

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY
Institute for Physical Research and Technology

VRTech

Publication of the

Virtual Reality Applications Center

.iastate.edu

Creating research opportunities for students
through interdisciplinary partnerships



Research Experience for Undergraduates
Emerging Interface Technologies

FALL 2006



VRAC

- \$16 million in contracts
- 52 active, interdisciplinary projects
- 60 faculty investigators from 7 colleges
- 180 graduate and undergraduate researchers

HCI Initiative

- 68 graduate students
- 37 in the PhD program
- 24 in the Master's program
- 7 in the Certificate program
- 63 HCI faculty
- 19 departments represented

By the Numbers

At its core, VRAC's mission is to build interdisciplinary partnerships by creating opportunities for research that focus on the rapidly expanding interface between humans and computers. VRAC brings together faculty, students, and industry leaders to work on interdisciplinary teams to research and develop virtual reality and other emerging interface technologies that improve the lives of everyday people. As such, our educational programs and students are an integral part of meeting these challenges. This issue of *VRTech* highlights VRAC's educational mission and the many contributions made by students.

In addition to offering Master's and PhD degrees in the Human Computer Interaction graduate program, VRAC has broadened its outreach to undergraduates. This summer, VRAC hosted an NSF Summer Program called **Research Experiences for Undergraduates**, bringing together students from many different disciplines and geographic locations to work on multi-disciplinary teams of faculty and graduate students. These students brought energy, enthusiasm, and talent that continues to resonate with faculty and graduate students.

VRAC has also initiated the **HCI Graduate Certificate Program**, designed to support students working in business and industry by providing advanced courses in information technology online. This year, the program admitted seven off-campus students from three states. Students working for companies as far away as Lockheed Martin in Texas and Ceridian Corporation in Minnesota have joined students working for companies as near as Rockwell Collins, Pioneer Hi-Bred International, Iowa Foundation for Medical Care, and HyVee to take classes online.

As a research center, VRAC is committed to creating opportunities that respond to the dynamic field of HCI by continuing to build strong partnerships and educational programs that meet the needs of students and industry. Interdisciplinary to an extreme, VRAC offers students a wide range of opportunities for working with the people involved in developing leading technologies that intersect with our everyday lives.

We hope you enjoy this issue of *VRTech* and look forward to your feedback.

James H. Oliver

A Look Inside this Issue

4

Research Experience for Undergraduates



6

Learning by Building Applications



8

Deere Day

10

Students Shine in HCI

VRTech | Fall 2006

Lynette Sherer, **Managing Editor, VRAC**
 Karen Gulbrandsen, **Editor, VRAC**
 Kevin Teske, **Photo Editor, VRAC**
 Robert Mills, **Contributing Editor, IPRT**
 Ted Martens, **Designer, VRAC**
 Grant Luhmann, **Designer, Ames Laboratory/IPRT**



Tabitha Johnson (standing), an ISU computer science major, was one of 15 students that participated in HCI's undergraduate program in the summer of 2006.



Undergraduates from around the country worked to develop new applications revolving around human computer interaction during a new summer program. **Back:** Derrick Parkhurst, Chad Kilgore, Adam Lavelly, Tabitha Johnson, Rob Dixon, Neil Roberts, Garland Trice, Pam Shill **Middle:** Nick Hammonds, Dipayan Mitra, Andrea Schwager, Nicole Jensen, Tyler Brown, Josh Mahan **Front:** ChenRu Zheng, Natalie Greco, Michelle Reinke, Kim Weaver, Erica Zbornik

Tabitha Johnson wanted to get experience and training in the latest information technologies. So, Tabitha, an ISU undergraduate student, decided to participate in the Summer Program for Interdisciplinary Research and Education—Emerging Interface Technologies (SPIRE-EIT). “I got so much more than I expected,” Tabitha

Research Experiences for Undergraduates

says. “Not only did I learn new skills, but I also learned a lot about working with people from different disciplines.”

