2007

COMPONENTS

Center for Computation and Technology at Louisiana State University

LSU

LSU Center for Computation & Technology

The Center for Computation & Technology is an interdisciplinary research center that advances LSU's Flagship Agenda and promotes economic development for the state by using computational applications to aid research and develop solutions that benefit academia and industry. CCT is an innovative research environment, advancing computational sciences, technologies and the disciplines they touch. Researchers at CCT use the advanced cyberinfrastructure— high-speed networks, high-performance computing, advanced data storage and analysis, and hardware and software development—available on campus to enable research in many different fields. By uniting researchers from diverse disciplines, ideas, and expertise are disseminated across LSU departments to foster knowledge and invention.

When I came to Louisiana four years ago to lead the CCT, I envisioned a collaborative, interdisciplinary research environment, where scientists could work side by side with artists, musicians, and others to enable breakthroughs in all areas of research, striving to show how advanced cyberinfrastructure is impacting everything from grid computing and physics to animation and visualization.

The past years have brought tremendous growth and many successes in our attempt to create a completely new, and novel, interdisciplinary research center. CCT's achievements—research projects, papers, proposals, and awards—make quite an impressive list .

To highlight just a few accomplishments, we spearheaded the state's commitment to the Louisiana Optical Network Initiative (LONI), ensuring Louisiana is one of the most well-connected places in the world, and have built many projects on this foundation. In the past year alone, we have successfully driven development of a $15 million project called the LONI Institute , involving all LONI partners; secured $15 million for a new high-performance computing machine room; helped create the new "CyberTools" project to develop advanced applications and cyberinfrastructure, funded at $12 million by the National Science Foundation and Louisiana Board of Regents; led a $2.2 million award from the National Science Foundation to enable LONI to join the TeraGrid, a backbone of the national cyberinfrastructure; and helped LSU lead a multidisciplinary hiring initiative in computational sciences that will bring more world-class faculty to the University.

But perhaps the best way to illustrate CCT's triumphs is to simply walk the halls of the center. Every faculty member, staff member, and student here represents what makes CCT so special, and together they represent its biggest success. It is just amazing that in so little time we've assembled such a great group of diverse and talented individuals, which to me is the most important sign of growth and progress.

To sum up what we have already achieved, and how this is already noticed around the world, I would like to quote Jim Pool, former executive director of Caltech's Center for Advanced Computing Research:

"It is my impression that CCT has the best opportunity among all the academic sites to develop into a center with a major research agenda. Other academic sites seem to have either a facility orientation or a struggling research program. For past decade, several major academic institutions, including premier Ivy League universities, have tried with little success. Remarkably, LSU has gotten much farther than any of these places in a very short period."

Following these achievements in the formative years of CCT, we now are moving forward to develop a thoughtful plan to advance our efforts, individually as well as collectively, focusing on strategic outcomes.

We are focused on the advancement, organization, and expansion of research activities at CCT and across campus while developing a tighter integration between the computing and research components, which is essential to our mission. We also are working to successfully leverage and progress LSU's and the state's investments in LONI, for which CCT can play a strong leadership role in advancing its use by Louisiana researchers. Through our work, we are positioning LSU for success in bids for national supercomputing center funding and many other projects of great importance to Louisiana.

The contents of this year's "Components" give an overview of some key accomplishments from CCT. We are always working to find groundbreaking ways of enabling research through cyberinfrastructure and are guided by our commitment to further the research and educational goals of the University and to further the economic development objectives of Louisiana. I am confident we will succeed and that I will have even more successes to report in the 2008 edition of "Components." I hope you enjoy this issue and learn more about the innovative work ongoing at the CCT.

Ed Seidel, PhD
Director
LSU Center for Computation & Technology

CCT: Center for
Computation & Technology

The Center for Computation & Technology, or CCT, is an interdisciplinary research center located at Louisiana State University in Baton Rouge. CCT advances LSU's Flagship Agenda and promotes economic development for the state by using computational applications to aid research and develop solutions that benefit academia and industry.

LSU previously housed the Center for Applied Information Technology & Learning, called LSU CAPITAL. In 2003, LSU CAPITAL was integrated as a full research center on LSU's campus and renamed the Center for Computation & Technology.

CCT is an innovative research environment, advancing computational sciences, technologies, and the disciplines they touch. Researchers at CCT use the advanced cyberinfrastructure—systems that incorporate high-speed networks, high-performance computing, advanced data storage and analysis, and hardware and software development—available on campus to enable breakthroughs in many academic fields, from physics to computer science to art and animation.

CCT's director is Ed Seidel, PhD, who is internationally renowned for his work in numerical relativity. Seidel, Floating Point Systems Professor of Physics & Computer Science, received the 2006 Sidney Fernbach award, an international honor from the Institute of Electrical and Electronics Engineers that recognizes career achievements in using high-performance computer technology to solve problems in demanding application areas, such as physics or engineering. Seidel was honored for his work to develop collaborative, high-performance computing approaches to solve complex problems in physics, such as Einstein's equations of general relativity, specifically for colliding black holes.

In addition to Director Ed Seidel, staff at the CCT include Chief Scientist Thomas Sterling, PhD, Seola Arnaud and Richard Vernon Edwards Jr. Professor in LSU's Department of Computer Science, former NASA scientist, and co-creator of the Beowulf class cluster that is a building block of the world's supercomputers; Associate Director Gabrielle Allen, PhD, Department of Computer Science associate professor and co-creator of the Cactus Framework; and Susanne Brenner, PhD, Department of Mathematics professor and recipient of the 2005 Humboldt Research Award.

CCT employs more than 30 faculty members, all of whom hold joint appointments with other LSU departments and colleges, such as the Department of Computer Science, College of Basic Sciences, and College of Music & Dramatic Arts. CCT recruits researchers from all disciplines to create an environment where scientists work side by side with artists and musicians to advance the future through high-performance computing.

The CCT is primarily located in Johnston Hall on the LSU campus, but offices and cyberinfrastructure also are housed in the Frey Computing Services Center. LSU's supercomputer, SuperMike, was located in Frey and used for nearly five years for advanced research. In June 2007, SuperMike began being dismantled to make way for construction of the University's new supercomputer, Tezpur.

Named for one of the world's hottest peppers, Tezpur is nearly three times as fast as SuperMike and is one of the most powerful supercomputers owned by any university in the nation. Tezpur also is one of the 50 most powerful supercomputers in the world.

Tezpur will be an integral part of allowing CCT researchers to use the resources of the Louisiana Optical Network Initiative, or LONI. LONI is a high-speed, fiber-optic network that links supercomputers at the state's major research institutions, allowing greater collaboration on research that produces results faster and with greater accuracy. LONI puts the state on the National Lambda Rail, allowing Louisiana researchers to collaborate with scientists around the country. With LONI, Louisiana possesses one of the most advanced networking environments in the world.

All CCT research activities are organized into broad, interdisciplinary focus areas, each led by a CCT faculty member. Staff within the focus areas develop research agendas that share expertise and technologies across LSU departments. Focus areas are coordinated by CCT Assistant Director for Computing Applications and Department of Computer Science Associate Professor Gabrielle Allen, PhD, one of the lead creators of the Cactus toolkit.

The four CCT focus areas for research are:

Core Computational Science

This focus area is researching and developing methods, tools, and techniques to enable a broad array of applications areas. The Core Computational Science focus area integrates faculty from the LSU Departments of Computer Science, Electrical and Computer Engineering, and Mathematics in the development of software, algorithms, and hardware. Research groups in this area include:
- Scientific Computing
- Distributed Systems
- Computational Mathematics
- Visualization

Coast to Cosmos

The Coast to Cosmos focus area is building research groups to model the complex physical world in which we live. The research groups have common needs for advanced software to support large-scale simulations, collaborative tools to enable diverse sets of scientists to interact, and visualization and analysis tools to understand results and compare experiments. This area currently includes faculty from the LSU Departments of Physics & Astronomy and Mechanical Engineering, with research groups in:
- Numerical Relativity and Astrophysics
- Engineering Applications
- Coastal and Environmental Studies
- Computational Fluid Dynamics

Human and Social World

The Human and Social World focus area concentrates on complex computational problems as they relate to applications in the humanities, arts, business, and social sciences. This focus area explores the intersection of technology with all forms of human expression and creativity and how such technology can be effectively used and adopted with non-traditional application groups, such as animation and visualization. It investigates how new technologies can be used to complement research in social sciences and the humanities, as well as provide new tools, platforms, and environments for artistic expression. Two research groups make up this focus area:
- Emerging Computational Applications
- Technology Adoption

Material World

The Material World focus area develops research groups in the computational fields of material science, chemistry, and biology. Current activity in this area involves faculty in the LSU Department of Electrical & Computer Engineering.

