal**

Mechanics of solids, fractures and failure, wave propagation, nondestructive evaluation, composite materials, structural health monitoring, biomechanics.

Fellow, ASME, 1994

Fellow, American Academy of Mechanics, 1994

Fellow, International Society for Optical Engineering, 2005

## SYSTEMS AND CONTROL

**James S. Gibson**

Control and identification of dynamical systems. Optimal and adaptive control of distributed systems, including flexible structures and fluid flows. Adaptive filtering, identification, and noise cancellation.

**Robert T. M'Closkey**

Nonlinear control theory and design with application to mechanical and aerospace systems, real-time implementation.

**Jeff S. Shamma**

Feedback control and systems theory.

Fellow, IEEE, 2006

**Jason Speyer**

Stochastic and deterministic optimal control and estimation with application to aerospace systems; guidance, flight control, and flight mechanics.

Member, National Academy of Engineering, 2005

Life Fellow, IEEE, 2004

Fellow, AIAA, 1985

**Tsu-Chin Tsao**

Modeling and control of dynamic systems with applications in mechanical systems, manufacturing processes, automotive systems, and energy systems, digital control; repetitive and learning control, adaptive and optimal control, mechatronics.

### JOINT APPOINTMENTS

Albert Carnesale
Kuo-Nan Liou
J.S. Chen

### ADJUNCT PROFESSORS

Emilio Frazzoli
Les Lackman
Webb Marner
Neil Morley
Robert S. Shaefer
Jeff Shamma
Raymond Viskanta
Xiang Zhang

### PROFESSORS EMERITI

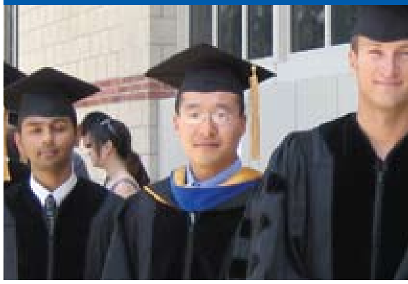
Andrew F. Charwat
Peretz P. Friedmann
Walter C. Hurty
Robert E. Kelly
Cornelius T. Leondes
Michel A. Melkanoff
D. Lewis Mingori
Peter A. Monkewitz
Philip F. O'Brien
David Okrent
Russell R. O'Neill
Alex Samson
Lucien A. Schmit, Jr.
Richard Stern
Russell A. Westmann

### STAFF

| | |
|---|---|
| Abdalla, Laila | Fund Manager |
| Bedig, Janice | Management Services Officer |
| Bulhoes, Lili | Staff Personnel/Payroll |
| Castillo, Angie | Student Affairs Officer |
| Castro, Coral | Purchasing and Reimbursements |
| Cooper, Dale | Associate Development Engineer |
| Dang, Duy | Fund Manager |
| Duffy, Alex | Web and Publications Manager |
| Kono, Lance | Facilities Manager |
| Lebon, Abel | Student Affairs Officer |
| Lozano, Miguel | Senior Laboratory Mechanician |
| Padilla, Alicia | Fund Manager |
| Shatto, David | Administrative Assistant |
| Terranova, Marcia | Academic Personnel/Payroll |
| Tran, Vivien | Administrative Assistant |

# Graduates 2006-2007

## DOCTOR OF PHILOSOPHY



*Commencement, June 2007.*

**Ali Ahmed Abou-Sena:** "Experimental Measurements of the Effective Thermal Conductivity and Interface Thermal Conductance of a Lithium Ceramic Pebble Bed" (Prof. Abdou)

**Ibrahim Ali Odeh Al-Shyoukh:** "Online-Information-Based Learning and Decision Making under Uncertainty" (Prof. Shamma)

**Gokcay Altin:** "Damping Properties of Terfenol-D Composites" (Prof. Carman)

**Zhiyong An:** "Numerical and Experimental Studies on Thermal Deformation of Ceramic Breeder Pebble Systems" (Prof. Abdou)

**Arnaud Benahmed:** "Band-Gap Assisted Surface Plasmon Sensing" (Prof. Ho)

**Branden Brough:** "Molecular Mechanics: The Integration of Synthetic and Natural Molecules into Nanomechanical Systems" (Prof. Ho)

**Grayson Bush:** "The Influence of Effective and Magnetoelectric Coupling on the Elastic and Wave Mechanics of Linear Multiferroic Continua" (Prof. Carman)