Tabitha joined 14 other students from nine universities in a ten-week session designed to give students the opportunity to work with the technologies used and the people involved in HCI. Students majoring in fields as diverse as music, graphic arts, computer engineering, and mechanical engineering worked with graduate students and faculty in multidisciplinary teams to explore and develop emerging interface technology solutions.

To get the skills needed to do their projects, students participated in graphics, modeling, and programming workshops led by **Kim Weaver** and **Chad Kilgore**, HCI graduate students. For Weaver and Kilgore, the challenge was getting people from so many different backgrounds to work as teams. But, as Weaver said, “it was the after-hours activities that brought people together and helped create close-knit groups that wanted to learn together.”

Students also participated in a luncheon lectures series given by faculty on the ongoing research projects at ISU. The students’ experience culminated in an end-of-the-summer symposium where

they presented their projects using posters and interactive technical presentations.

This program will continue for at least the next two summers and is funded in part by the National Science Foundation. Dell is a program partner who has helped the program by supporting development of the Innovative Learning Environment. To learn more about the program, visit <http://www.hci.iastate.edu/reu>.

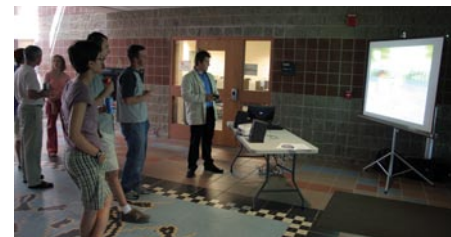
Research Teams

Over ten weeks, students worked on a variety of projects involving advanced

information technology. The projects also gave students a chance to work in multidisciplinary teams with graduate student mentors and faculty.

Meta!Blast: Exploration of a Virtual Plant Cell

Meta!Blast is an educational video game designed to teach cell biology to high school and undergraduate stu-



dents. As an educational tool, the virtual cell uses gaming techniques to let students explore cellular layout, organelles, and biochemical reactions, reinforcing key concepts about plant cell structure and function. Designed to work on a variety of platforms, Meta!Blast will be free and accessible on the Internet by 2008. The approach used by the team will provide the infrastructure to develop future applications.

Interns Tyler Brown, Music Education; Nicole Jensen, Biomedical Engineering; Erica Zbornik,

Biochemistry, Cell & Molecular Biology
HCI Graduate Student Mentors David Kabala, HCI; Teresa Karr, HCI
Faculty Mentors Eve Wurtele, Genetics; Diane Bassham, Genetics; Julie Dickerson, Computer Engineering; Steve Herrstadt, Art & Design.

Baublock: The 3D Sketchbook

“Baublock is an effort to bring art into technology and technology into art.” In this project, artists and human-computer interface designers collaborated to de-



velop an entirely new computer interface—the Video See through Augmented Reality Desk—that transfers traditional artistic skills into the digital realm.

Interns Tabitha Johnson, Computer Science; Josh Mahan, Computer Science; ChenRu Zheng, Psychology, Art & Design
Faculty Mentors Derrick Parkhurst, Psychology; Dennis Dake, Art and Design

Addiction Education using Science and Technology

This team worked on developing video game software to educate high school students about the physiological effects



of methamphetamine abuse on the brain. To create an intriguing, realistic, and accurate scientific animation, the team used

3D modeling and virtual reality. In the future, this animation will be featured on an educational website that uses animations and games to educate students about drug addiction. The project also received a \$7,000 grant from Principal Financial Group for Scholarships for scholarships to continue this project over the 2006-2007 academic year.

Interns Natalie Greco, Biochemistry, Cell & Molecular Biology; Michelle Reinke, Graphic Design/Neuroscience; Andrea Schwager, Psychology/Neuroscience
Graduate Student Mentor Kim Weaver, HCI
Faculty Mentors Amy Wisniewski, Biology, Drake University; Derrick Parkhurst, Psychology

Haptics-based Interactive Product Development in Virtual Reality

In this project, students used haptics technologies (devices that provide force feedback) to advance an engineering tool for product design. Using existing software architecture, the students analyzed the benefits of an application



that allows real-time stress analysis of 3D models that incorporate visual and tactile information. This system helps engineers analyze weaknesses in structures virtually, rather than in traditional testing environments.

