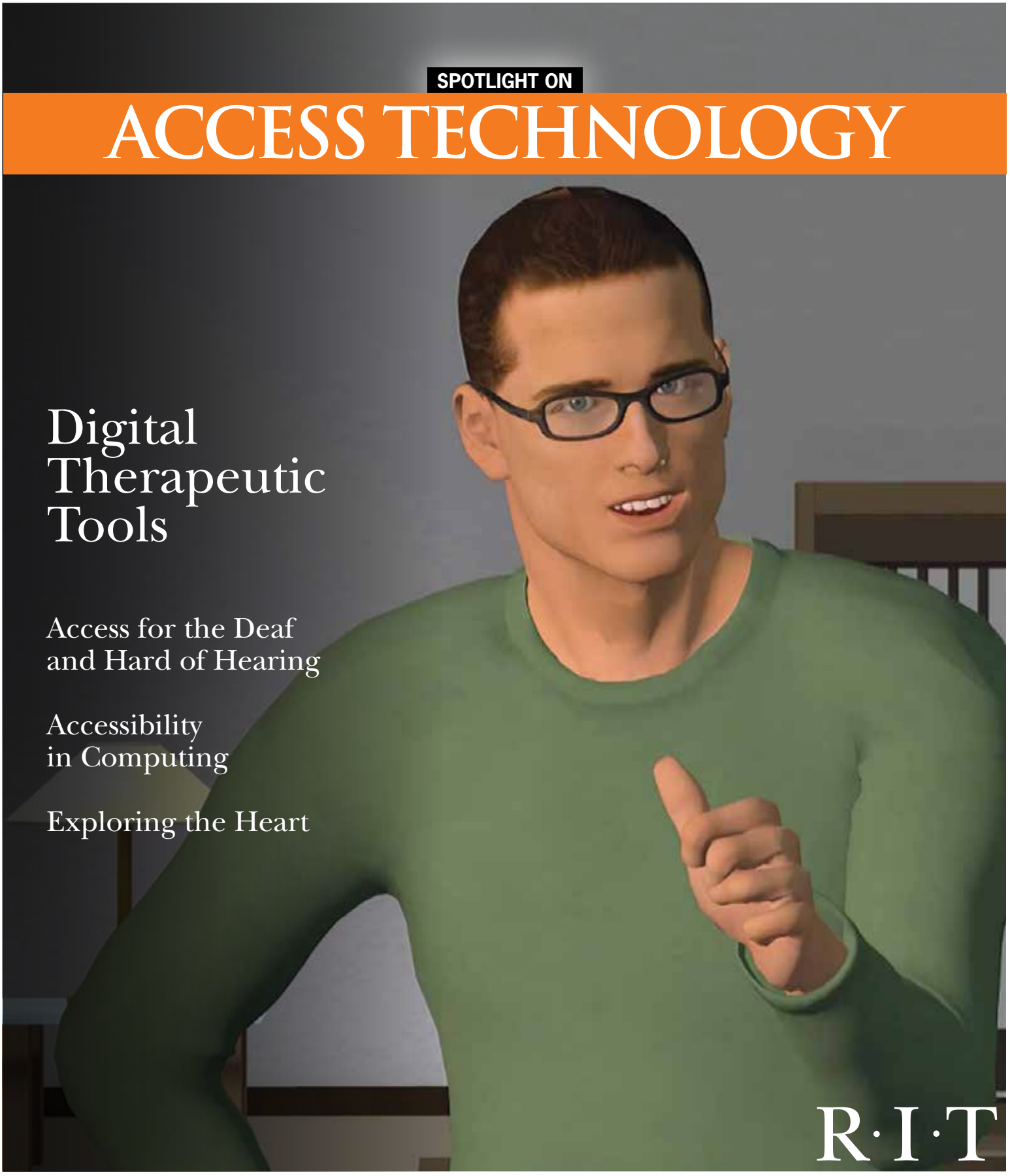
RESEARCH at RIT

The Rochester Institute of Technology Research Report

Spring/Summer 2013



SPOTLIGHT ON

ACCESS TECHNOLOGY

Digital Therapeutic Tools

Access for the Deaf and Hard of Hearing

Accessibility in Computing

Exploring the Heart

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The Rochester Institute of Technology
Research Report–Spring/Summer 2013

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Building on a History of Effective Access Technology

It is my pleasure to introduce you to some of the exciting work going on at RIT in the area of effective access technology, an area of research and development that makes it possible for those living with challenges to more fully participate in society.