**Fardad Chamran:** "Fabrication of Three-Dimensional Microbatteries" (Prof. C.J. Kim)

**Chang-Hwan Choi:** "Nanoengineered Surfaces: Design, Fabrication, and Applications to Microfluidics and Tissue Engineering" (Prof. C.J. Kim)

**Eric Gans:** "Characterizing Ni-Mn-Ga Bulk and Composites for Actuation and Damping" (Prof. Carman)

**Benjamin Zed Hayes:** "Experimental Study of the Effect of Channel Orientation and Flow Oscillations on Nucleate Boiling Heat Transfer and the Critical Heat Flux" (Prof. Dhir)

**Ming-Tsung Hung:** "Heat Transport in Polymer Thin Films for Micro/Nano-Manufacturing" (Prof. Ju)

**Amit Jain:** "Strength/Moisture Relationship for Interfaces and Joints for Robust Prediction of Reliability" (Prof. Gupta)

**Jason Robert Marden:** "Learning in Large-Scale Games and Cooperative Control" (Prof. Shamma)

**Pawel Konrad Orzechowski:** "High-Performance Adaptive Control of Optical Jitter in Laser Beam Systems" (Profs. Gibson and Tsao)

**Sung Sik Park:** "Magnetic Nanocomposites: A New Synthesis Method and Microwave Absorption Properties" (Prof. Hahn)

**Pei-Wen Seah:** "Because We Are Egocentric" (Prof. Shamma)

**Tadej Semenic:** "High Heat Flux Removal Using Biporous Heat Xenon Flashlamp Induced Oxygen Fluorescence" (Prof. Catton)

**Ratnesh Kumar Shukla:** "Effect of Brownian Motion on Thermal Conductivity of Nanofluids" (Prof. Dhir)

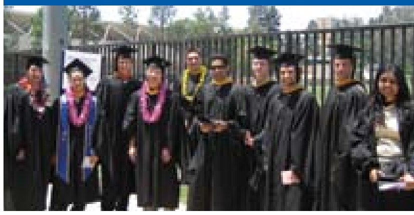
**Werayut Srituravanich:** "Plasmonic Nanolithography" (Prof. Zhang)

**Xiaoyong Su:** "On the Creation of Radio Frequency Identification (RFID) Based Automatic Identification and Data Capture Infrastructure" (Prof. Gadh)

**Junqing Wang:** "Linear Time Varying Repetitive Control and its Applications" (Prof. Tsao)

**Xiaowen Wang:** "Numerical Simulations of Hypersonic Boundary-Layer Stability and Receptivity" (Prof. Zhong)

**Jia Yan:** "On the Design of Deviation-Function Based Gerotors-Theory and Algorithm" (Prof. Yang)



*Commencement, June 2007.*

## M.S. Thesis Plan

**Marcus George:** Closed Loop Control of Transverse Jet Instabilities (Prof. M'Closkey)

**Nathan Kwok:** Resistance Heating For Self-Healing Composites (Prof. Hahn)

**Satyashree Srikanth:** Peptide-Based Capture Probe To Detect Bacteria (Prof. Ho)

**Jonathan Gordon Sugar:** Photovoltaic Performance of Amorphous Silicon Flexible Solar Modules under Mechanical Loading (Prof. Hahn)

## M.S. Comprehensive Exam Plan

**Angel Cortez Aleman** (Prof. Hahn)
**Omar Sabah Alquaddoomi** (Prof. Zhong)
**Hamarz Aryafar** (Prof. Kavehpour)
**Adam Baker** (Prof. Speyer)
**Natasha Christine Barra** (Prof. Abdou)
**Ethan Andrew Baumann** (Prof. Speyer)
**Leiana Michele Brito** (Prof. Eldredge)
**Michael Andrew Calkins** (Prof. Eldredge)
**Anthony Sean Chen** (Prof. Mal)
**Ken Jian Chen** (Prof. Tsao)
**Wai Ho Chu** (Prof. Tsao)
**Kevin Christopher Chu** (Prof. Tsao)
**Juliett Davitian** (Prof. Karagozian)
**Ian Brady Dunbar-Hall** (Prof. Speyer)
**Michael Cheng Feng** (Prof. Carman)
**Ed Fong** (Prof. Smith)
**Samuel Edgar Glidden** (Prof. Frazzoli)
**Wen Guo** (Prof. Abdou)
**Anna Haudenschild** (Prof. Hahn)
**Sally Hoo** (Prof. Ju)
**David Samuel Hu** (Prof. Mal)
**Soojung Hur** (Prof. Pilon)
**Dane Allen Johnson** (Prof. Carman)
**Benjamin Gregory Kalenik** (Prof. Mal)
**Konstantinos George Karpodinis** (Prof. Ju)
**Genevieve Victoria Kayat** (Prof. Karagozian)
**Chad Scott Lillian** (Prof. J. Kim)
**Christopher Lim** (Prof. Tsao)
**Michael Jonathan Lopez** (Prof. Catton)