Interns Nicholas Hammonds, Music; Dipayan Mitra, Mechanical Engineering; Garland Trice, Computer Science/Graphic Arts
Graduate Student Mentor Dao Vo, Mechanical Engineering
Faculty Mentor Judy Vance, Mechanical Engineering

VR



Touch Table for Command & Control

To design an interface for immersive command and control applications in virtual reality, this team made a touch-screen table that tracks the touch of multiple fingers at once. Computer vision techniques are used to interpret the points of infrared light as moving fingertips. A single finger on the table is treated as a typical mouse, which allows the table to be used with existing applications. Adding multi-finger gestures to software is simple for programmers using the functions provided by the table’s program. In the future, this 4’ x 5’ table will be integrated into the command and control Battlespace project at Iowa State University.

Interns Rob Dixon, Computer Science/Math; Adam Lavelly, Aerospace Engineering; Neil Roberts, Psychology.

Graduate Student Mentors KC Dohse, HCI; Tom Batkiewicz, HCI.

Faculty Mentors James Oliver, Mechanical Engineering; Derrick Parkhurst, Psychology; Eliot Winer, Mechanical Engineering; Alexander Stoytchev, Computer Science.

Learning by Building Applications

Students at VRAC have many opportunities to engage in new research projects in human-computer interaction. Students develop relationships with leaders in industry and work on multi-disciplinary teams to build new applications and interfaces that intersect with our everyday lives. Here are a few highlights of their work.

Creating New Interfaces

As a former creative writing and computer science student, **Michael Oren** became interested in HCI because it blends

both the humanities and sciences in new ways, encouraging cross-pollination of ideas. Currently, Oren is working on his MS in HCI with **Chris Harding**, Professor of Geological and Atmospheric Sciences, to develop a 3D geologic structure that uses not only sight, but also touch and sound to convey detailed information about subsurface rock formations.

Traditionally, 3D geologic shapes have been modeled using visual-only systems. Because it integrates sight, sound, and touch, this multi-modal VR system will lay the foundation for the next generation of mainstream computer systems modeling 3D geologic structures. As Oren says, "it's exciting to be able to present data in new and interesting ways, especially to develop interfaces that will impact people's everyday lives."

Working on Multi-Disciplinary Teams

For **Trevor Brown**, an undergraduate in Biology, the multidisciplinary nature of VRAC's research projects is exactly what makes the work engaging, stating that "working with individuals who have backgrounds in biology, computer science, music, education, and traditional and digital art has allowed me to realize my work in ways I might not have been able to otherwise."

Undergraduates such as Brown are contributing intellectually to MetNet and Meta!Blast. MetNet, is a suite of bio-informatics tools available to biologists worldwide to virtually analyze and share data, visualizing metabolic pathways and gene expression. Meta!Blast is a vir-

tual reality computer game to help high school students understand cell and metabolic biology. **Gaoder Vue**, who is working on her Bachelor's of Fine Arts, has also enjoyed the challenges of working on this team: "Because I am not a biology major, I can ask someone who is in the field to help me understand the processes in the cell and I can explain how to translate words into a design, images, or animation."

MetNet and Meta!Blast are supported by grants from the National Science Foundation and ISU's Liberal Arts and Sciences Computer Advisory Committee and an Integrative Graduate Education and Research Traineeship award.

The MetNet, Meta!Blast Team includes:

Graduate students Yves Sucaet, Kathryn McMullen, Jie Lie, Wieslawa Mentzen, David Kabala, Mohammed Alabsi, Michael Lawrence, Lifeng Zhang, Heather Babka.

Undergraduates Brian Alley, Karan Bhatia, Trevor Brown, Elizabeth Dunham, Teena Gulabani, Kaitlyn Herrnstadt, Elizabeth Miller, Michaela Payne, Gaoder Vue.