Effective access technology is all around us in the form of walking sticks, hearing aids, wheelchairs, automatic doors—amenities that have become a part of everyday life. However, there are many more societal access needs that may be met with the use of new technology. RIT is actively engaged in the adaption of current technology and the development of new technologies for access. When everyone participates, we all benefit.

RIT has a very rich history of making significant contributions in effective access technology through both the National Technical Institute for the Deaf (NTID) and collaborations with community partners like the Al Sigl Center, ArcWorks, the Veterans Administration, and many others. Last fall, RIT started a new program designed to get even more student teams working to develop effective access technology and we are currently providing seed funding to 16 different student teams. These projects will develop innovative new technologies in the areas of learning, mobility, hearing and visual impairment, and the treatment of both substance abuse and autism spectrum disorders.

I trust that you will find this overview of effective access technology innovation here at RIT as compelling as I do. I also invite you to join us and see firsthand what is going on as we host the first-ever RIT Effective Access Technology Conference, which will be held at the RIT Inn and Conference Center, June 11, 2013. This conference will feature keynote addresses from leading experts in effective access technology and will include an exhibit of more than 50 assistive and adaptive technologies from RIT and our partner organizations. Please visit the event website at www.rit.edu/access and join us for a view of the future of effective access technology.

Sincerely,

Ryne Raffaelle
Vice President for Research
and Associate Provost

Inside this Issue

Effective Access Technology at RIT

Many people must live every day with a variety of physical and mental challenges. Over one billion people, or approximately 15 percent of the world's population, live with some form of a disability. At Rochester Institute of Technology (RIT), we know that when barriers to inclusion are removed and persons with disabilities are empowered to participate fully in society, our entire community benefits.

RIT is Not New to Access Technology: In 1965 President Lyndon Johnson signed the National Technical Institute for the Deaf Act to provide deaf and hard-of-hearing students with outstanding technical and professional education programs, complemented by a strong sciences curriculum, that prepares them to live and work in the mainstream of a rapidly changing global community. NTID at RIT has introduced and deployed innovative access technology for the deaf community ever since then.

Technology Provides Leverage

Societal participation can be especially difficult for those among us who are confronted by multiple disabilities (deafness and cognitive challenges, blindness and mobility issues, etc.). Unfortunately, these instances of multiple challenges are increasingly frequent among our growing elderly and veteran populations. Over the past five years, we have seen a 39-percent increase in the total number of veterans living with service-related disabilities and a dramatic 100-percent increase in veterans with a 70- to 100-percent disability rating.

The good news is that this is the best time imaginable for people with disabilities and/or special needs to take advantage of new technology for connection and independence. Researchers at Rochester Institute of Technology are developing a significant number of new types of technologies—or have adapted existing technologies—to improve access for persons with disabilities. From advanced robotics to new technologies for hearing or visual impairment to the use of social and interactive media, researchers are developing remarkable new ways for people to connect.

RIT values its tradition of developing assistive and adaptive technology and working with our community to serve those with disabilities and special needs. One of the best examples is RIT's National Technical Institute for the Deaf (NTID). Formally established in 1965 through an Act of Congress, NTID began operation in 1967 and is currently one of the most accessible education communities in the world for deaf and hard-of-hearing students. NTID's long and rich history of innovations for the deaf and hearing-impaired community is unparalleled. The NTID-created speech-to-text system is used all over the world to provide communication access to individuals who are deaf. This tradition continues with RIT/NTID's recent award of a $1.75 million grant from the William G. McGowan Charitable Fund as the lead investment in the construction of the new Sebastian and Lenore Rosica Hall. This first-of-its-kind facility will engage deaf and hard-of-hearing students and their hearing peers, along with faculty and corporate partners, in the innovation process.