For more information on CCT research activities, visit www.cct.lsu.edu.

Lighting Up

LONI

Three years after Governor Kathleen Babineaux Blanco committed $40 million throughout a 10-year period to fund the Louisiana Optical Network Initiative, leaders at the state's major research institutions have created a system that makes Louisiana one of the most well-connected places in the world.

The Louisiana Optical Network Initiative, called LONI, is a high-speed, fiber-optic network that connects supercomputers at Louisiana's premier universities—Louisiana State University, Louisiana Tech University, LSU Health Sciences Center in New Orleans, LSU Health Sciences Center in Shreveport, Southern University, Tulane University, University of Louisiana at Lafayette, and University of New Orleans—allowing greater collaboration on research that produces results faster and with greater accuracy.

LONI puts the state on the National Lambda Rail, allowing Louisiana researchers to collaborate with scientists around the country and the world on major initiatives.

In addition to the supercomputers at universities, LONI centers around a 50-teraflops supercomputer called Queen Bee, located in the state Information Systems Building in downtown Baton Rouge. The supercomputer's name comes from a nickname of Governor Blanco, to honor her commitment to building LONI during her administration.

Queen Bee is the 23rd most powerful supercomputer in the world. In fall 2007, Queen Bee was integrated into the TeraGrid, a nationwide, National Science Foundation-funded research infrastructure that incorporates high-performance computing resources across the country. Through Queen Bee, the state will allocate resources to support a national research community.

Connecting to Mississippi

LONI also has a new customer base in the state next door. Four Mississippi universities—Jackson State University, Mississippi State University, University of Mississippi, and University of Southern Mississippi—buy into the LONI network to conduct economic development-oriented project research at those sites. Mississippi also will use LONI's advanced resources to connect the state to Internet 2.

LONI Executive Director Charlie McMahon, who is also CCT's chief technology officer, explained these schools are customers of the network.

"LONI becomes their service provider and gives them access to the networks and infrastructure they need for research," McMahon said.

The LONI Institute

LSU, Louisiana Tech University, Southern University, Tulane University, University of Louisiana-Lafayette, and University of New Orleans received funding in June 2007 to create a state-of-the-art research collaborative that will enhance Louisiana's scientific and economic development capacity.

Funding for this project, totaling more than $15 million, created a bold new multi-institutional, multidisciplinary endeavor called the LONI Institute. The primary funding is from the Louisiana Board of Regents' Post-Katrina Support Fund Initiative, or PKSFI, and from significant matching funding from all institutions involved. The PKSFI program provides funding for state projects designed to boost scientific research and economic development for Louisiana following Hurricanes Katrina and Rita.

The LONI Institute is not located in a single building but is a collaboration of researchers among the six LONI sites that creates a multi-disciplinary environment. The CCT is the central hub of the distributed institute, coordinating activities from LSU.

The six LONI Institute partners will conduct research primarily in biology, materials science, and computational sciences. The institute will use the advanced resources of LONI to drive research and education, which will lead to economic development for the state.

The LONI Institute creates several new faculty, staff, and graduate student research positions at the six universities. In addition, the institute will initiate projects in cooperation with industry to advance economic development in Louisiana.

CCT Director Ed Seidel, the principal investigator for this proposal, explained how the LONI Institute will catalyze Louisiana's work to build up its cyberinfrastructure base.

"Louisiana has made great investments in IT through its Vision 2020 initiative and through the creation of LONI," Seidel said. "Now that we have the resources in place, we need to develop research projects and find the staff who can use the advanced technology in Louisiana to further academics and create more opportunities for business and industry so we can fully capitalize on these investments."

In the LONI Institute proposal, Seidel noted strong computational science efforts in Illinois produced an estimated trillion-dollar impact on the world economy, generating more than $120 million in corporate partnerships, $400 million in grants, and spawning numerous companies in the past two decades.

Seidel and the other project partners believe the LONI Institute could lead to significant economic development for Louisiana, making the state much more competitive for industrial partnerships with companies that depend on computing advances for their competitive edge. Industries that depend on computational sciences include petrochemical, aerospace, manufacturing, pharmaceutical, and many others.

For more information on the LONI Institute, please visit www.institute.loni.org.

LSU Pioneers Use of **High-Definition** Video Transmitted Via Internet for College Course Offerings

CCT Chief Scientist Thomas Sterling wanted to implement a new kind of course that allowed more college students to learn about the expanding field of high-performance computing. And, in the process of doing so, he taught himself some valuable lessons as well.

"Teaching this course was a humbling experience," said Sterling, who also is a professor in LSU's Department of Computer Science. "I think that the creators of the course learned more than the students did, not just in the course itself, but in the very process of education and this new medium."

has access to a high-speed network connection for ease in streaming the course, and also because there is a high-performance computing expert at each of those universities who can assist with the trial run as necessary.

The course had a test run prior to the start of classes by hosting a live demonstration with outgoing Arkansas Governor Mike Huckabee and other distinguished guests on December 18, 2006.

Sterling traveled to Arkansas to demonstrate the course, and the participants were connected live with CCT Director Ed Seidel, who was at LSU, for a second part of the demonstration. Audiences in

Sterling's course, "High-Performance Computing: Concepts, Methods, and Means," premiered in the spring 2007 semester and was the first course of its kind in the United States, marking the first use of high-definition video broadcast via the Internet for distributed classroom instruction. The course was not only offered at LSU, but through advances in technology, was exported to schools internationally as well.

Sterling, an internationally recognized supercomputing expert who was with NASA prior to joining CCT, wanted to create a course that could embrace the new technology available in today's college classrooms while also offering more students the chance to learn about a field that will impact all areas of business.

"As an objective of starting this course, we wanted to level the playing field and broaden the impact and availability of a very difficult area of information to an ever-expanding community," Sterling said.

The idea for using this technology for the class grew out of a research project on the use of optical networks done in collaboration with colleagues at MCNC of North Carolina and Masaryk University in the Czech Republic.

CCT Director Ed Seidel, PhD, supports the course as a way to bring the technology of high-performance computing to more people who can go on to use that technology in the workplace.

"It is amazing to see a research project lead to such an important application in practice in just a year," Seidel said. "It is a good example of the immense payoff of research and the state's investments in the Louisiana Optical Network Initiative and other information technology programs for things we do in everyday life—in this case, education."

For the alpha run of the course, which began on January 16, 2007, it was offered to students at Louisiana Tech University, the University of Arkansas, MCNC—North Carolina, and Masaryk University in the Czech Republic.

These sites were selected for the first run of the course because each

both Fayetteville, Arkansas, and Baton Rouge, Louisiana, were able to participate in the demonstration, showing how the course would work in transmission across great distances.

So, does Sterling feel his course was a success?

"We certainly did not do everything we intended to do with respect to the course, but we did fully achieve very important goals. We did so in two ways: first, we brought a body of material that has never been available in a single-semester course, creating a new focus area that did not exist before. In doing this, we made it possible for anybody who wants to jump forward in this field to do so in a relatively easy manner," Sterling said. "And second, through technology, we found a way to distribute this material at a level of quality and over great distances, which had not been done together before by using HD video, by using a series of other storage techniques for replay and by using high-bandwidth networks such as LONI, AREON [Arkansas Research and Education Optical Network], and European networks. We have been able to distribute this material live and through replay mode for time warping. As a result, a new form of information has become available to a much broader audience, and this was our objective, and this was our success."

Sterling said he plans to teach the course again in the spring 2008 semester, and plans to expand the number of participating colleges and universities.