Faculty Eve Wurtele, Genetics, Development & Cell Biology; Diane Bassham, Genetics, Development & Cell Biology; Dan Berleant, Electrical & Computer Engineering; Anson Call, Art & Design; Dianne Cook, Statistics; Julie Dickerson, Electrical & Computer Engineering; Steve Herrnstadt, Art & Design; Heike Hofmann, Statistics; Adah Leshem-Ackerman, Ecology, Evolution, & Organismal Biology; Les Miller, Computer Science; Joanne Olson, Curriculum & Instruction; Debra Satterfield, Art & Design



Solving Humanitarian Problems

Students also have the opportunity to use their talents to solve humanitarian problems. **Stephen Gent** and **Nathan Johnson**, both research assistants, are working with **Mark Bryden**, professor of mechanical engineering, on a project that makes wood-burning cooking stoves safer for the billions of people in the world who use them for cooking and heating. To facilitate research and development of safe cooking technology, Bryden founded ETHOS—Engineers in Technical and Humanitarian Opportunities of Service—a nonprofit organization

that encourages collaborative North-South partnerships between universities, research laboratories, engineers, and non-governmental organizations in foreign countries. In the photo above, Johnson (on the right), during a trip to Honduras, discusses stove design with a man from the local community.

For more information about this project, visit <http://www.vrac.iastate.edu/ethos/>.



VVRAC students are the heart and soul of a unique partnership between VRAC and Deere & Company, one of the world's leading manufacturers of agricultural, forestry, construction, and turf-care equipment, with major manufacturing facilities in Iowa. "The students are instrumental" in the Deere relationship, said **Jim Oliver**, VRAC director. The partnership is a multi-year effort encompassing over 10 distinct research projects aimed at applying virtual reality technology to improve product and manufacturing process development at Deere.

Student involvement was readily apparent at the 2006 installment of VRAC's annual "Deere Day" event, which updated Deere personnel on the progress of the many projects and helped promote the technology among Deere units

around the world. "The students take a great deal of pride in it," Oliver said. "It's a great chance to showcase their work."

VRAC graduate students made most of the presentations and ran the many technology demonstrations shown during the event. That was only fitting, since the students also do much of the work on the research projects, guided by VRAC faculty members and Deere experts.

Indeed, for many VRAC students, their Deere project is a major component of their advanced degree program. Deere's close working relationships with the students also pays off for



the company, as it ends up hiring many of them after graduation.

Jerry Duncan, manager of collaborative science at Deere, is the company's point person on the VRAC relationship and co-host for Deere Day. He and Oliver agree that the day is about cross-fertilization of ideas. "It works great," said Duncan. "Every time we have a 'Deere Day,' one of our people says, 'I can use that technology in a different way.'"

The research falls into several categories, according to Oliver. Some projects are aimed at filling gaps in Deere's capabilities or infrastructure, while others are aimed at developing technology that's not commercially available.

The partnership, now in its 12th year, is benefiting Deere in many ways. For example, the technology is helping various Deere units move away from physical prototypes to virtual prototypes, where most design and analysis is done in software. This approach creates better performing products in less time and at a lower cost.

VR

VRAC graduate student **Kalyan Kappagantula** (left) "drives" a virtual loader during a demonstration of hardware-in-the-loop simulation technology developed for Deere. It's part of a project leveraging three year's worth of research, introducing realistic operator 'feel,' incorporating soil models, adding more machine drivetrain models, and embedding electro-hydraulic controls.

VRAC graduate student **Abhishek Seth** (lower left) explains the workings of a virtual part assembly system to Deere's **Yvonne Mueller**. Using special glasses, users can view 3D models of parts and components to investigate how they can best be assembled. The project's aim is to create a more realistic interaction between the user and the digital representation of the products. With this technology, shop personnel or members of the product design team can identify cost saving measures early in the design process.

Ken Kopecky (above left), a VRAC graduate student, looks on as **Brad Keleher** of Deere "paints" using a virtual reality system. Training skilled painters for Deere product lines is a time- and resource-intensive process, so the company is working with VRAC to develop a virtual painting system to speed the training process and reduce cost and time.



