

# UCLA ENGINEER

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FALL 2009, ISSUE NO. 22

## VIRTUAL ANATOMY



- > Ancient Art Unraveled
- > Alumnus Aaron Cohen '58
- > Clean-Tech Leaders

**UCLA** Engineering  
HENRY SAMUELI SCHOOL OF  
ENGINEERING AND APPLIED SCIENCE  
*Birthplace of the Internet*



At the UCLA Henry Samueli School of Engineering and Applied Science, we are committed to interdisciplinary scholarly work in emerging areas. And throughout the school, more and more of this work is happening outside of traditional engineering disciplines.

This commitment is highlighted by two feature stories in this issue. The cover feature on Demetri Terzopoulos introduces his many years of progress in human simulation and computer modeling — work that was first popularized as special effects in Hollywood films earning Terzopoulos an Oscar, but now has applications in medicine, security and other fields. A second feature on Ioanna Kakoulli details her research and analysis of ancient art and artifacts using advanced engineering techniques.

One of my priorities as dean has also been to increase diversity in both the student population and among faculty at UCLA Engineering. In the past few years, we have recruited some exceptional women to the faculty and some of their work has been included in this issue. Terri Hogue is leading an outreach program that helps to get young students excited about science; Yu Huang received a 2009 PECASE Award, the nation's highest honor for young researchers, for her work in renewable clean energy; Diana Huffaker has created a leadership program in clean technology; and I have already mentioned the feature on Ioanna. Also, of our six new faculty hires for 2009, three are women.

Engineering has historically been a male-dominated field. But this is changing. And we are proud to be playing a significant role in this movement, with women who set the highest standards for excellence in the classroom, in innovative research, and in serving the community.

Sincerely,

Vijay K. Dhir  
Dean

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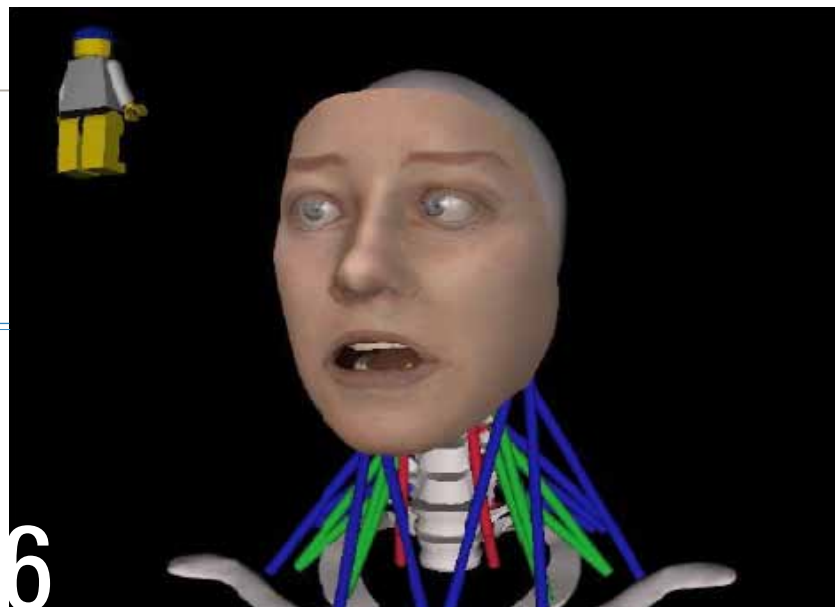
**6** Realistic Human Simulation