"We are now in discussion with at least a dozen additional campuses in Louisiana, the United States, in Europe, and even in Asia about distributing this course next year," Sterling said.

Sterling also is looking into alternative ways of disseminating the information provided in the course, so that students can participate even if they are not able to watch the course in real time. Some methods include a DVD series of the course and iPods containing all the course lectures on Podcast. Both these methods are being developed now, and Sterling is writing a textbook for his course so it can easily be taught at other schools.

While there is always room for improvement, Sterling noted much of the coursework will remain the same in spring 2008.

"We got many things right and the plan is to build on these accomplishments and new strengths while enhancing certain aspects of the material and the technologies being employed to optimize the learning experience for all students, both here on campus and at remote sites," Sterling said.

And Sterling feels he has in fact "struck a blow" in reversing the trend of too few college graduates entering the high-performance computing workforce against a growing demand for workers in this field.

"Time will only tell, but I think this was a very important contribution and all of those people who contributed to making this possible and to crafting it and capturing it in a different form have contributed to what I think is a reversal of this very severe degradation of the U.S. workforce and supercomputing," Sterling said. "Hopefully, it will turn it around."
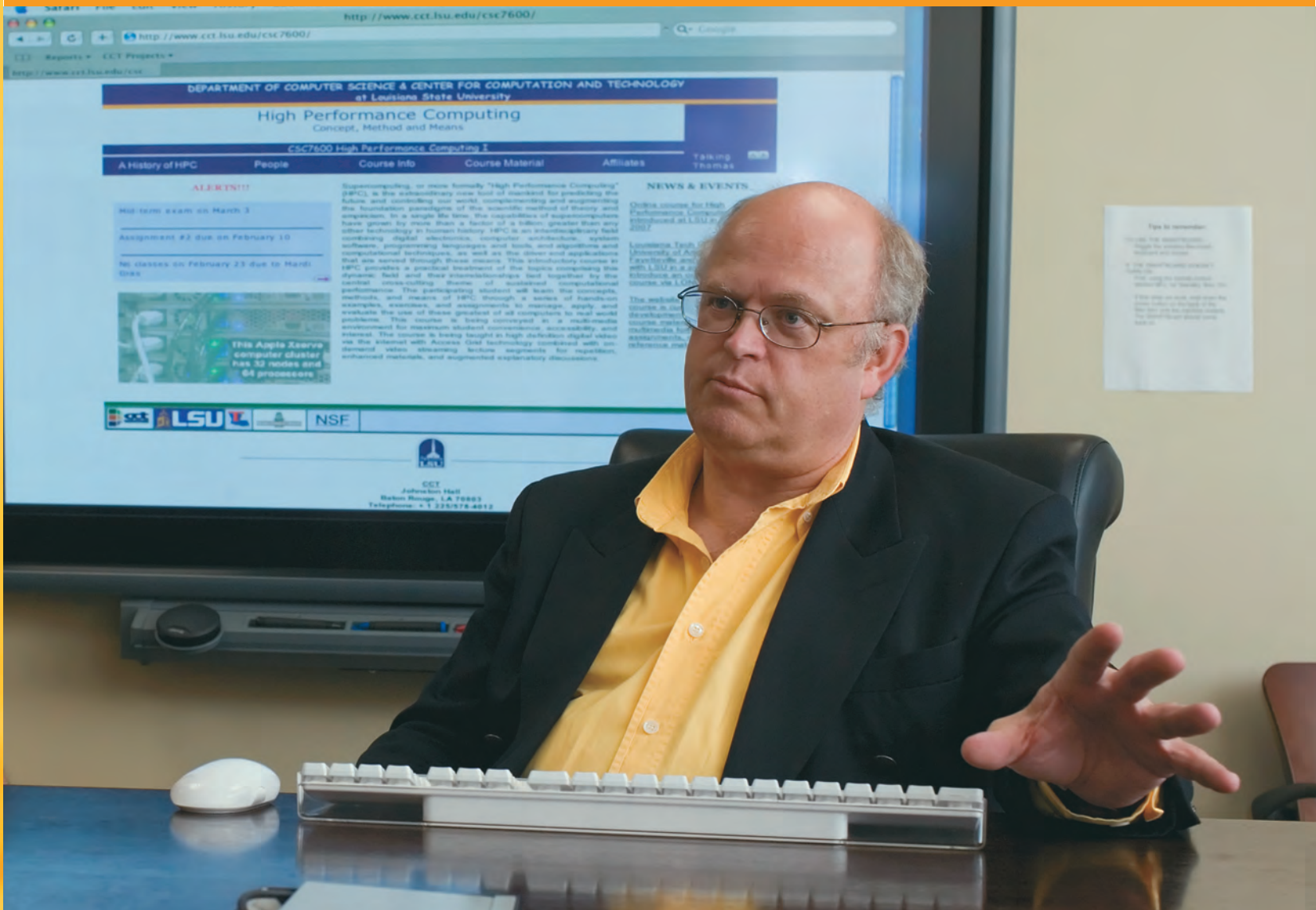
Sterling Creates Computer Architecture and Systems Software Library at CCT

As part of his vision in creating the CCT, Director Ed Seidel wanted the center to have a fully functioning laboratory to conduct research and experiments on different computational applications. Chief Scientist Thomas Sterling shared this vision and, shortly after arriving at CCT in 2005, he began the process for developing such a lab.

Seidel and Sterling have designated workspace at CCT to house the Computer Architecture and Systems Software Library, which Sterling describes as a facility that will support and enable University research.

"Our goal is to enable research across the University to be possible and to be done faster and better, and we do that by providing advanced cyberinfrastructure to enable it and providing high-performance computing to be for collaboration," Sterling said.

In the laboratory, students and staff will conduct research to determine how hardware relates to software and software relates to hardware. The lab is centered around two test beds and one small, configurable computing cluster with four working nodes and one head, or master, node. "The master node is up and running all the time and can be accessed remotely, and the four separate nodes can be modified for experimentation," Sterling said.

Three general elements will be used in experimental elements on each node—networks, special purpose accelerators, and FPGA blades, which are reconfigurable logic cards.

"The idea is to mix elements using these nodes to create different kinds of networks to run different operating systems and applications, integrating power measurement equipment," Sterling said.

Sterling said this initial effort will provide information about how new hardware and computer architecture could serve various applications and computational needs.

The laboratory will be used by multiple researchers for various purposes, but will have two initial goals: conducting research in ParalleX, and exploring the application of accelerators to certain computational applications.

With ParalleX, research is being conducted to investigate new concepts and opportunities in advanced parallel computer architecture and programming environments. The ParalleX group will look at how future large-scale computers can be programmed in ways that incorporate multiple elements effectively.

Also, the group will explore how computing can be governed or controlled as the scale of the machines increases. "Historically, as the technology and architecture have changed, we have had to worry about how to shift the paradigm to take advantage of it," Sterling said.

The ParalleX research will implement changes to the computational model to realize an environment that allows future applications to be easily implemented with new conventions. "We hope that the long-term results of this research will guide future computer architecture development," Sterling said.

With the accelerator research, the lab will explore ideas such as how to speed up storm surge forecasts in advance of a hurricane using a clear speed accelerator. This type of innovation could lead to more accurate warning systems in the future.

Also, CCT's information technology staff can use the laboratory structure to test out new hardware and see its usefulness and operational aspects.

Overall, the Computer Architecture and Systems Software Library will set the foundation for future CCT and LSU research.

"Our goal is to use the upcoming year to lay the groundwork for a full, real laboratory at the CCT," Sterling said.

Bringing Researchers Together

CCT Brings Researchers from All Over The World to Baton Rouge for First Conference on Tangible and Embedded Interaction

In February 2007, CCT brought researchers and industry representatives from five continents to downtown Baton Rouge for the first International Conference on Tangible and Embedded Interaction (TEI).

This conference was an outgrowth of CCT's Annual Mardi Gras Conference, and was the first time a worldwide group of researchers who all specialize in this field came together to discuss new trends and techniques.