RIT is proud of our longstanding commitment to supporting our wounded service members. For over 50 years, RIT's Veteran Services Office has been dedicated to supporting and advocating for active-duty military, veterans, and their dependents. RIT is proud to partner with the U.S. Department of Veteran Affairs in the "Yellow Ribbon" program and "Servicemembers Opportunity

Colleges Consortium" initiatives, which offer educational support to veterans, servicemembers, and their families. NTID has developed a program designed especially for veterans who have suffered hearing loss as a result of their service.

RIT's work in assistive and adaptive technology has been done in collaboration with many local institutions, including the Al Sigl Community of Agencies, Arc of Monroe County, Association of the Blind and Visually Impaired (ABVI), Nazareth College Physical Therapy Clinics, and the Veterans Administration. These partnerships have identified the new technologies—or adaptations of existing technical resources—that can foster independent choices for and direct connections to those living with multiple disabilities and/or other special needs. Last year alone, RIT, with its partners, executed on some 71 different research projects relating to access technology. This important work is being conducted all across campus, in eight different colleges, with a cumulative total of over $10M in support from funders including the National Science Foundation and the National Institutes of Health, along with many other private, state, and federal organizations.

Computational Support

Innovative uses of interactive media (i.e., social networking, virtual reality, cyber technology, human visualization, and gaming tools) have resulted in new interventions for the treatment of developmental disabilities. Elsewhere in this issue, you'll read about RIT's Laurence Sugarman developing computer games to be used in tandem with existing biofeedback technologies that help individuals develop skills to manage a variety of mental, emotional, and behavioral challenges. Indeed, RIT's Career Opportunities for Students with Disabilities Community of Practice, dedicated to meeting our diverse student population's full range of needs, was awarded the 2012 Robert Greenberg Award for Innovation for providing cutting-edge services to enable college students with disabilities to be more competitive in their job searches.

In RIT's College of Health Sciences and Technology, professor Caroline Easton and her colleagues are developing and building standardized, virtual-reality role- play tools for use with clients struggling with co-occurring substance abuse and domestic violence issues. Clients are encouraged to interact with virtual characters and are paired up with avatar coaches who help teach, reinforce, and promote coping skills. These virtual tools help shape healthier communication skills, develop pro-social behaviors, and improve both the client's health and overall well-being of the family. Clients engage, through games, in role-playing exercises that allow them to learn healthier coping skills and manage their substance abuse, anger management, communication skills, and conflict resolution.

Capstone Projects to Address Disabilities

RIT faculty and students have long been engaged in the development of assistive and adaptive technologies for persons with physical disabilities. Since 2006, faculty and student innovators have completed over 50 capstone engineering design projects aimed at helping people with disabilities. RIT-developed assistive devices, workplace adaptations, and rehabilitation aids have impacted individuals and organizations in the greater Rochester area. One student project involved the refashioning of an RIT-developed upper extremity exerciser for stroke rehabilitation into a low-cost gait and terrain monitor prototype. Other projects resulted in improved pool lift seats, redesigned wheelchair trays, and modified keyboards for Arc of Monroe County. RIT researchers implemented a work cell redesign for the Association of the Blind and Visually Impaired (ABVI) and redesigned a Closure Tube Assembly for ArcWorks. Collaboration with the Nazareth College Physical Therapy Clinics has led to the development of several new pieces of equipment for the clinics along with improvements to the campus facility.

RIT embraces its role as a leader in educating diverse people of all needs and abilities of our community. This commitment calls RIT to work to ensure access for all, in all spheres of activity and influence. The university is unique in its great range of community partnerships, groundbreaking technological capabilities, and an unfailing belief in the need to provide the innovative solutions that will make full access for the community a goal that can be realized.

