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## Director's Message

# IMSC shines for critical NSF review

The major steps in IMSC's critical three-year review process by the National Science Foundation (NSF) have been completed, and we will receive final word in early fall on our proposal for a five-year contractual renewal as an Engineering Research Center (ERC).

As the first step in the process, we submitted IMSC's "Year Three Annual Report and Proposal" to NSF on April 15, a comprehensive report prepared following strict NSF guidelines that described the substantial progress of our programs.

Next, we showcased our programs for an NSF site review panel that visited IMSC on May 18-20. The NSF team also met with members of our Scientific Advisory Board (SAB) to hear first-hand their review of the Center's activities. In a private meeting between the review team and 32 attending SAB members, SAB Chairman Andrew G. Tescher presented the SAB's annual "SWOT" analysis on strengths, weaknesses, opportunities and threats, as prescribed by NSF.

The SAB is composed of IMSC's

corporate partner representatives and provides a valuable outside perspective on the effectiveness of the Center's work. This Board reviews IMSC's programs and offers feedback and suggestions for their direction, which is critically important for the Center as well as for NSF. The annual mid-year meeting of the SAB is timed to overlap with the site visit so that industry members can meet with the NSF team.

The report of the NSF team after the site visit was excellent, and we were extremely pleased when the team praised IMSC's work on all fronts—vision, research, education, industry collaboration and technology transfer, community outreach and Center management.

In the final major step of the renewal process, Deputy Director  
*(Please turn to page 7)*



**Chrysostomos L. (Max) Nikias**

## UWB radio draws national interest

The ultrawideband radio work of two IMSC corporate partners—introduced originally by IMSC—was featured recently in *USA Today* and *The New York Times*.

Time Domain of Huntsville, AL, and Sierra Monolithics of Redondo Beach, CA, have been working together on UWB technology since they were

first introduced by IMSC several years ago.

And now their work has made headlines in the national press.

Sierra Monolithics used a silicon germanium integrated circuit fabrication process of IBM—another IMSC corporate partner—to create fully  
*(Please turn to page 7)*



Photo by Dan Avila

*Lon Hatamiya, Secretary, California Trade and Commerce Agency (right), visited IMSC in March to reinforce the State's support of IMSC and personally deliver the State's ongoing financial commitment to IMSC Director Chrysostomos L. (Max) Nikias, who briefed him on IMSC activities. Secretary Hatamiya also toured IMSC laboratories and met with IMSC investigators and students.*

### Inside IMSC News

- New student program begins ..... 2
- Lockheed Martin praises IMSC ..... 3
- Technology transfer plans expand .. 4
- Spurgeon named to key post ..... 4
- Compression research scores ..... 5
- Student Conference sets record ..... 5
- Haptic Museum aims high ..... 6

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# New undergraduate research program reaches out

IMSC recently launched a new program that not only expands undergraduate participation in IMSC's research efforts, but also provides project management experience to IMSC graduate students who supervise and mentor the undergraduates and increases corporate partner-student interaction through participation of company representatives as "industrial mentors."



**Chad Jenkins**

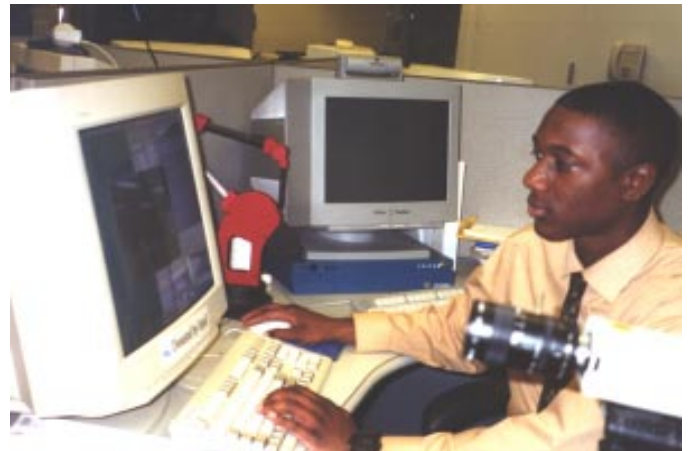
according to Prof. Jerry Mendel, IMSC Associate Director for Education. "It's a win-win situation for everybody—for the undergraduates, for graduate mentors, for industry and for the faculty," he said.