Tangible and Embedded Interaction is an emerging field of technology that manipulates physical objects (e.g., paper, blocks, furniture, and clothing) to make them interfaces for digital information. This approach is rapidly growing and has already had a commercial impact in many areas of business.

This field has important implications for many areas of local business, including video conferencing, health care, entertainment, consumer products, software applications, and beyond.

The conference showcased 50 contributions by 140 authors from 15 countries, including from companies such as Sony, Nokia, Philips, and Intel.

"Hosting this conference in Baton Rouge helped establish the city and LSU as major players in this technology field, which we believe also has important economic, cultural, and business development implications," said Computer Science Assistant Professor Brygg Ullmer, who co-organized the conference with four faculty from Boston, Germany, the Netherlands, and New Zealand.

Participants spent time listening to lectures from researchers in this field, including a keynote address by Tom Rodden, PhD, Mixed Reality Laboratory—University of Nottingham and director of Equator.

Between lectures, participants were able to visit a series of booths set up for demonstrations and interactive exhibits of new tangible objects.

Projects the attendees presented at the conference showcased new developments in technology, design, computer science, sociology, and art. Presentation formats included talks, posters, interactive exhibits, and performances. Example projects included instrumented furniture, board games, pillows, architectural windows, paper, wallpaper, shoes, hammocks, many new kinds of graspable physical objects and even an art piece involving meat.

Ullmer, whose research specialty at the CCT is applying tangible and embedded interaction to visualization, co-created the CCT Mardi Gras conference around this theme and recruited peers from around the world to participate. He and his collaborators hope to make the TEI conference an annual event, and planning for next year's conference in Bonn, Germany, is already underway.

For more information on the planning for TEI '08, please visit http://tei-conf.org/.

"Distributed Applications" Theme of CCT Mardi Gras Conference 2008

CCT staff are planning the 15th annual Mardi Gras 2008 conference, which will take place in Baton Rouge from January 31 through February 2, 2008.

Fat Tuesday falls on February 5, 2008, so the conference is timed each year to let participants take part in Carnival festivities.

The theme of Mardi Gras Conference 2008 is Distributed Applications. The conference will show how advanced networks such as Enlightened, the National Lambda Rail, and G Lambda, along with LONI, can enable breakthroughs in research, economic development, and computing applications.

To learn more or register to participate in CCT's Mardi Gras Conference 2008, please visit www.mardigrasconference.org.

IGERT Program Emphasizes
Interdisciplinary Collaboration

Now in its third year at LSU, the National Science Foundation's Integrative Graduate Education and Research Traineeship, or IGERT, program is uniting LSU students and faculty members from different disciplines to collaborate on research.

Other IGERT programs are in place on LSU's campus, but staff with the Center for Computation & Technology lead the IGERT on Computational Fluid Dynamics, which provides doctoral students with enhanced, multidisciplinary education and training to prepare them for research in multi-scale computational fluid dynamics and its applications for complex problems in science and engineering.

The IGERT on Computational Fluid Dynamics is a five-year grant program of more than $3 million from the National Science Foundation. The program will continue through June 2010.

In CCT's IGERT program, faculty and students from different LSU departments who all use computational fluid dynamics—the study of fluid flow in nature—for their work come together to see the similarities and differences in its applications for their areas.

The IGERT on Computational Fluid Dynamics has eight students from eight different academic concentrations including computer science, oceanography, physics, and engineering participating.

Lannette Carroll, CCT's outgoing IGERT coordinator, explained students often join the IGERT program for the enhanced interdisciplinary aspect they would not otherwise receive. "IGERT breaks down departmental barriers and helps the students connect with other disciplines," Carroll said.

LSU Department of Physics & Astronomy Professor Joel Tohline said this kind of collaboration is a dream come true for him and other faculty members who have worked for years to institute interdisciplinary learning.

"After just a year and a half, we have eight students from eight different disciplines working together who would not otherwise have met and talked if it were not for IGERT," Tohline said.

Another aspect of the IGERT program is outreach to the K-12 grades. In April 2007, the IGERT students organized and hosted a workshop for more than 30 high school students and their teachers.

The workshop introduced students to the tools scientists use to conduct research, particularly those used in high-performance computing for computational fluid dynamics. Students got to view presentations by Tohline and CCT Director Ed Seidel and also worked through two tutorials led primarily by the IGERT students.

Students learned to visualize results of a glaucoma computer model developed by the LSU Computational Fluid Dynamics group that simulates fluid flow and pressure distribution in the eye using the visualization software tool Amira. They also took part in a high-performance computing tutorial using the Cactus Framework, running simulations of black holes on the large-scale computing resources of the Louisiana Optical Network Initiative.

"These tutorials gave students a chance to get some hands-on experience at working with real scientific research data and tools they could not get in a regular high school classroom setting," said CCT and LSU Department of Computer Science Associate Professor Gabrielle Allen. "Through these sorts of workshops, students have the chance to see what computational research is really about. We hope the experience will help inspire them to study science and engineering in college."

The IGERT participants will organize future workshops to expose more high school students to innovations in science and engineering research.

To enhance the interdisciplinary aspect of IGERT, Tohline implemented weekly meetings during the summer semester for the eight IGERT students to help them learn more about how the same equations and computational fluid dynamics principles apply to all of their different study areas.

"This way, they can really exchange ideas with each other and work together in ways that were not possible before," Tohline said.

Farid Harhad, a computer science PhD student, said IGERT appealed to him because of the chance to work collaboratively, and that he would recommend the experience to other LSU students.

"The IGERT curriculum, professors, and internships are perfect opportunities that students ought to consider if they are interested in either academia or industry," Harhad said. "Regardless of which path is chosen, students who join IGERT will have a leading edge because they will be able to do innovative research and become ready to work in increasingly interdisciplinary and collaborative environments."

For more information on the IGERT program at CCT, visit http://www.cct.lsu.edu/IGERT/.

Happy Birthday, Cactus

CCT staff celebrated the 10th birthday of the Cactus framework on April 24, 2007, acknowledging the work of many researchers around the world that went into creating this open-source, modular, portable, programming environment for collaborative high-performance computing.

The Cactus Framework was developed at the Max Planck Institute for Gravitational Physics in Potsdam, Germany. Gabrielle Allen, PhD, who is CCT assistant director for computing applications and an associate professor in LSU's Department of Computer Science, was a lead creator of Cactus. Following the formation of CCT in 2003, much of the Cactus development work was transferred to the CCT research group, which includes Allen and other original collaborators.

Cactus allows researchers from around the world to work simultaneously on supercomputers to solve complex problems. Cactus originally was developed for collaboration in numerical relativity—tracking, studying, and proving the existence of gravitational waves by mapping black hole collisions.

Today, Cactus is used in dozens of research groups worldwide in a growing number of application domains, including astrophysics, relativity, computational fluid dynamics, coastal modeling, bio-informatics, and more, to exchange codes and define data formats.

For more information, visit www.cactuscode.org.

CCT Researcher Helps Create

Charter School
in New Orleans

Beginning in August 2007, New Orleans-area students were given the chance to work more closely than ever with students and researchers at the university level as part of a pilot charter school project.

The new charter school, called the Abramson Science and Technology Charter School, is a K-12 program that gives students a math and science-based education with a focus on using state-of-the-art technology. Students also work collaboratively with universities and are mentored by experienced scientists to enter into national and international science project competitions.

The charter school was formed at the site of an existing public school, Marion Abramson Senior High School in New Orleans east. Hurricane Katrina extensively damaged this part of the city and the charter school is a way to rebuild the education infrastructure in the area.

This new concept for education was developed through a workgroup comprised of LSU, Southern University, Southeastern Louisiana University, Southern University of New Orleans, and the LSU Health Sciences Center in New Orleans and led by Tevfik Kosar, an LSU Department of Computer Science assistant professor and CCT researcher.

"Louisiana tends to be weaker in education indicators overall, but particularly in math and science," Kosar said. "Several of us who do research in these fields at the universities in Louisiana wanted to study ways we could contribute to the education of students in elementary and secondary schools to improve these rankings. We believe that our experience in these specific areas, as well as the resources that universities can provide, will make a great contribution to the overall K-12 education in the state."