Improved Ankle Foot Orthotic (AFO): A common reason a patient is prescribed an AFO is a condition called foot-drop, a disorder involving a lack of ability to articulate the foot. Jointed plastic AFOs that hold a person's foot in a neutral position are the current standard for addressing foot-drop. Interviews with patients and clinicians identified current AFOs need to allow for greater ranges of motion while walking on ramps or stairs. Christopher Sullivan, as part of a Senior Design Project in the Kate Gleason College of Engineering, developed a prototype AFO that will provide a variable support system for the foot that addresses those needs.

MindGamers: Professors Laurence Sugarman and Steve Jacobs work with student Kenneth Stewart on MindGamers, a role-playing video game platform in development at RIT's Center for Media, Arts, Games, Interaction and Creativity (MAGIC). The package is designed to teach calming and self-regulating skills to teenagers with autism spectrum and obsessive-compulsive disorders.

Mental and Behavioral Health

Digital and Therapeutic Tools

by Susan Gawlowicz

Gaming technology offers mental health care providers novel ways to treat patients, whether teenagers with autism spectrum disorder or substance abusers with a history of family violence. Professors at Rochester Institute of Technology are exploring the possibilities of using virtual reality in therapy.

The Challenge

A man arrested for domestic violence attends a crowded group therapy session on anger management. He comes home drunk and bristles when his wife accuses him of drinking. Their children standing in the doorway watch the argument escalate into shoving and swearing. Their father hits their mother; they absorb the violence.

A 15-year-old boy with autism spectrum disorder stands in line at his high school cafeteria, avoiding eye contact and conversation with his classmates as if his life depended on it. He wishes the lunch ladies would stop telling him to have a good day.

Effective mental and behavioral health treatment can help people with substance abuse and aggressive tendencies end their addiction and learn healthy conflict resolution skills; likewise, young people with autism spectrum or obsessive-compulsive disorders can learn how to work with their problems and achieve their goals.

Two projects at RIT's Institute of Health Sciences and Technology are combining interactive media with therapy to teach people how to change their thoughts and behavior. RIT professors Caroline Easton and Laurence Sugarman are forward-thinking faculty whose projects are laying the foundation for a defining niche that could set the Institute apart from other centers. Easton and Sugarman's respective research taps RIT's strengths in gaming and medical illustration to add a virtual component to mental and behavioral health treatment.

"We're interested in progressive, preventive approaches to keeping people healthy," says Daniel Ornt, dean and vice president of the Institute of Health Sciences and Technology, part of the RIT-Rochester General Health System Alliance. "We're directing our efforts toward health and wellness, and introducing technologies as new approaches to helping people improve their health. Behavioral/mental health is a key area for achieving good health, so we are excited about growing educational programs and research in that area."

RIT is carving a progressive niche in health sciences education: Daniel Ornt, dean and vice president of the Institute of Health Sciences and Technology/ College of Health Sciences and Technology, is cultivating a culture focused on finding technological solutions for improving health care.

Addiction, Violence, and Cyber Therapy

Easton, a forensic clinical psychologist in the College of Health Sciences and Technology and a 1990 alumna with a BS in biotechnology, is a leader in clinical forensic psychology. Her research treats the combustible combination of co-occurring substance abuse and family/intimate partner violence, which, until recently, had been treated separately.

The model Easton developed in 1997 and refined at the Forensic Drug Diversion Clinic she established at Yale University Medical Center in 2003 targets anger problems and aggression with cognitive behavioral therapy, a proven method for treating substance abuse, depression, and anxiety. In her method, therapy

Substance abuse and domestic violence are global issues that break hearts everywhere: RIT alumna and forensic clinical psychologist Caroline Easton has an alternative to the "one-size-fits-all" approach for treating substance abuse and aggression. Her method is attracting attention internationally.

"Treating Family Violence as a Contagious Disease": Teraisa Chloros, a graduate student in medical informatics in the B. Thomas Golisano College of Computing and Information Sciences, demonstrated the Noldus facial expression analysis software at a conference exploring alternative models for treating family violence. The March event was hosted by RIT's College of Health Sciences and Technology. Here, Chloros describes software that can be layered into digital therapeutic tools to teach clients positive communication skills.

helps teach people health coping skills to reduce the maladaptive behaviors of substance use and aggression. Healthier coping skill sets are taught to clients to help them cope with cravings, learn more pro-social communication skills and anger controls. The healthier the skills sets, the better the treatment outcomes are and hence, less family conflict.