Chad Jenkins, a Ph.D. student in Computer Science and the University Liaison on the IMSC Student Council, drafted and refined the basic guidelines of the program. "This program will help us build even more of an IMSC community because these undergraduates will be able to see the big picture, how things really fit together," he said.

Sixteen undergraduates were awarded grants for research projects that began this summer and will last from nine to 12 months. IMSC investigators, graduate students and industry representatives will work closely with the undergraduates over the life of the projects.

"It's a great program because it really reaches out to undergraduates and brings them directly into our research program,"

Undergraduates from California State University, Los Angeles (CSULA), were eligible to apply as part of a collaboration between IMSC and CSULA to enhance participation by underrepresented minority students. The CSULA School of Engineering is the only engineering school in the state with a predominately minority student population.



**VIDEO PRODUCTION**—Grantee Nathaniel Dawkins, a sophomore in Communications, will use a state-of-the-art video editing system to provide support for IMSC projects.

Students will prepare a short research report on each project, presenting their results at a special one-day conference. Some students have already begun their projects this summer, while others will start in the fall.

The students are studying a wide range of topics. For example, in the audio field, one student will carry out multi-channel experiments in aural recognition, localization and spatialization for the visually impaired, and, in the haptics field, other students will conduct experiments on the usability of haptic interfaces.



**MOVIELOC RESEARCH**—Jesse Patterson, a junior in Biomedical Engineering (left), and Anthony Ko, a junior in Electrical Engineering, will assist in the development of MovieLoc, one of IMSC's Demonstration Technologies projects.

The projects were conceived by IMSC's key investigators and graduate students to enhance present research efforts in the extension of the Media Immersion Environment (MIE) and in IMSC's three research areas of Computer Interfaces, Media Communications and Information Management. Students submitted proposals in early spring, and the selections were made in May.



**AUDIO RESEARCH**—Grantee David Miraglia, a senior in Cinema/Television Critical Studies, will conduct audio research to assist the visually impaired.

# IMSC supports Lockheed Martin's MPEG-4 work

Lockheed Martin Corp., an IMSC corporate Senior Partner, has called on the Center to provide support to the company in showing how the new, developing MPEG-4 multimedia compression standard will fare in the real-world networking environments of satellite and Internet transmission.

Through the participation of an IMSC graduate student, the Center worked with Lockheed Martin on the first successful real-time display of MPEG-4 by geosynchronous satellite last October.

That historic feat occurred when Lockheed Martin and other telecommunications organizations conducted a demonstration for the 45th meeting of the International Motion Picture Experts Group (MPEG) Committee, the standards-setting body for the international broadcasting community.

"We showed that the early stage MPEG-4 was operational not just in a lab but, more importantly, in the networking environment of satellite transmission," said Andrew G. Tescher, Lockheed Martin's principal representative to the MPEG standards committee and to IMSC.

Tescher is a Technical Consultant at Lockheed Martin's Interactive Technology Center (ITC) in Sunnyvale, CA, and Chairman of IMSC's Scientific Advisory Board (SAB).

## Bandwidth optimized

The "multicast" broadcast was transmitted from the ITC facility in Sunnyvale to an MPEG committee meeting in Atlantic City, NJ, and demonstrated how bandwidth can be optimized by sending multiple programs, such as video, audio and overlay information like subtitles, in such a manner that users can configure their own programming by selecting each program individually.

Several weeks earlier, in preparation for the broadcast, IMSC graduate student Cissy Fang Liu had traveled to ITC in Sunnyvale to provide technical support. She worked with Tescher and other staff for a week on the complex

systems integration required for the multicast.

Liu spoke enthusiastically of her experience working at Lockheed Martin.



Cissy Fang Liu

*"It was exciting working on the (historic MPEG-4) multicast."*

"It was exciting working on the multicast," she said, noting that it was truly an international endeavor with development support from leading telecommunications research and development organizations in the United States as well as in Italy, France, Germany and Israel.

Liu, who came to USC from China two and a half years ago, first earned a Master's Degree in Electrical Engineering and now is working on her Ph.D. in the field.

IMSC is also conducting research for Lockheed Martin on the implementation over the Internet of very low bandwidth MPEG-4 speech.

"In this project, IMSC investigators are using the MPEG-4 technology in a 'real network environment' at the low bandwidth of 2 kbps," Tescher said.

He pointed out that this compressed speech uses only five percent of the bandwidth of a standard telephone connection. Liu is a researcher on this project, which is headed by IMSC key investigator Prof. C.-C. (Jay) Kuo.