Kosar and the initial workgroup formed the Pelican Educational Foundation, which now includes members of the universities listed above, in December 2005.

The group researched innovative education methods that worked in other states to improve students' educational outcomes and learned schools that focus on math and science had worked effectively.

The Pelican Foundation decided to implement such a school in Louisiana and received approval in January 2007 from the State Board of Elementary & Secondary Education to begin the first school in the New Orleans area.

Kosar said he hopes Abramson Science and Technology Charter School will be a successful model that can be replicated in other parts of the state.

The Pelican Foundation is also pursuing federal funding opportunities from agencies such as National Science Foundation and Department of Education to boost the collaboration between universities and K-12 institutions in Louisiana.

In this first year, the school accepted 360 students from kindergarten through eighth grade. The school eventually will grow to go through the senior year of high school. Students were admitted based on availability and did not need previous experience with a technology-based education.

"People do not always recognize that Louisiana is very advanced in computer science, and this new school concept, along with other projects going on here at LSU, is part of an effort to raise awareness about the innovative work we are doing here," said Sitharama Iyengar, PhD, Roy Paul Daniels Professor and chair of the LSU Department of Computer Science.

The school is overseen by a governing board, of which Kosar serves as president.

The Abramson Science and Technology Charter School emphasizes integrating technology into the traditional classroom curriculum. Students also receive an interdisciplinary education and use many elements of technology in these areas.

The fine arts program integrates digital art and technology into the curriculum, and students can take classes in graphic design, Web design, multimedia, animation, photography, digital drawing, video production, media arts, and studio art.

"Our students work on projects that require cooperative teaching efforts in language arts, fine arts, math, social studies, and

science. We believe that education, as well as science, is moving toward cross-disciplinary boundaries, and so this new school is embracing that concept and allowing children to work this way from a much earlier age than before," Kosar said.

The school provides Web-based training, examination, and monitoring, and staff encourage student collaboration with universities to participate in national and international science competitions.

"The idea is to use high-end computing in education and give students a technology-focused, math and science-based education," Kosar said. "We are really optimistic about it. I believe that in a few years, it will be the top ranking K-12 school in Louisiana."

CCT Researcher Leads Innovative PetaShare Research

Researchers today are generating vast amounts of data, much of which is needed and used by scientists in different disciplines. In order to use this data effectively, researchers need innovative data scheduling, management, and storage tools.

LSU Department of Computer Science Assistant Professor Tevfik Kosar received a $1 million grant from the National Science Foundation to create advanced cyberinfrastructure for data archival, processing, and visualization, which is called PetaShare. The PetaShare project is funded for four years, and Kosar and his research group recently completed their first year.

Five Louisiana universities are collaborating on the PetaShare project, with LSU's Center for Computation & Technology as the lead. Along with LSU, the other schools, Louisiana Tech University, University of New Orleans, Tulane, and University of Louisiana–Lafayette, are all Louisiana Optical Network Initiative (LONI) sites.

"LONI is a major driver of this initiative," Kosar explained, saying high-speed, fiber-optic networks can help transfer large amounts of data faster than traditional networks, enabling advanced data transfer and sharing processes.

There are 25 senior researchers from 10 different disciplines actively involved in the PetaShare project. The researchers work in diverse fields such as coastal and environmental modeling, bio-informatics, numerical relativity, general physics, medical imaging, computational fluid dynamics, and engineering.

With PetaShare, researchers from different universities at locations all around the world can collaborate on research more effectively and access data from multiple disciplines simultaneously. This kind of system could be effective for areas such as hurricane modeling, where scientists would need multiple data sets to cull information on water level, storm surge, sediment deposit, wind speed, and numerous other elements to create a unified model.

Kosar and his research team are working with this grant to develop a prototype for PetaShare, with plans to expand the completed system to universities and research institutions worldwide.

Summer Camps Bring
Technology Knowledge
to High School Students

Coursework in digital art and high-performance computing is not often a component of the average high school student's curriculum. To help expose students to advanced technology at a younger age, CCT staff developed and organized two summer camps for high-school-age students.

The professors who created the camps developed curricula to help students learn more about technology in digital media as well as high-performance computing, and CCT's education and outreach manager, Katie Lea, recruited students to attend.

"A critical component of our mission is working with students in elementary and secondary grades to help them learn more about the technology we use at CCT," Lea said. "Many of today's high school students want jobs in industries that use the kind of technology we have here, but many do not get to see this in their regular classroom setting. These camps are a way for us to invite the students here, teach them about the cyberinfrastructure we have, and help them learn how to use it, with the idea they will go to college better prepared."

In June, CCT hosted a Digital Arts and Technology camp, led by the staff who developed the Red Stick International Animation Festival. The camp was a five-day workshop on the latest innovations in animation and digital media.

"One of the great crises in digital media is that students who enter college and want to work in digital media, whether it is game development, animation, visual effects, or visualization, are never exposed to these skills in their high school environments," Red Stick Festival Director Stacey Simmons said. "The festival offers workshops that can help them develop their skills, but it's very short. The camp will give students a more intense experience that hopefully inspires them to pursue education and careers in digital media."

Students learned basic digital concepts, artistic requirements, and creative processes, traits that will strengthen their understanding of the digital technology field. Teachers at the Digital Art and Technology Camp hosted seminars on drawing concepts, scriptwriting, storyboarding, story telling, and animation.

At the end of the week, each student at the camp had the chance to produce a five-second animated segment using Flash. The Baton Rouge Cartoonists Society also hosted an evening workshop for students to teach them about careers in professional animation.

Simmons said these kinds of camps can go a long way in securing more animation industry in Baton Rouge.

"We are working very hard to demonstrate to the industry that there are people here who want to work in this area and have the skill sets necessary to do so," Simmons said. "If we can start teaching students from the time they are in high school, they will be more enthusiastic about pursuing this field in college. Also, they will come in with a better knowledge of what academic track they wish to pursue for digital media instruction. This in turn will make it much easier to lure the big companies to the capital area to either open satellite offices or recruit staff. It also helps students build confidence for opening companies of their own as they get older."

The second CCT summer camp, developed by CCT Chief Scientist and Department of Computer Science Professor Thomas Sterling, was a High-Performance Computing Boot Camp, nicknamed the Beowulf Boot Camp. Sterling is co-inventor of the Beowulf class cluster, which today is a building block of the world's supercomputers.

In this July 30–August 2 camp, students from five area high schools—Tara High School, Istrouma High School, Glen Oaks High School, Baton Rouge High School, and the University Lab School—worked under Sterling's direction and learned how to build basic supercomputing clusters, then use them for applications. Sterling instructed them in hardware and software concepts and also invited teachers from those high schools to attend and learn. After the camp, the students and teachers were able to take the clusters back to their classrooms to use in further lesson plans.

Sterling said the camps are an excellent way to not only narrow, but close the gap between high school students and the advanced technologies of a university.

"Today, the job of a college professor is not only teaching college students, but outreaching to K-12 students as well to get them interested," Sterling said,

noting a report from the National Science Foundation identified a need for disseminating high-performance computing education to a broader and younger audience. Sterling noted this early preparation ultimately benefits LSU as well because it encourages students to pursue science and technology-based careers in college.

Based on the success of the first round of summer camps, Lea is planning to repeat the camps next year and is looking into expanding them to include students from other grades.