"The one-size-fits-all approach has been used for 30 years or so, and it hasn't changed," Easton says. "It costs $5.8 billion a year in taxpayer money, not to mention damage to families. Children witnessing untreated mental health and behavioral health issues often end up as victims or as offenders themselves."

The mental and behavioral health issues Easton treats are global health concerns. Her method has attracted international attention from colleagues also struggling to treat family violence among clients with addictions. Collaborators in Brazil and Great Britain, as well as colleagues in the United States, are adopting her model for treating individuals with co-occurring substance abuse and domestic and intimate-partner violence issues.

Gail Gilchrist, head of the Center for Applied Social Research at the University of Greenwich in London, is implementing Easton's method in eight ambulatory clinics across London. Gilchrist visited RIT in March to give the keynote talk at the conference Treating Family Violence as a Contagious Disease: Moving Beyond a One-Size-Fits-All Treatment Approach, sponsored by RIT's College of Health Sciences and Technology and the Office of Research.

Easton is exploring the potential of virtual reality tools to treat and educate individuals with substance abuse and aggression issues through role playing and modeling positive behavior. Exhibits at the conference in March displayed virtual reality, cyber and human visualization tools that RIT medical illustration students are developing with Easton. Their interactive software supplements Easton's integrative model of care for assessing and treating substance abuse, domestic violence, and the interaction between the two.

Easton points to "Al-Virt" as an example. The virtual coach, created by graduate student Alan Gesek, will help clients improve their nonverbal and verbal communication skills. The customizable avatar is an empathetic character and a positive role model that teaches healthy communication skills through role-playing exercises and realistic vignettes. Facial recognition software is layered into the program to enable the cyber coach/avatar to respond to a client's emotional cues. Easton predicts that virtual role playing will be more palatable for patients who find standard therapeutic role play with the therapist as uncomfortable. "Having this tool helps shape and reinforce healthy behavior," she says. "The clients are videotaped acting out behavior, and they're shown what they look like doing it. Then they're shown a healthy way of resolving the same conflict. It really helps them even more. It's based on social learning theory."

Mental Health Professionals and Game Designers Team Up : The team of mental health and game design students and professionals meet weekly at the RIT Center for Media, Arts, Games, Interaction and Creativity (MAGIC). Laurence Sugarman, right, works with team members pictured here including Stephen Oyarijivbie, left, a '12 alumnus in game design development, student Whitney Brown, in back, and Stephen Jacobs, associate professor at RIT's School of Interactive Games and Media.

Virtual Coach: Alan Gesek, a graduate student in RIT's medical illustration program, created "Al-Virt," a virtual coach, to model healthy communication and conflict-resolution skills for individuals receiving treatment for substance abuse and domestic violence offenses. Gesek worked closely with Caroline Easton, professor of forensic psychology in the RIT College of Health Sciences and Technology, to develop the interactive program. Image provided by Alan Gesek.

Her multidisciplinary research team of faculty and students includes RIT professors James Perkins, Richard Doolittle, Glenn Hinz, Shaun Foster, and Steve Jacobs; and students from the medical illustration program, Valerie Altounian, Alan Gesek, Teraisa Chloros, Timothy Fitzgerald, and Nirja Desai. The faculty-student team creates interactive role-playing scenarios grounded in Easton's evidence-based research. The students' technological skills merge and glue the storyboard together, Easton says.

"I think virtual reality tools are the future," Easton says. "Human visualization, cyber, virtual tools, and gaming are all going to be an important part coupled with our best practice procedures. This is where the College of Health Sciences and Technology is going to be great. It's about furthering these tools and coupling them with our patient interaction."

MindGamers

Another project that taps strengths of the Institute of Health Sciences and Technology and the B. Thomas Golisano College of Computing and Information Sciences has the potential to advance RIT in the field of therapeutic interactive gaming, or "games for health," a category within the genre of "serious games."