## IMSC student's work praised

Tescher praised Liu's work on the multicast and her continuing research on the compressed speech project. "She is an extremely capable researcher, and we're very pleased at being able to work with a student of such high caliber," he said.

Mark George, Manager of ITC and SAB member, gave high marks to IMSC's policy of facilitating student

interaction with corporate partners through encouraging student participation in specific company-sponsored research projects, publicizing internships and regular employment opportunities and arranging other opportunities for student-company involvement.

George pointed out that he is pleased with the progress of IMSC's research, now in its third year. "IMSC works closely with us and responds whenever we need support. We're very happy with the collaboration," he said.

## IMSC's research lauded

Gary Hafen, Manager of the Software Engineering Division of Lockheed Martin's Skunk Works in Palmdale, CA, and the Corporate University Executive for USC, said he has been very impressed over the years with IMSC's research.

He foresees possible opportunities in the future to make use of the Center's research in the company's work in human-computer interactions and high bandwidth communications involving aircraft.

He also said that IMSC's research could be relevant to the development of a "virtual product development environment" in which engineers in different offices across the nation can work together.

Dale von Haase, Director of Aerospace Science at Lockheed Martin's headquarters in Bethesda, MD, and a member of IMSC's Board of Councillors, also stressed that IMSC's research has been "very beneficial" to the company.

He especially cited Liu's trip to Sunnyvale for the multicast as being a good example of how IMSC is producing students who are eminently qualified to work in the multimedia industry.

*For more information on IMSC's research on compression, see "IMSC contributes to compression standards," on page 5.*

# IMSC begins new initiatives to transfer technology

To further spur on its successes in technology transfer and the formation of spin-off companies, IMSC is launching new initiatives to transfer technology to the multimedia industry.

In addition to the recent staff additions in its Industry and Technology Transfer Office, IMSC will use the services of two organizations specializing in this area.

A company in the heart of Silicon Valley with extensive, specialized Internet/World Wide Web experience and USC's School of Engineering Technology Transfer Center (ETTC) will serve as links for IMSC to the booming industry expansion.

The Silicon Valley company, ConceptLabs of Sunnyvale, will serve in the role of incubator, but will offer much more than the usual incubator, according to Isaac Maya, IMSC's Director of Industry and Technology Transfer Programs.

"ConceptLabs provides in-house personnel with in-depth knowledge of the kind of Internet technologies IMSC has developed—a capability woefully absent in almost all incubators," Maya said, emphasizing that this particular ingredient adds considerable import to ConceptLabs' other capabilities, such as the development of venture/seed capital and the provision of administrative, legal and business support. Rao Machiraju, Co-founder of ConceptLabs, is a member of IMSC's Scientific Advisory Board and was formerly the Manager of the Learning Communities Laboratory of Apple Computer.

Maya pointed out that the advantages of IMSC's partnership with ConceptLabs are "to refine and improve ideas and technology at an early stage in order to hit particular windows of business opportunity, quickly move the technology from the development stage to end-product stage to start-ups and strategic partners and provide a Silicon Valley presence."

The School of Engineering Technology Transfer Center, which also serves as NASA's Far West Regional Technology Transfer Center, presents a perfect partnering opportunity for IMSC, accord-

ing to Maya. The ETTC will provide expertise in the area of technology transfer, support industry awareness of IMSC's technologies, leverage NASA technology transfer programs and provide technology inventory and assessment services. Maya also stressed that in addition to working with ConceptLabs and ETTC, IMSC is stepping up its efforts to facilitate the launching of new companies and to license IMSC technology. For example, he said, IMSC is negotiating with

Internet Broadcasting Corp. of Seattle to license IMSC's immersive audio and 3D modeling and mosaic technologies.

Maya pointed out that IMSC and its faculty will benefit from these efforts through licensing and royalty fees and equity stakes in spin-off companies. "We want to rapidly get this technology to our partners and those businesses that are most closely associated with the consumer marketplace and in the best position to gauge commercial value," he said.



Isaac Maya, IMSC's Director of Industry and Technology Transfer Programs, and Ann Spurgeon, IMSC's newly-named Associate Director of Industry Programs.

## Ann Spurgeon appointed IMSC's Associate Director of Industry Programs

Ann Spurgeon, an experienced industry relations manager, has been appointed IMSC's Associate Director of Industry Programs.