"This is just a wonderful contribution to Baton Rouge, to Louisiana, and to the high school students," Sterling said. "Hopefully, when these students graduate high school, they will come back to LSU and become our advanced students."
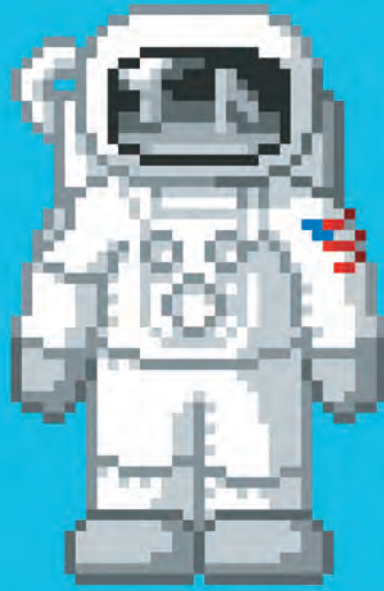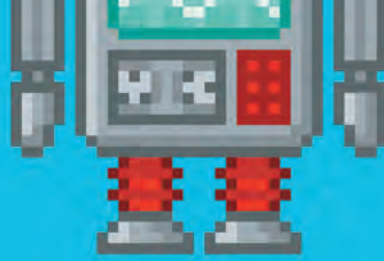
Digital Industries Consortium to Lead
Economic Development
for Baton Rouge
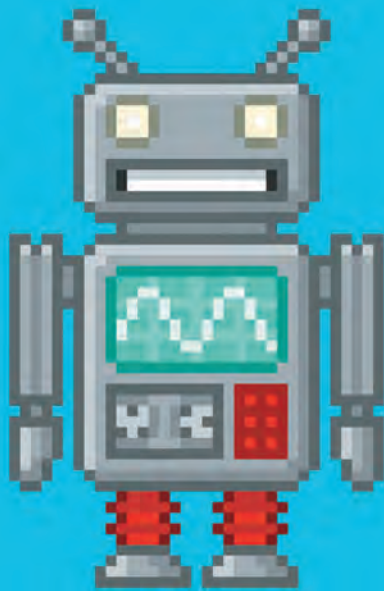
Ten years from now, CCT Director of Special Projects Stacey Simmons wants Baton Rouge to be a digital media Mecca. And, she believes Louisiana's capital city is clearly on this path.

As executive director of the newly formed Baton Rouge Area Digital Industries Consortium, she is committed to working with other city and state groups to recruit the best and brightest in the animation, digital arts, visualization, and video game design industries here.

"I think in 10 years, you are going to see feature film companies, you are going to see video game development companies, you will see a major video game publishing company—all these plans are already in the works, so I think in 10 years we are going to be very successful. Baton Rouge is going to be synonymous with digital media," Simmons said.

Digital media industries already are cropping up in the capital area—several video game companies are developing business in Louisiana, and the state's tax credit infrastructure for the entertainment industry has led to several films being produced in and around Baton Rouge.

The anchor event for bringing the animation industry to Baton Rouge is the annual Red Stick International Animation Festival, which Simmons created with her colleague Stephen David Beck, an LSU music professor and director of CCT's Laboratory for Creative Art and Technologies.

"We wanted to come up with some kind of activity that highlighted the links between art and technology, because that's what the focus of our lab was all about," Beck said, explaining the roots of Red Stick.

The idea for an animation festival was sparked on a trip to Dreamworks Studios, where Beck and Simmons learned the supercomputer used to render the "Shrek" movies was only slightly smaller than LSU's then-supercomputer, SuperMike.

"We were really impressed with that, thinking 'Wow, SuperMike could render a movie,'" Beck said. This led to the development of the Red Stick festival, which first took place in 2005.

"Animated films require as much supercomputing power as we have on the LSU campus, so this festival was a way to harness that idea and make the power of supercomputing available to more people in a way they could relate to, and to show them what we do here at CCT," Simmons said.

The festival takes place every April at a variety of locations in Baton Rouge's Downtown Arts District, and brings scientists, animators, and artists together to show how high-performance computing is impacting the entertainment industry.

The concept behind the festival, showcasing the synergy between art and technology, led to the formation of the Baton Rouge Area Digital Industries Consortium. The Consortium comprises CCT, the LSU Office of Research and Economic Development, the East Baton Rouge Parish Mayor-President's Office, the Baton Rouge Area Foundation, and the Baton Rouge Area Chamber.

These groups all are sponsors of the festival, and the members began looking for more ways to promote digital industry development in Baton Rouge, leading to the creation of the consortium, which began meeting in spring 2007, shortly after the third annual Red Stick International Animation Festival.

"All of those organizations came together and said this is critical and important to us from an economic development perspective, and we want to work together to make it happen," Simmons said.

The consortium will recruit more digital industries to the capital area, and also will develop training and education opportunities so people in Baton Rouge can provide an adequate workforce for digital industries. In addition, the consortium will raise awareness about the state's entertainment industry tax credit program to entice companies to Baton Rouge.

Stephen Moret of the Baton Rouge Area Chamber said a combination of factors gives the city potential to become one of the great communities in the country for this kind of business. "We think that in the future, we are going to become one of the top 10 digital media markets," Moret said.

Baton Rouge Mayor Melvin "Kip" Holden said the consortium is important because it allows key groups in the city to partner in an effort to join in a vibrant and growing industry.

"As it grows, we don't want to be left behind, so Baton Rouge can say to companies throughout the whole country that if you need a place whereby you can come in and deal with this type of industry, then we have the infrastructure in place, we have the people in place, we have the know-how and intelligence to really make a product that you will be happy about," Holden said.

The Consortium's initial goals are to build on the success of the Red Stick International Animation Festival to attract industry to the area, while also working to increase technology learning opportunities for both college and K-12 students.

LSU Vice Chancellor for Research and Economic Development Brooks Keel noted CCT and the University also have the advanced computing resources animation companies need to render today's films.

"When you put all that together, from education, to research, to high-performance computing, to connectivity to the tax aspects of it, I think you have the correct type of environment that's going to make it very attractive for industry to come here," Keel said.

And, all participants in the consortium agreed a major draw for industry will be the unique culture of the Baton Rouge area.

"I can tell you that not only do we have the quality of the workforce here, and the intelligence in regard to the people who are already here working in the industry, but we have hospitality that is second to none, and you can always get some good food and have a good time, and as we always say, *laissez le bons temps rouler*, let the good times roll," Holden said.

Red Stick Festival Raises Awareness of Organ Donation Through Animation Collaboration

A cat may have nine lives, but if you become an organ donor, you can save nine lives.

This was just one of the messages developed by Baton Rouge area schoolchildren who spread the message about organ and tissue transplant awareness during Animation Collaboration for a Cause, part of CCT's Red Stick International Animation Festival.

Animation Collaboration is a portion of the festival is where artists work closely with school-age children from Louisiana to help them use animation to express their feelings and share their stories about various social issues.

Animation Collaboration takes place at Red Stick through a partnership between LSU and AnimAction, a company that focuses on youth expression through animation. AnimAction projects emphasize working collaboratively and expressing creativity.

The 2006 inaugural Animation Collaboration Films, which focused on Hurricane Katrina, were created by 90 local students and still are being screened around the world.

LSU's Red Stick Festival Director Stacey Simmons said the Animation Collaboration films are so inspiring, she plans to make this an annual part of the festival.

"We hope that we can use this part of the festival each year to not only raise awareness of different causes, but to show participants how animation is an innovative means of communicating about today's important social issues," Simmons said.

This year, Animation Collaboration focused on organ and tissue donation, and was supported by AnimAction and the James Redford Institute for Transplant Awareness (JRI). James Redford, an actor, writer, producer, and son of Robert Redford, is a recipient of two liver transplants and created his foundation to raise awareness about the need for more people to choose donation.

Animation Collaboration began with two days of workshops on April 4 and 5 at the Shaw Center for the Arts in Baton Rouge, where 40 children from four Baton Rouge schools created animation to express their feelings about organ and tissue donation.

The students, who came from Istrouma High School, Woodlawn High School, St. Luke's Episcopal School, and the Louisiana School for the Deaf, met with representatives of the Louisiana Organ Procurement Agency, or LOPA, to learn statistics about the need for organ donation in Louisiana.

Lana Stevens of LOPA told the children the number of people in the United States who need a life-saving organ transplant would fill Tiger Stadium. In Louisiana alone, there are more than 1,500 people waiting to receive an organ transplant.

To illustrate which organs from the body can be transplanted, the LOPA staff showed students "donor dolls," which feature removable organs that can be donated. Eight bodily organs can be donated—the heart, both lungs, the liver, small intestine, both kidneys and the pancreas can be donated. One organ donor can save up to nine lives, since the liver can be used in two transplants—a small piece for a child, and the larger piece for an adult.