**8** Stimulus Funds Help Start Program to Create Clean-Tech Leaders

**10** Entrepreneur Makes a Life of Giving Back

**12** Middle and High School Students in Los Angeles Learn from UCLA Science and Engineering Experts

**14** Advanced Techniques to Study Ancient Civilizations



**6**

**2** Research Summaries

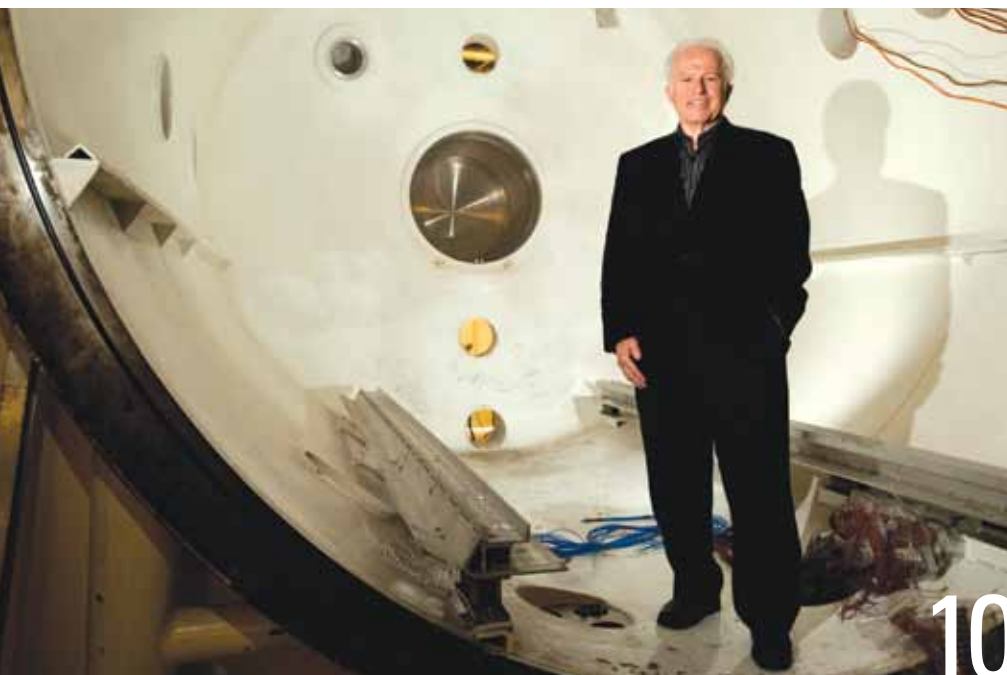
**4** Faculty News

**16** School News

**20** Student News

**24** Alumni News

**30** 2008-09 Annual Report



**14**



**10**

# ADVANCED TECHNIQUES TO STUDY ANCIENT CIVILIZATIONS

Matthew Chin

The UCLA campus is virtually split into two parts — a fact many students learn at freshman orientation. North Campus — the realm of visual and performing arts, humanities, and social sciences — and South Campus — the domain of engineering, physical and biological sciences, and medicine.

These labels are often only for convenience. UCLA is home to innovators who cross disciplines, combining advanced technology with classical scholarship to create new knowledge.

One great example of this type of scholar is Ioanna Kakoulli, who works in the emerging field of archeometry, an integration of science and archeology.

Kakoulli is an associate professor of materials science and engineering, with a joint appointment at the UCLA/ Getty Archaeological and Ethnographic Conservation Program and the Cotsen Institute of Archeology.

Kakoulli's research includes the continuing study of ancient Greek painting and color technology, using advanced analytical techniques and synchrotron light source to decipher the materials ancient artists used.

At the height of the Late Classical to Hellenistic Period (~400 to 100 BC), painting was particularly significant, since it was not confined to a specific area, nor to a specific ethnic group. Art became the *lingua franca* among different groups of people, from the Balkans to the Levant, and as far as India, throughout which ideas and goods flowed freely. Greek painters had perfected techniques and manufacturing of materials that resulted in lasting, beautiful art.

Painting during this period went beyond the alluring composition of beautiful colors. Pliny the Elder (1st Century AD) provides the most significant insight in ancient Greek art, mentioning Agatharchos from Athens (5th Century BC) as the first artist to introduce perspective in painting, and Apollodoros, a vase painter, as the one who expressed realism and introduced shading that was



*Ioanna Kakoulli, at the Getty Conservation Institute in Malibu, standing over UCLA students' class projects that recreate, deteriorate, and then restore examples of ancient art.*  
photo by Todd Cheney

extensively used by acclaimed Greek painters, Zeuxis and Apelles.

“Pliny further refers to Polygnotus from Thasos ‘...who first depicted women with see-through clothing...’ Scientific studies of surviving examples from this period have shown how pictorial representations — something like what we understand of paintings today — was born in this period,” said Kakoulli.