As her primary responsibility, she will manage IMSC's existing industry relationships. She will communicate regularly with IMSC corporate partners to ensure that their administrative questions are answered and that their research needs are being addressed.

She will be coordinating and conducting visits by corporate partner representatives to IMSC and by IMSC faculty and staff to company locations. She will also coordinate student internships with corporate partners.

"Ann brings a strong sense of professionalism to our department. Her experience in managing industry relations is evident in the way she has approached her responsibilities at IMSC," according to Isaac Maya, IMSC's Director of Industry and Technology Transfer Programs.

Spurgeon said she is looking forward to her work with IMSC's corporate partners. "I was very impressed by the supportive working relationship shown by our industry

*(Please turn to page 8)*

# IMSC contributes to compression standards

IMSC continues to be a leader in the compression field with contributions to the next generation of multimedia standards.

Collaborative work with industry partners has borne fruit as both an IMSC/Rockwell team and an IMSC/Texas Instruments team have scored high in international competition for contributions to the development of the next Joint Photographic Experts Group (JPEG) standard for compressing still images. The new standard is known as JPEG-2000 since it is scheduled to be completed in 2000.

The two teams are working with other investigators to incorporate their methods into the evolving standard, which is being developed by the International Standards Organization (ISO). With the development of JPEG-2000, investigators are trying to achieve low bit-rate image coding with rate-distortion and subjective image quality performance superior to existing standards.

The IMSC/Rockwell team contributed a multi-threshold wavelet codec (MTWC) that ranked second in the ISO's contribution phase, according to Prof. C.-C. (Jay) Kuo, IMSC's principal investigator. Twenty-four proposals were evaluated on their compression performance on 35 test



*Professor C.-C. (Jay) Kuo (left) and Professor Antonio Ortega discuss IMSC's latest data compression research.*

images, and IMSC/Rockwell's MTWC performed at least 3 dB better than today's JPEG standard in all test images at all bit rates.

Now, in the second development phase, called the convergence phase, the best compression technologies are being integrated to yield the best possible compression algorithm. Currently, in this phase, the IMSC/Rockwell team is improving the coding performance based on a new generation verification model. Moreover, other functionalities, such as watermarking, error resiliency,

post processing, and visual quality, will also be incorporated.

The IMSC/Texas Instruments team's proposal in the JPEG-2000 contribution phase was an image encoder, based on wavelets, capable of handling both natural images (e.g., photographs) and simple images (e.g., scanned bi-level images or graphics). IMSC's contribution to the proposal was an algorithm for the coding of simple images, according to Prof. Antonio Ortega, IMSC's lead investigator on the project. He said that the IMSC/Texas Instruments team's proposal ranked seventh overall for perceptual quality and even higher for compound documents, those composed of both natural and simple images.

Another standard, the MPEG standard for video, is also being upgraded by the ISO, and the IMSC/Rockwell team is contributing to that revision as well. The new MPEG standard, called MPEG-4, will support a much wider variety of multimedia applications than the present MPEG standard.

Additionally, IMSC is contributing to the International Telecommunications Union's development of standard H.263++, an improved standard for video conferencing and the video phone.

## Student Conference sets attendance record

The Third Annual IMSC Student Conference on April 16 at USC's Davidson Conference Center was the largest ever with 140 registrants.

This year's theme of "Turning Data into Dollars" and a focus on the entrepreneurial and economic aspects of multimedia sparked increased interest campus-wide, with notably more participation from students at USC's Marshall School of Business.

Steven Puri, President of Centropolis Effects, a company that produces digital visual effects for movies, gave the keynote address.

Tom O'Malia, the Director of the Lloyd Greif Center for Entrepreneurial Studies at the Marshall School, spoke as a Special Presenter on entrepreneurship and discussed how to assess opportunities and risks and develop a business plan.

The day-long conference, which was sponsored by the IMSC Student Assembly, featured 18 student research presentations. Bogdan Hoanca, who received his Ph.D. in Electrical Engineering in May, won the competition for the best student research paper with his entry, "High Throughput Networks for Multimedia Applications." The research involved a new class of optoelectronic architectures using free space digital optics.

*(Please turn to page 8)*

## Haptic Museum seeks to offer remote "touching"

In the long-term vision of IMSC's Haptic Museum project, 12-year-old Sarah picks up and examines a fragile ancient Chinese vase—without getting shooed away.