Tissue from the body, such as bone tissue, corneas, ligaments and heart valves, also can be harvested for transplant. While organs can only be donated if someone experiences brain death, tissue can be donated following cardiac death, which is far more common. And, tissue donations can enhance the lives of more than 50 people, primarily through reconstructive surgeries.

Once the LOPA staff gave students the facts about organ and tissue transplants, Clifford Cohen, AnimAction director, began working with the children to teach them how they could use animation to express their feelings on the subject.

Working in groups by school, the children created short, animated, PSA-style films to highlight the need for organ and tissue transplants. The films were screened during the Red Stick International Animation Festival on Friday, April 20.

Kelly Ranum, LOPA executive director, sat on a panel for the film screenings and said when members of LOPA meet with families who have had a loved one die and donate his or her organs, the feelings they express afterward are mirrored in the students' video presentations.

Ranum emphasized animation can be a great vehicle for informing people about transplants, since the films focused on the positive element of organ donation – the families of an organ donor knowing their loved one's donation saved lives.

"Your animation can spread the message faster than our statistics," Ranum said. "You are helping people to see the bright light of organ donation."

To showcase the implications of this project, Cohen of AnimAction showed a documentary he recorded during the workshop segment about why the Animation Collaboration is an important activity. And, Cohen said he is ready to tackle a new social topic for Animation Collaboration 2008.
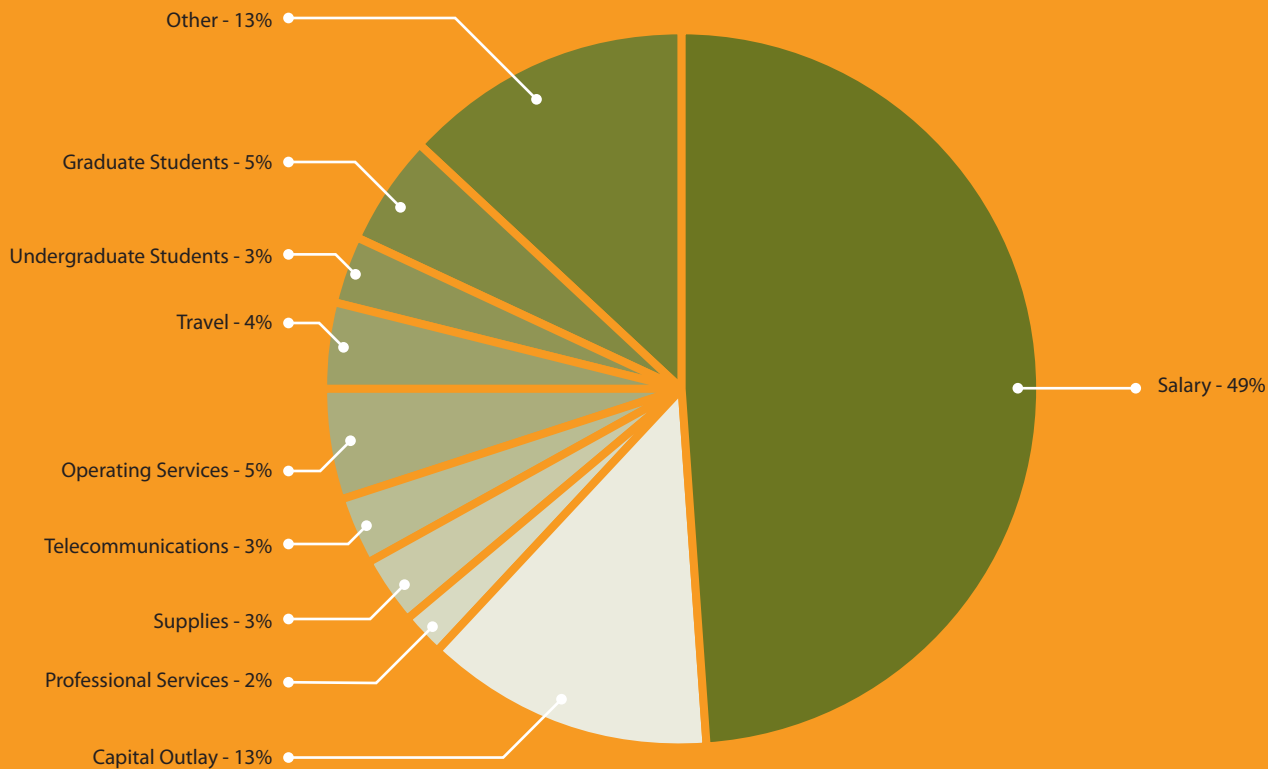
"Our audiences get larger every year, and we look for collaborative opportunities, such as this feature at Red Stick, to reach out to more youth who can benefit from using animation as creative expression," Cohen said. "We hope to continue having a presence at Red Stick to raise awareness about a new cause each year."

CCT Education and Research Highlights

- Irina Craciun, a mathematics undergraduate student, won second prize for the Ellinor Behre Award for Science Writing for a paper she wrote titled "On a Problem in the Stability Discussion of Rotating Black Holes."

- Richard Duff, a petroleum engineering doctoral student, received third place for his poster at the 2007 National Technical Conference and Exhibition—American Association of Drilling Engineers. Richard's poster was titled "Observation and Modeling of Torsional Vibration Regimes." Also, a paper and poster from Richard Duff and Yaakoub El-Khamra, a CCT research staff member, on "Real-Time Simulation in Grid Environments: Communicating Data from Sensors to Scientific Simulations" was presented at the meeting, and a presentation from Richard Duff on "Torsional Vibration in Drilling: Modeling and Field Examples" was shown.

- Two CCT students' papers were selected for presentation at the National Conference for Undergraduate Research. The abstracts were from Razvan Carbunescu, a computer science undergraduate student, who wrote "Study of Pollutant Dispersion in Urban Canyons Using the Cactus CFD Toolkit;" and Ana Elena Buleu, an electrical engineering undergraduate student, who wrote "An Ontological Scheme for Specifying Time in HDF5." Both students also gave oral presentations during the conference.

- CCT computer science student Anuradha Vij was selected to attend the National Diversity Leadership Conference in Dallas to represent LSU and CCT.

- Sirish Tummala, a computer science graduate student, had a paper accepted for publication in Journal of Coastal Research. The title of the paper is "Data Management Challenges in Coastal Applications."

- Computer science graduate students Mehmet Balman and Esma Yildirim received student scholarships to attend the Open Grid Forum (OGF19) in North Carolina.

- Emrah Ceyhan, a computer science graduate student, had a paper, "Toward a Faster and Improved ADCIRC (ADvanced Multi-Dimensional CIRCulation) Model," accepted for publication in the Journal of Coastal Research.

- Marc Noel, CCT undergraduate research student, received a job offer from Microsoft Corporation, based in Seattle. During his time at CCT, Noel worked with Department of Computer Science Assistant Professor Tevfik Kosar to deploy a campus-wide distributed system (Campus Grid) using the existing idle computational resources at LSU. This system, once completed, will provide a computational power of around 2,000 processors for free, in addition to the already existing supercomputing resources at the campus.

- Three of Department of Computer Science Assistant Professor Tevfik Kosar's students—Ibrahim Suslu, Wei Zhang, and Xinqi "Jack" Wang—received student scholarships to attend the Midwest Grid Workshop '07.

- Andrew Davidson, an electrical and computer engineering undergraduate student, Razvan Carbunescu, a computer science undergraduate student, and Irina Craciun, a mathematics undergraduate student, were accepted to present their papers/posters at the Louisiana Academy of Sciences' annual meeting.

- Enrique Pazos, a physics graduate student, won the prize for the best student talk at the third Gulf Coast Gravity Conference on March 23.

- Two of Department of Computer Science Assistant Professor Tevfik Kosar's computer science graduate students, Mehmet Balman and Ibrahim Suslu, had papers accepted in the International Conference on Enterprise Information Systems Doctoral Consortium.