MindGamers is a role-playing video game platform in development at RIT's Center for Media, Arts, Games, Interaction and Creativity, or MAGIC. The first application, "MindGamers in School," is designed to teach calming and self-regulating skills to teenagers with autism spectrum and obsessive-compulsive disorders. A patient will play the game during therapy sessions to learn to control stress physiology and overcome repetitive thoughts and behaviors.

MindGamers is a collaboration among Sugarman, director of the Center for Applied Psychophysiology and Self-Regulation at RIT's Institute of Health Sciences and Technology and clinical associate professor in pediatrics at the University of Rochester School of Medicine and Dentistry; Stephen Jacobs, associate professor of RIT's School of Interactive Games and Media; and Robert Rice Jr., director of clinical internships in the Mental Health Counseling Program at St. John Fisher College.

Sugarman anticipates having a playable first-level game by fall.

Collaborating to Build Therapeutic Gaming Environments: RIT student Whitney Brown, a new media design major, talks with Robert Rice Jr., from the St. John Fisher College Mental Health Counseling Program about refinements to MindGamers, a therapeutic video game for teens with autism spectrum and obsessive-compulsive disorders.

MindGamers in Action: MindGamers uses three avatars for patients to customize: one to resemble themselves, and two corresponding "imps" (on the clouds above the patients' shoulders) to externally reflect the patients' goals and problems as they move through scenes simulating their daily life.

"I expect MindGamers should be ready for clinical trials as a game versus standard therapy or medication, even, by early 2014."

Seed funding Sugarman and Jacobs won from the Effective Access Technology Program offered by RIT's Office of the Vice President for Research supports student researchers from the School of Interactive Games and Media in the Golisano College of Computing and Information Sciences. The student team works with Jacobs to build environments and scenarios to reflect the needs of potential players. Feedback from clients at Easter Seals Diagnostic and Treatment Center in Rochester, which works with Sugarman and Rice, is driving the content of the game.

"My clients want something that fits with modern video games," Rice says. "That includes graphics and game play. Many of my clients are attracted to games involving character creation."

Creating the game with feedback from potential players gives the team reassurance that MindGamers will reach and meet the needs of teens with autism, anxiety, and obsessive-compulsive disorders.

"In mental health games, overall, we are enabling the players to tell their own story," Jacobs says. "That's what we do with MindGamers. We provide a place for the therapist and player to customize and build on."

MindGamers uses three avatars for patients to customize: one to resemble themselves, and two corresponding "imps" to externally reflect the patients' goals and problems as they move through scenes simulating their daily life.

"The goal-based imp is the player's ideal version of himself, equipped with items the patient and therapist have named that remind them of goals they are trying to reach or the process they are trying to take to reach their goals," Jacobs says. "The problem-based imp is how they envision their current problem."

The therapist and player set triggers for game play. For someone suffering from germophobia, that environment might include messy trash cans. Choosing to avoid the receptacles or compulsively "fix them" in response to stress gets in the way of meeting their goals for the game, Jacobs explains.

"The movement has really just begun," Rice says. "We are just learning how and why people are so engaged and, perhaps, changed by playing video games."

Biofeedback data is collected through sensors attached to the player's fingers and strapped around his or her waist. The sensors monitor four inputs—sweat gland activity, body temperature, heart rate, and breathing—as the player navigates the environment. The information helps patients connect their physiological changes to stressful situations and, through therapy, learn calming techniques to manage and reduce stress.

The biofeedback device uses a product made by MindMedia BV, which specializes in physiological monitoring and feedback products for researchers, clinicians, and health care professionals. The Netherlands-based company loaned the team the NeXus-10 Biofeedback hardware and Biotrace software to create its prototype game. The medically approved biofeedback device and physiological inputs will generate data to measure and compare outcomes.

"MindGamers is about self-regulation. That's a major point of the Center for Applied Psychophysiology and Self-Regulation," Sugarman says. "It's about balancing health care with what people can do for themselves. That's both fundamental and cost-effective."