In fact, the young museum-goer is surfing the museum's Web site and not even in the museum itself. She's at home using a haptic device on her computer to experience realistic tactile sensations when "touching" the museum's art objects.

Sarah actually feels the Chinese vase's weight, shape and surface structure. She does this by "holding" a digitized, three-dimensional model that appears on the screen.

At the museum, a staff person retrieves the same model and uses another haptic device to demonstrate the vase's interesting contours and textures.

Sarah interacts with the museum staffer, asking such questions as, "Why is this side rough but that side smooth?" or "What is this indentation on the bottom for?"

To realize this vision, IMSC investigators are currently working in collaboration with the Fisher Gallery, USC's accredited art museum, to develop the necessary haptic technologies.

The software being developed in the Haptic Museum Demonstration Technologies project also will have



*Professor Margaret McLaughlin, key investigator on IMSC's Haptic Museum project, works with the CyberGrasp haptic device, as Lingling Zhang, a Master's student in Communications Management, checks measurements.*

many uses beyond the museum setting, according to Dr. Margaret McLaughlin, IMSC's principal investigator on the project and Professor of Communication at USC's Annenberg School for Communication. She said that the software will be valuable in a wide range of areas, such as scientific visualization, medical simulation and manufacturing.

In working with the Fisher Gallery, IMSC investigators are digitizing teapots from the gallery's Narramore collection and experimenting with two haptic devices that generate tactile sensations of the digitized teapots—the PHANToM, a pen-like device that provides force feedback to the fingertip as the user traces the contours of the object, and the CyberGrasp, a glove that provides realistic whole-hand force feedback as the user grasps, pokes and prods objects on the screen.

In developing a high fidelity haptic system, IMSC investigators are focusing their work in four fundamental areas, according to McLaughlin. The first area is the development of fast contact and collision-detection algorithms for the virtual object, and the second is the accurate tracking of the user's hand position as he or she uses

the haptic display. The third is the development of algorithms for generating appropriate force feedback for the user who is probing the virtual object. The fourth is the assessment of the usefulness of haptic acquisition and display and exploration of the interaction of audio, visual and haptic displays in the exhibition of museum objects. The work on collision detection, tracking and force feedback is being done in collaboration with Professor Gaurav Sukhatme of the Robotics Research Laboratory.

The initial goal with respect to haptic collaboration is to be able to record, store and replay haptic data, so that visitors to a virtual museum can experience pre-recorded haptic sessions; that is, they can have their tactile experience of an object "guided" by following an art expert's pre-recorded exploration path. Professor Cyrus Shahabi in Computer Science has conducted investigations in this area for the project.

McLaughlin pointed out that as the Haptic Museum project evolves, investigators plan to integrate the entire range of media types supported by IMSC's Media Immersion Environ-  
*(Please turn to page 8)*

### IMSC News

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# National interest building in ultrawideband radio . . .

*(Continued from page 1)*

customizable chips for Time Domain in its development of a radio using UWB wireless technology.

One of the chips was featured in a photo of Ralph Petroff, Time Domain's Chief Executive Officer, and Larry Fullerton, Time Domain's Chief Technology Officer, that accompanied two articles in the April 9 edition of *USA Today* on the potential of UWB wireless technology. *The New York Times* featured the work in an article last December.

One of the main goals of IMSC's industry program is to facilitate such corporate partner collaborations, according to Prof. Robert Scholtz, IMSC's key investigator on UWB wireless technology. Scholtz, who is Chair of USC's Electrical Engineering Systems Department, heads the UltRa Lab, which investigates UWB technology.

Paul Withington, Time Domain's Vice President and Senior Technologist and a member of IMSC's Scientific Advisory Board (SAB), praised IMSC's role in facilitating the collaboration with Sierra Monolithics. Charles Harper, President of Sierra Monolithics and also an SAB member, also praised IMSC's role, saying, "Without IMSC, the collaboration wouldn't have happened."

Withington stressed that Time Domain's "interaction with IMSC's UWB radio efforts has been very beneficial." Harper also emphasized the high value of working with IMSC, saying that the Center provides access to a variety of cutting-edge multimedia technologies that will allow Sierra Monolithics to expand into other areas as well, especially in the optical networking arena.

Scholtz and his investigators are conducting experiments with a Time Domain radio link, and Sierra Monolithics is fabricating the chips for the radio.

The national press coverage reflects a growing interest in UWB technology, also known as impulse radio.