*Commencement, June 2007.*

**Kevin Lu** (Prof. Kavehpour)
**Hiram Lucena** (Prof. Gibson)
**Kristen Samuel Magowan** (Prof. Gibson)
**Daniel P. McDonald** (Prof. Gibson)
**Kenneth McKell** (Prof. Shamma)
**Paul Coleman Merrill** (Prof. Pilon)
**Salman Monirabbasi** (Prof. Gibson)
**David Andrew Musgrove** (Prof. Frazzoli)
**David Nguyen** (Prof. Ghoniem)
**Vasile Nistor** (Prof. Carman)
**Jason Marcus Nunez** (Prof. Bendiksen)
**Sang-Joon Park** (Prof. Abdou)
**Kenneth Howard Parker** (Prof. Eldredge)
**Katherine Pensader** (Prof. M'Closkey)
**Saul Perez** (Prof. Hahn)
**John Thomas Rieman** (Prof. Shamma)
**Albert Joseph Robinson** (Prof. Eldredge)
**Thomas James Ronacher** (Prof. Eldredge)
**Michael Edward Rynne** (Prof. Bendiksen)
**Karin H. Salha** (Prof. Yang)
**Piyush Sharma** (Prof. Dhir)
**Teruaki Shimojo** (Prof. M'Closkey)
**Ann Stephanie Shreck** (Prof. Gibson)
**Jason Yu-Hene Siu** (Prof. Zhong)
**Michelle Alice Styczynski** (Prof. Carman)
**Yu Tajima** (Prof. Abdou)
**Junichi Takeuchi** (Prof. Abdou)
**Benjamin Tam** (Prof. Yang)
**Jonathan Andrew Tesch** (Prof. M'Closkey)
**Yuk Hay Tham** (Prof. Gibson)
**Cynthia Aylan Thung** (Prof. Gadh)
**Ryan Michael Tiraschi** (Prof. Ju)
**Felipe Torres** (Prof. Klug)
**Sean Michael Tully** (Prof. Zhong)
**Santi Udomkesmalee** (Prof. Bendiksen)
**Pedran Vaghefinazari** (Prof. Shamma)
**David Wei-Min Wang** (Prof. Zhong)
**Kenneth Wei** (Prof. Zhong)
**Andrew Otto Weil** (Prof. Bendiksen)
**Jason Tomas Wilson** (Prof. Tsao)
**William Warren Wood** (Prof. Chen)
**Biao Zhou** (Prof. Yang)

# Publications

## Journal Articles

### Fluid Mechanics

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## Systems and Control

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# Conference Papers

## Fluid Mechanics

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## Heat and Mass Transfer

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## Manufacturing and Design

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# Overview

## Faculty and Staff

| | |
|---|---|
| Ladder Faculty: | 31 |
| Joint Faculty: | 3 |
| Emeritus Faculty: | 15 |
| Adjunct Faculty: | 8 |
| Lecturers: | 36 |
| Research Staff: | 26 |
| Administrative Staff: | 23 |

## Recognitions

| | |
|---|---|
| Society Fellows: | 23 |
| CAREER or Young Investigator Awards: | 9 |
| NAE members: | 8 |
| Regular Faculty: | 3 |
| Affiliated Faculty: | 2 |
| Emeriti: | 3 |

## Publications

| | |
|---|---|
| Journal Articles: | 83 |
| Conference Papers: | 46 |
| Books and Book Chapters: | 3 |
| Patents: | 5 |