On the Web

College of Health Sciences and Technology
www.rit.edu/healthsciences

Media, Arts, Games, Interaction & Creativity
magic.rit.edu

Investigating Protein Function

Paul Craig

Molecular visualization software gives biochemists like Paul Craig, head of the School of Chemistry and Materials Science at RIT, tools for advancing research on how large molecules known as proteins function and the groupings of amino acids that determine their function.

Craig and his collaborator, Herbert Bernstein, professor in the department of mathematics and computer science at Dowling College, in Long Island, N.Y., are in the second year of a three-year study funded by a $437,100 grant from the National Institutes of Health's National Institute of General Medical Sciences. Their work is based on data from Research Collaboratory for Structural Biology Protein Data Bank—a repository of biological structures of proteins, nucleic acids, and complex assemblies.

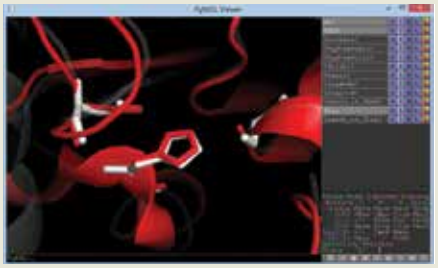
The RIT-Dowling team is using a structural alignment algorithm to predict the biological functions of 3,000 proteins based on the features of the active sites of these enzymes. They are focusing on amino acids and their spatial relationships that dictate a protein's specific mission in the living systems. Their work could someday lead to medicines that target proteins and switch on or off specific functions associated with various diseases.

The teams of students on both campuses are comparing the selection of proteins with a library of 400 protein motifs associated with known functions. The team is verifying and statistically rating the matches using three-dimensional modeling. The project uses existing active-site templates and new templates created by RIT students.

Craig and Bernstein are beginning to publish their findings, with one paper in press with *Biochemistry and Molecular Biology Education*, and a second nearing submission. Two students from the RIT team presented posters at the American Society for Biochemistry and Molecular Biology in Boston in April, while a total of eight students gave poster presentations at national conferences last year.

"Our first goal was to improve our software and expand our library of motif templates, basically a library of structures to compare against, and to use software to predict function," says Craig, a professor of biochemistry and bioinformatics. "What some of our students have done is to take our predictions into the lab and actually test them.

"One of the directions I'd like to go with this is to create a curriculum for biochemistry teaching labs for colleges across the country where students can use this approach to test predictions."



Form Follows Function: A protein of unknown function, pictured in red, aligns with an enzyme known as a lipase. The enzyme, a catalytic protein, depicted in white, breaks down or digests fats. Greg Dodge, a fourth-year biochemistry major, who works in professor Paul Craig's lab, superimposed the large molecules using the software program ProMOL. His results indicate a similar chemical function based on likeness of form.

Understanding The Message: a Key to Healthier Living

James DeCaro

Vincent Samar

How healthy is the deaf and hard-of-hearing community when most of the information that leads to healthy lifestyles is presented in a language they may not fully understand?

To help address that issue, the Centers for Disease Control and Prevention established the National Center for Deaf Health Research (NCDHR) in 2004 at the University of Rochester to promote health within the deaf and hard-of-hearing community, under the leadership of director Thomas Pearson and associate director Steven Barnett.

The National Technical Institute for the Deaf's Center for Access Technology, directed by James DeCaro, is a community partner in the program and collaborates to develop surveys in signed and written languages used and understood by members of the community.

Subcontracts with NCDHR involve developing sign language-based health surveys and research measures to support a variety of health-related research, surveillance, and intervention programs funded by the CDC and National Institutes of Health.

"Deaf people who use American Sign Language are medically underserved and are often excluded from public health surveillance and research," says Vincent Samar, an associate professor in NTID's department of liberal studies and co-principal investigator on the CDC subcontract.

Since 2004, deaf and hearing researchers and community members worked together to develop and administer linguistically and culturally appropriate health surveys. Surveys were developed in ASL, signed English, and English print so the community respondents had the option to communicate in the form they were most familiar with.