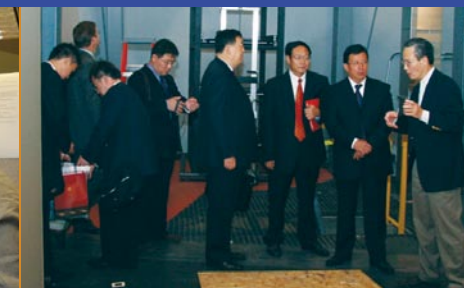
In May, VRAC hosted visitors **Xavier Fischer** and **Renaud Briand**, researchers from **LIPSI-ESTIA** in France. **LIPSI-ESTIA** is hosting **Virtual Concept 2006**, an international consortium focused on VR for product design and manufacturing.



Visitors from the University of Wales, Mesa Labs, and NASA-Ames toured the facility to see the equipment and technologies at VRAC.



Four ambassadors to the United Nations toured VRAC as part of a three-day tour showcasing the state. The foreign delegates came from Colombia, Honduras, Hungary, and Mali. The tour was hosted by Senator **Grassley's** office.



VRAC and ISU welcomed a delegation from Gansu Province, People's Republic of China and Lanzhou Jiaotong University. The visit is part of an agreement between the two universities to work together on educational degree programs and on collaborative partnerships between businesses and industries in Iowa and Gansu Province.

VRAC Hosts Visitors

Partnering with Industry



Watch This Space

VRAC's venerable **C6** virtual reality environment is in the final stages of an upgrade that will once again make it one of the most advanced systems of its kind in the world. With nearly \$5 million in equipment and facility upgrades, the new system will project 100 million pixels in total on its six walls.

The new equipment — a 48-node Hewlett Packard workstation cluster featuring 96 graphics processors, 24 Sony digital projectors, an eight-

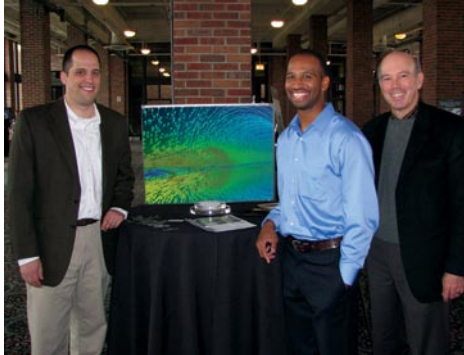
channel audio system and ultrasonic motion tracking technology — is being installed by **Fakespace Systems Inc.** of Marshalltown, Iowa. The project is supported by a U.S. Department of Defense appropriation through the **Air Force Office of Scientific Research**.

VRAC will be celebrating the reopening of the new **C6** with a special event in 2007. Watch for all the details in the spring 2007 issue of **VRTech**.

VRAC Team Chalks Up R&D 100 Award

Each year, **R&D Magazine** recognizes the 100 most innovative products with what the **Chicago Tribune** has dubbed, "The Oscars of Invention." The winning of an **R&D 100 Award** provides a mark of excellence known to industry, government, and academia as proof that the product is one of the most innovative ideas of the year.

This year, **Mark Bryden** and his research team received an **R&D 100 Award** for their work for developing a software tool that helps engineers visualize and work with large sets of 3-D data. It is used by universities, national labs, and private companies, such as **John Deere & Company**, for virtual engineering. Bryden's project uses virtual engineering to make engineering analysis easy and intuitive by eliminating the need to build a physical model.



Doug McCorkle, **Gerrick Bivins** and **Mark Bryden** (left to right) display their winning technology at the **R&D 100 awards**.

Designing Interaction 2007

The **Human Computer Interaction** annual forum, "Designing Interaction 2007," will take place spring of 2007 at **Howe Hall** on the Iowa State University campus. It will feature student poster presentations and technology demonstrations. The date and featured speakers have yet to be determined; for the latest news visit <http://www.hci.iastate.edu/forum.php>.

The Human Computer Interaction (HCI) initiative is driven by unprecedented technological progress, making the study of the relationship between humans and computers a dynamic and significant field of technical investigation. Interdisciplinary by definition, this emerging field impacts nearly every area of human endeavor and offers students a wide range of opportunities to work on research solutions both inside and outside of the university. Here are a few samples of the work our students are doing.