## Research Facilities

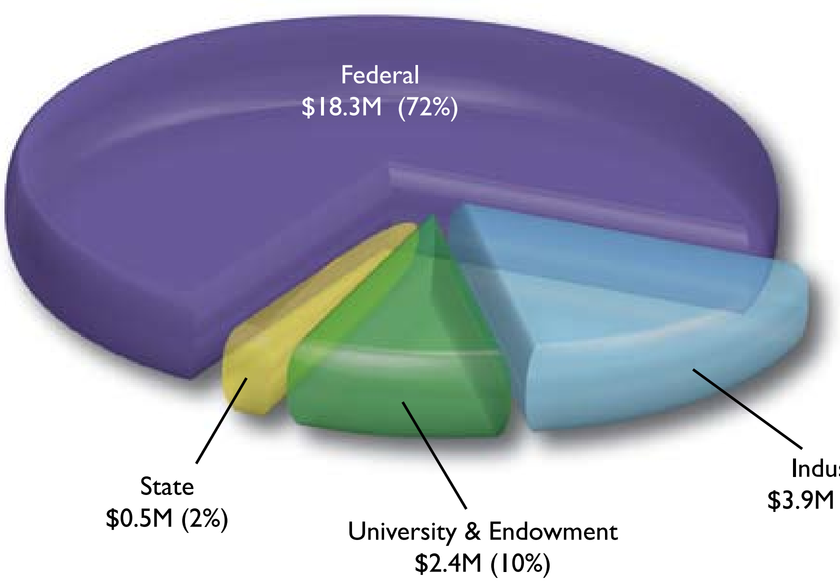
Department contributes to three Research Centers:

CCC
CMISE
CNSI
SINAM

Laboratories and Research Groups: 32
Facilities square footage: 32,743 sq. ft.
Department square footage: 76,918 sq. ft.

## Fiscal Year 2006-2007 Sponsored Research Budget - Total $25M

(Fiscal Year 2006-2007 Sponsored Research Expenditures - Total $13M)



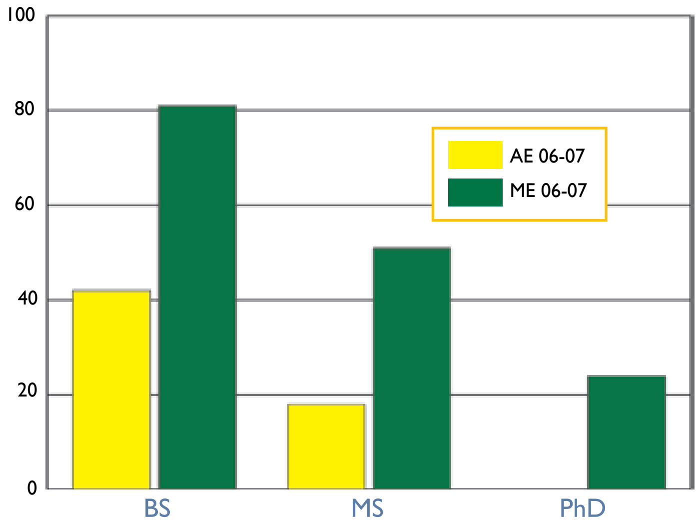
## Undergraduate Students

| | |
|---|---|
| Students Enrolled: | 591 |
| Applicants: | 1953 |
| Admitted: | 471 (24%) |
| New Students Enrolled: | 156 (33%) |
| Average Freshman GPA: | 3.84/4.0 |

## Graduate Students

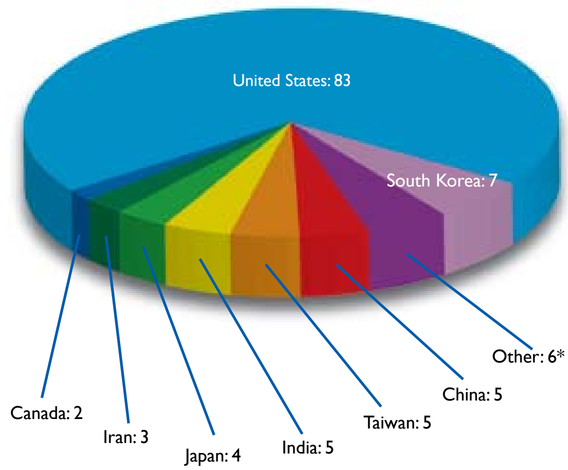
| | |
|---|---|
| Students Enrolled: | 239 |
| Applicants (MS and PhD): | 439 |
| Admitted: | 206 (47%) |
| New Students Enrolled: | 92 (45%) |
| Average GPA: | 3.40/4.0 |