Last year, a workshop organized by



**ULTRAWIDEBAND RADIO**—Professor Robert Scholtz (right), IMSC's key investigator in ultrawideband wireless technology, discusses research with Joonyong Lee (left) and Jean-Marc Cramer, both Ph.D. students in Electrical Engineering.

IMSC on this novel radio technique served as a catalyst for focusing private industry concerns on restrictive regulation by the Federal Communications Commission (FCC), and now the agency is reevaluating those policies that hinder comprehensive research and commercialization of UWB systems.

UWB technology uses pulses of radio energy rather than radio waves to transmit information wirelessly in a digital form, offering a broad range of possible applications, from wireless voice and high-speed data communications to advanced radar systems. Ultrawideband radio could offer extremely low-power communications systems that tend to penetrate physical objects, are almost immune to eavesdropping, can tolerate significant levels of interference, and can eliminate many forms of multipath fading.

Scholtz said IMSC's work in ultrawideband is aimed ultimately at determining the architecture for the next generation of UWB radio, with such objectives as understanding the UWB propagation characteristics of potential operating environments and demonstrating fully mobile indoor wireless communication of full motion video.

For more details on IMSC's UWB technology research, log on to IMSC's Web site at <http://imsc.usc.edu/Research/mc/wireless.html> and the UltRa Lab's Web site at <http://ultra.usc.edu/ulab>.

## IMSC shines . . .

*(Continued from page 1)*

Alexander Sawchuk, Research Associate Director Ulrich Neumann and I presented to an NSF ERC Review Panel on June 10. Two members of the site review team were also members of this panel. The ERC Panel, which previously was involved only in NSF's initial proposal stage for ERCs, met for the first time this year to review the three-year renewal proposals in order to add a second dimension to the review process.

I would like to express my deep appreciation to IMSC faculty, staff and students for their dedication and hard work over the past three years and especially over the past few months during the review process.

We are ready to build on our impressive achievements and, as the NSF review team anticipates, to realize our potential over the next five years to become the leading multimedia technology center, not only nationally, but internationally as well.

## Haptic Museum . . .

*(Continued from page 6)*

ment, the Center's testbed for integrated media applications. Such data types include art vocabularies and thesauri, provenance indices, continuous media (audio and video), images, and haptic sessions and annotations.

Additionally, as the storage needs for haptic data are being evaluated, compression issues are emerging as an important research area for IMSC investigators, according to Professor Antonio Ortega, an IMSC investigator in Electrical Engineering. "Compres-

sion techniques are needed to support efficient storage and retrieval, and these techniques must be decodable in real-time decompression, so that real-time retrieval and rendering can be performed," he said.

Professor Gerard Medioni, an IMSC investigator in Computer Science, said that the rendering of haptic data presents significant challenges, including the design of end effectors to convey not only local shape, but also smoothness, texture and friction; the development of physically plausible models of dynamics to model deformable or fluid objects; and real-time implementation.

## Student conference breaks record . . .

*(Continued from page 5)*

The conference also offered morning and evening panels with IMSC and industry representatives, industry members of IMSC's Scientific Advisory Board and breakout sessions led by IMSC faculty. The morning panel focused on intellectual property and technology transfer issues, and the evening panel featured multimedia industry entrepreneurs discussing their work. The two breakout sessions were on "IMSC Intracenter Communication" and "The Future of the IMSC Student Assembly."

A "Resume Book" with resumes from IMSC students and conference registrants was provided to all industry participants. For a copy, send email to Ann Spurgeon, Associate Director of Industry Programs, at [aspurgeo@imsc.usc.edu](mailto:aspurgeo@imsc.usc.edu).

For more details on the Center's work in this area, visit IMSC's Haptic Museum Web site at <http://imsc.usc.edu/Research/ci/art.html> and the project's Web site at <http://digimuse.usc.edu/museum.html>.

## Spurgeon . . .

*(Continued from page 4)*

partners at the Scientific Advisory Board meeting in May. This type of collaboration is a vital component for the continued success of the Center," she said.

Spurgeon comes to IMSC from the City of Hope in Los Angeles, where she worked in industry development and the donor relations department. Her responsibilities there included organizing and managing large industry dinners, dedications, receptions and other events.

She has also worked as an event planner for other organizations, as an airline flight attendant and as a teacher.

She holds a Bachelor of Arts in Health and Physical Education from Ohio Northern University in Ada, Ohio.

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