Students Shine in HCI

Recent Graduates

Lewis Hill, PhD in HCI, received ISU's Research Excellence Award for his doctoral research on the Synesthetic Music Experience Communicator, a project that combined



Lewis Hill

formation of live performances into informative and entertaining visual presentations. In addition, Hill also received the Iowa African American Hall of Fame's Award "The Future Is Now" for his work.

Branko Strok, MD, MS, was the first to graduate from HCI's Graduate Certificate program. As an informatics physician for the Iowa Foundation for Medical Care, West Des Moines, Strok works with physician offices and hospitals to apply health information technology solutions to manage health records electronically. For Strok, the HCI courses helped him better understand issues relating to the usability of computer applications. He is using the knowledge to educate Iowa physicians about how to evaluate electronic health re-

human computer interaction, music technology, and human perception. Several virtual worlds were developed to facilitate group education, rehearsal, and the artistic trans-



Jared Knutzon, PhD graduate in HCI, has joined a research team at Lockheed Martin to do virtual prototyping and manufacturing of new concepts and designs. He says, "VRAC prepared me for the research world. I know how to assess a problem, divide it

into manageable tasks, look at solutions to each task, decide on a solution, and move a team toward an ultimate goal." While at VRAC, Knutzon researched the management of multiple UAVs from within a 3D virtual environment.

records systems before purchase and how to use the system efficiently to improve patient care. Strok is continuing his education in the PhD program at the University of Minnesota.

Tom Batkiewicz, MS HCI, is working on his PhD in the HCI program.

Tom Erlemeier, MS HCI, is employed by John Deere in Waterloo as a product engineer.

Jake Ingman, MS HCI, is working at ISU for the College of Engineering as a Youth Program Assistant.

Dongheng Li, MS HCI, is a software engineer for Microsoft.

Adam Patridge, MS HCI, went to Sierra Trading Post in Cheyenne, WY in ASP.NET web development.

New Students

The HCI Graduate Program admitted thirteen new students to the program.

Lisa McGarthwaite received this year's HCI Graduate Fellowship Award and is currently working on a MS in HCI with Julie Dickerson. She earned a BA in Graphic Design and Computer Science from Saint Mary's University of Minnesota in 2005.

Troy Abel is working on a PhD in HCI and a MFA in Graphic Design. His major professor is **Roger Baer**. He came to ISU from Valparaiso University in Indiana, earning a BA in Communications and a BSFA in Graphic Design.

Denise Bacher is working on her MS in HCI with **Steven Herrstadt**. She received a BS in Computer Science from ISU in 2006.

Todd Dusold is working on his MS with **Mark Bryden**. He received his BFA in Fine Arts from ISU in 2006.

Sridher Kaminani is working on his PhD in HCI while employed full-time at Rockwell Collins in Cedar Rapids. He earned an undergraduate degree in Computer Science and IT from India and an MS in Computer Science from Western Kentucky University. **Jim Oliver** is his major professor.

Andrew Koehring is working on his MS with **Eliot Winer**. Koehring will co-major in HCI and Mechanical Engineering.

Dawn Laux is working on her PhD in HCI with **Brian Mennecke** while she is working on her MS in Logistics, Operations, and Management Information Systems.

Marisol Martinez earned a BS in Mechanical Engineering in May from ISU. She is now working on her MS. **Eliot Winer** is her major professor.

Michael Oren is working with **Chris Harding** on a MS in HCI. He earned his undergraduate degrees in Computer Science and English from DePauw University, Greencastle, IN, in 2006.

Jivko Sinapov is working on his PhD, co-majoring in HCI and Computer Science, with **Alex Stoytchev**.

Jeremiah Still earned a BS in Psychology from Missouri Southern State University in 2004, his MS in Psychology from ISU in 2006, and is currently working on his PhD in HCI with **Veronica Dark**.