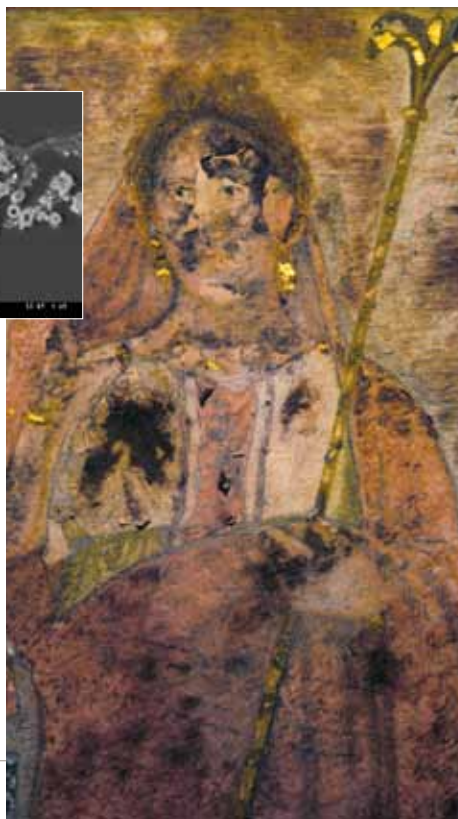
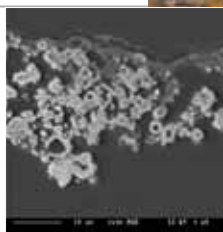
“Using modern technology, we are unmasking the secrets of ancient Greek painters and explaining, both in

Details from the painting decorating the throne in the 'Tomb of Eurydice' at Vergina, Greece.

left: A photomicrograph of a mauve color used in the painting. The stratigraphy of the sample shows the precipitation of the organic colorant on calcite crystals.

middle: The painter used gum arabic as the binding medium, and lakes (organometallic complexes) to create the illusionistic effect of transparency, clearly visible in the area where the gold bracelet is.

right: This photo was taken with oblique illumination, enhancing the surface texture of the painting. photos courtesy of Ioanna Kakoulli



historical and technical terms, the development of pictorial means, such as, the use of shading, three-dimensionality, spatial perspective, transparency, and gilding - innovations that characterize the Hellenistic period.”

Creating these works required more than just a keen eye and skilled hand. Scientific techniques have revealed these ancient artists used local and imported natural minerals, dyes and plant gums, because of their luster and material characteristics. They also used artificial composites such as high fired ceramics glass frits and organo-metallic complexes with the desired properties.

One of the works Kakoulli has analyzed extensively is the marble throne that decorates the tomb of Eurydice Sirra, Queen of Macedonia in the 4th Century BC, and better known as the grandmother of Alexander the Great.

The free-standing throne is the most outstanding feature of the tomb. The legs and armrests are decorated with female figures, lions and deer, and mythological creatures like griffins. The most impressive part of the throne is the painted ‘picture panel’ representing a painting of Pluto and Persephone on a four-horse chariot.

“For the study of this unique and archaeologically significant artifact, a variety of techniques were used. These included, broadband imaging from the ultraviolet to near infrared; optical and electron microscopy; infrared and x-ray spectroscopy, as well as chromatographic techniques,” said Kakoulli.

According to Kakoulli, the analysis has shed new light on the technology of ancient painted monuments, including

highly sophisticated techniques using a variety of natural (local and imported) and synthetic materials.

Though the technology of the ancient Greeks remains Kakoulli’s primary research interest, she also collaborates with other UCLA researchers.

She is the co-director of a project that examines Pre-Columbian mummified human remains in Northern Chile’s Tarapaca Valley. This project incorporates modern medicine, as well as natural and forensic science to examine organic materials — to the molecular level — that can deduce the types of diseases they may have had, and the types of drugs they may have used.

More recently, she is leading a research project on unique 12th Century Byzantine murals at the monastery of St. Neophytos in Paphos, Cyprus.

Kakoulli teaches students in the UCLA/Getty conservation program and in the materials science department through hands-on research projects.

“Our students are really very fortunate to have access to state-of-the-art facilities with advanced instrumentation at UCLA and the Getty Villa. Undoubtedly, UCLA and the Getty offer a unique educational and research platforms that enable and enhance learning and discovery. Our approach exposes students to critical and creative thinking that helps prepare them for successful careers,” said Kakoulli. ●

*More information on Ioanna Kakoulli’s research is available online at: <http://www.sscnet.ucla.edu/ia/archaeogroup/>*