### AE & ME Degrees Conferred 2006-2007




Totals: 123 | 69 | 24

### Graduate Enrollment for Fall 2006
By country of origin (120 total)

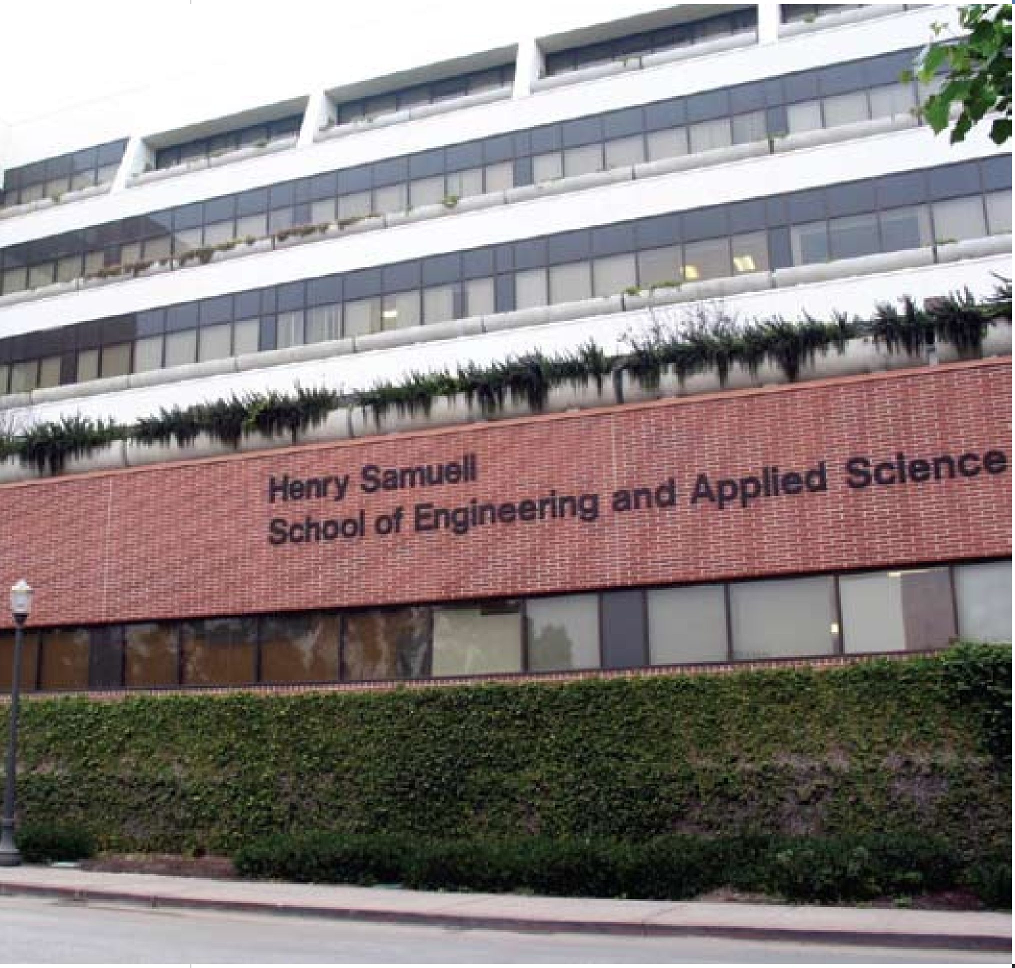



*(Brazil, France, Hong Kong, Italy, Lebanon, U.A.E.)

## Department Fellowships and Teaching Assistantships

| | |
|---|---|
| Graduate Division | $ 569,142.00 |
| TA Funding | $ 539,235.00 |
| HSSEAS | $ 176,000.00 |
| Cota-Robles Fellowship | $ 61,863.50 |
| GOFP Fellowship | $ 41,571.00 |
| NSF Graduate Fellowship | $ 38,285.56 |
| Research Mentorship Prog. | $ 25,785.50 |
| Chancellor's Prize Fellowship | $ 10,000.00 |
| **Total** | **$1,461,882.56** |

The Department gratefully acknowledges the UC Atkinson Archives, UCLA Photography, and the UCLA Office of External Affairs for permission to use many of the images in this report. Design and layout by Alexander Duffy.

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UCLA Engineering
Henry Samueli School of Engineering and Applied Science
Mechanical and Aerospace Engineering Department
University of California
Los Angeles, CA 90095