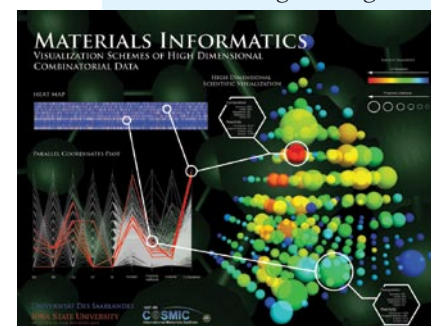
Second Row, Left to right: Todd Dusold, Jeremiah Still and Dawn Laux. Front Row, Left to right: Michael Oren, Eva Tao, Tanasha Taylor and Lisa McGarthwaite.

Li-Shan (Eva) Tao is working on her PhD in Hospitality Management, co-majoring in HCI. She is working with **Gary Hackbarth**. Eva earned a BS in Tourism from the Chinese Culture University in Taiwan and a MBA from St. John's University, New York in 2001.

Tanasha Taylor is working with **Shana Smith** on her MS in HCI. She received a BS in Mechanical Engineering from ISU in 2006.

Other Achievements

Matt Heying, MS in Mechanical Engineering, is working on his PhD in HCI with co-major Professors Krishna Rajan and Jim Oliver. Heying recently received Honorable Mention for his poster presentation in Science Magazine and the NSF's 2006 Science and Engineering



Visualization Challenge. His entry, Materials Informatics: Visualization of High Dimensional Combinatorial Data, showed how chemists and materials scientists can use visualization to easily extract information on the composition of thousands of catalysts and their chemical reactivity.

Nate Johnson, a VRAC research assistant, spent eight weeks this summer in Beijing, China at the Research Center for Eco-Environmental Sciences (Reeces), which is part of the Chinese Academy of Sciences. Thirty students were selected by the NSF to take part in the Chinese fellowship.

David Muth, a VRAC research assistant, did a graduate fellowship at INL this summer and is now working there.

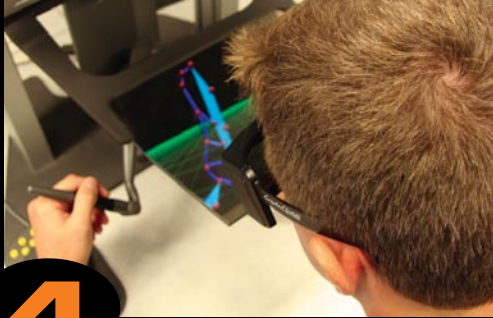
Tyler Streeter, PhD student in HCI, spent the summer at IBM's TJ Watson Research Center in Yorktown Heights, NY as an intern in the Biometaphorical Computing Research Group. This group includes researchers with backgrounds in electrical engineering, biology, and brain imaging. While the group's overall focus is on global brain modeling, Tyler's project was to implement and test a new computational model of the cerebellum. Tyler received his MS in HCI in the Fall of 2005.

Matthew Wach, a former VRAC student, is now writing software and games at Ternary Software in Philadelphia (<http://www.ternarysoftware.com>).



VRTech

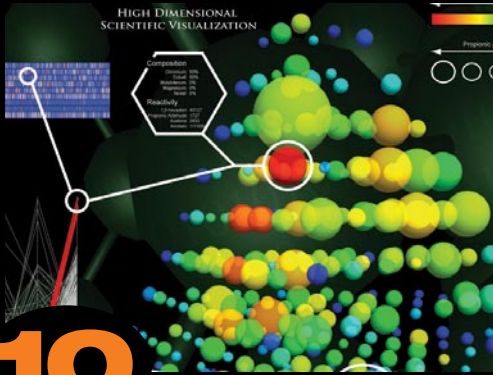
Publication of the
Virtual Reality Applications Center



4 Research Experiences for Undergraduates



8 Partnering with Industry



10 Students Shine in HCI

Contact Us

Contact us for information
about VRAC and its programs

VRAC Information: vrac@iastate.edu

HCI Programs: hci@iastate.edu

Visit our website www.vrac.iastate.edu

Iowa State University does not discriminate on the basis of race, color, age, religion, national origin, sexual orientation, gender identity, sex, marital status, disability, or status as a U.S. veteran. Inquiries can be directed to the Director of Equal Opportunity and Diversity, 3210 Beardshear Hall, (515) 294-7612.