- John Lewis, a CCT undergraduate researcher, was invited to present a paper on his work at the Argonne Symposium for Undergraduates in Science, Engineering, and Mathematics in Chicago. Lewis, a LA-STEM student at LSU who is advised at the CCT by Department of Computer Science Associate Professor Gabrielle Allen, presented a paper on his work with the Ubiquitous Computing and Monitoring Systems (UCoMS) team at the CCT. This group works to develop grid portal environments for applications in petroleum engineering. The paper, titled "Developing A Grid Portal For Large-Scale Reservoir Studies," discussed his work on the project, which involves computer scientists and petroleum engineers from several universities in Louisiana.

- CCT students John Lewis, Ian Wesley Smith, and Alex Nagelberg all received summer internships.

- The U.S. Department of Defense awarded a grant under its fiscal 2007 Defense Experimental Program to Stimulate Competitive Research (DEPSCoR) for a proposal by Department of Environmental Engineering Associate Professor Qin J. Chen. Department of Computer Science Associate Professor Gabrielle Allen and Department of Petroleum Engineering Assistant Professor Mayank Tyagi assisted in this proposal. Qin was the only researcher from Louisiana to receive a grant under this program. His proposal, "Integrated Modeling Framework for Simulations of Coastal Processes in Deltaic Environments Using High-Performance Computing," will be funded through the Department of Defense's Office of Naval Research.

CCT Investment Summary FY 2006-07

- Other - 13%
- Graduate Students - 5%
- Undergraduate Students - 3%
- Travel - 4%
- Operating Services - 5%
- Telecommunications - 3%
- Supplies - 3%
- Professional Services - 2%
- Capital Outlay - 13%
- Salary - 49%

Sponsored Conferences and Events 2006-07

14th Annual Mardi Gras Conference:
Tangible and Embedded Interaction

Dates: February 15-17, 2007
Attendees: 132
Submissions: 50 contributions by 140 authors from 15 countries
Location: Sheraton Hotel in downtown Baton Rouge, La.

Red Stick International Animation
Festival (3rd Annual)

Dates: April 18-22, 2007
Attendees: 4,000
Submissions: More than 200 film entries from 30 countries
Location: Downtown Baton Rouge Arts District – Shaw Center for the Arts, Manship Theatre, Old State Capitol, Louisiana Art & Science Museum

IT Eminent Lecture Series

Sponsored by CCT in partnership with LSU Department of Computer Science
Hosted on LSU's campus
Speakers Fall 2006-Summer 2007: 6

Distinguished Lecture Series

Sponsored by CCT and held on LSU's campus

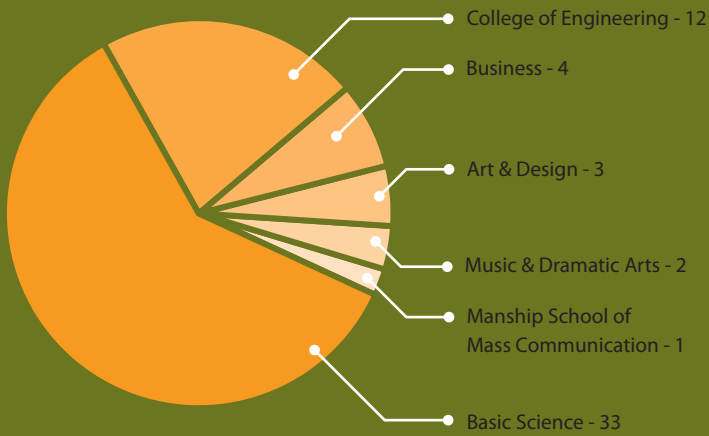- **Ian Foster, known as The Father of Grid Computing**

  "Scaling the e-Science Impact"
  November 27, 2006
  Foster is a computer sciences professor at University of Chicago and director of the Computation Institute at Argonne National Laboratory.

- **Jason Leigh, Director of the Electronic Visualization Laboratory**
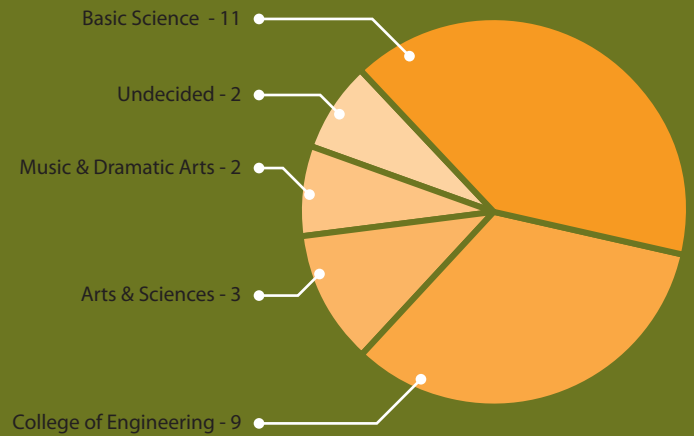
  "Emerging From The CAVE: Advanced Visualization And Collaboration Research At The Electronic Visualization Laboratory"
  May 24, 2007
  Leigh is an associate professor of computer science at the University of Illinois at Chicago, where he also serves as director of the university's renowned Electronic Visualization Laboratory.

CCT Students by College FY 2006-07
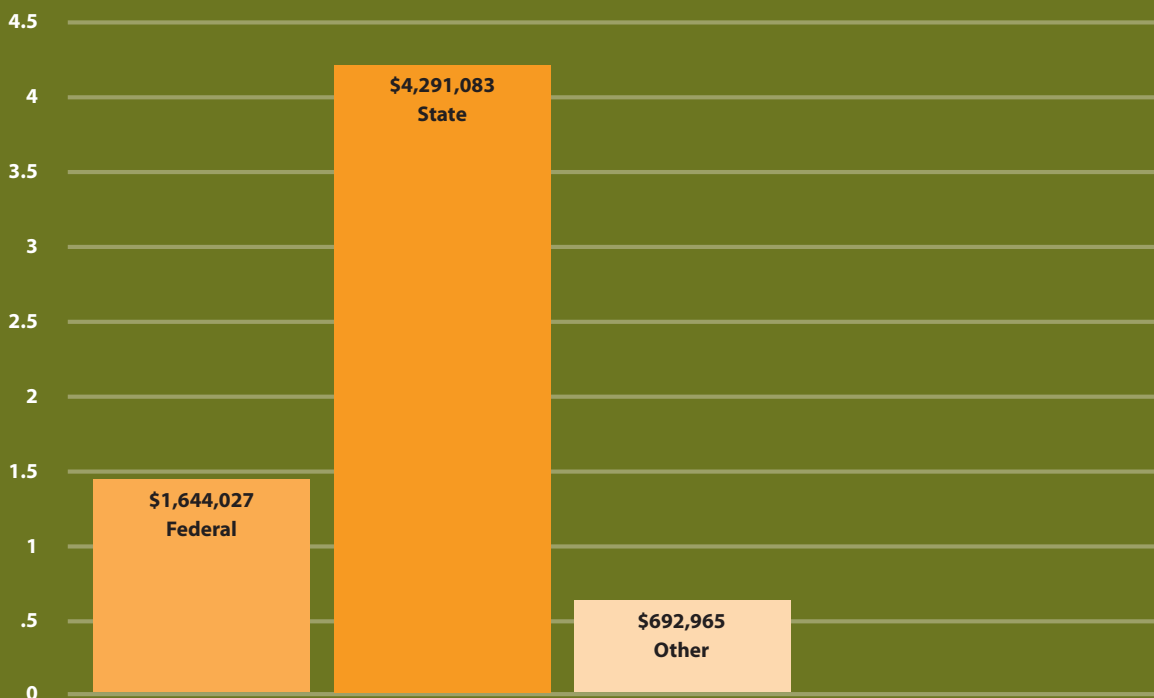
Graduate Students

- College of Engineering - 12
- Business - 4
- Art & Design - 3
- Music & Dramatic Arts - 2
- Manship School of Mass Communication - 1
- Basic Science - 33

Undergraduate Students

- Basic Science - 11
- Undecided - 2
- Music & Dramatic Arts - 2
- Arts & Sciences - 3
- College of Engineering - 9

CCT External Funding FY 2006-07

* in millions

- $1,644,027 Federal
- $4,291,083 State
- $692,965 Other

LSU
CENTER FOR COMPUTATION
& TECHNOLOGY

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COMPONENTS

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