Samar's team collaborated with NCDHR to develop video tools used to present surveys to community members. Samar also collaborates on the planning and execution of NCDHR research projects.

NCDHR's surveys have identified several high-priority health risk factors, including obesity, intimate partner violence, and suicide attempts. NCDHR has obtained new CDC and NIH funding to respond to these and other priorities.

For example, to respond to the deaf community's obesity-prevention priority, a "Deaf Weight Wise" program was launched to help promote healthy eating and exercise and reduce the risks of being overweight.

"The Deaf Weight Wise program is an excellent example of community-based participatory research and follow-up community intervention," Samar says. Now, with help from additional funding from the CDC, NCDHR is busy conducting research to determine if this program has been effective.

For more information, visit http://www.urmc.rochester.edu/ncdhr.

Town Hall Meeting: Members of Rochester's large deaf community gather for a "town hall" meeting to learn about wellness from the National Center for Deaf Health Research, based at the University of Rochester.

Enhancing Access
for the Deaf and Hard of Hearing

by Greg Livadas

RIT's Center on Access Technology (CAT) was established in 2006 by the National Technical Institute for the Deaf to improve educational opportunities in classroom access technologies, mobile technologies, audio and sound technologies, and training and evaluation services for deaf and hard-of-hearing people.

CAT Research is Far Reaching

Center on Access Technology Director James DeCaro, professor and NTID dean emeritus, says the research conducted there often involves collaboration with other RIT colleges, other universities or industries and professional organizations.

CAT has four predominant branches:

- The CAT Innovation Lab, where technology is designed, assembled, tested, and disseminated.
- Development and support of C-Print, a classroom captioning service developed by NTID in the late 1980s and refined as technological improvements were made. Michael Stinson, a professor in NTID's department of research, oversees C-Print. In recent years, a tablet has been added to C-Print, allowing drawings, equations, and diagrams to be captured in notes.
- A five-year, $1.6 million National Science Foundation grant to develop the Deaf STEM Community Alliance, a virtual academic community for college students who are deaf or

Advancing Classroom Technology: NTID instructor Brian Trager uses a See-through, Life-sized Interactive Monitor (SLIM), where he can face students while using a screen for notes and diagrams. SLIM, developed at NTID's Center on Access Technology Lab, enables deaf and hard-of-hearing students to read lips and see facial expressions by allowing teachers to face students rather than turning their backs to use a blackboard.

hard of hearing and majoring in science, technology, engineering, and mathematics fields, partnering with Cornell University and Camden County (N.J.) College.

- The Pre-College Education Network (P-CEN), improving the utilization of technology and sound teaching and learning practices to improve education for people who are deaf and hard of hearing in pre-college programs, primarily in Asia. Funding is from the Nippon Foundation of Japan.

"We really want to show that RIT and NTID are leaders in research for access technology for deaf and hard-of-hearing people," says Gary Behm, a retired engineer for IBM who is now director of the CAT Innovation Lab. "Not only are we improving technology, we're improving the quality of life for many people."

CAT Innovation Lab

NTID's Center on Access Technology Innovation Laboratory ("CAT Lab"), established in 2009, is a first-of-its-kind engineering facility that provides a place for students to get involved in the innovation process. The CAT Lab brings together faculty and associate, bachelor's, and master's degree-level deaf and hard-of-hearing students to collaborate on multidisciplinary projects related to developing and adapting access and instructional technologies, health care technologies and services, and more.

Face-to-Face Communication: The See-through, Life-sized Interactive Monitor (SLIM), developed at NTID's Center on Access Technology Lab, enables face-to-face communication when diagrams or notes need to be written on a board. It may also be used in remote settings, where a teacher and student are in different locations.

Not only will students benefit from these emerging technologies in the classroom, students are also gaining valuable

experience developing and testing it. In the last four years, about 20 engineering, computer science, information technology, and industrial design students from RIT have completed paid co-ops on various projects in the CAT Lab.

"Students who are involved in innovative projects develop leadership, teamwork, and communication skills," says CAT Associate Director E. William Clymer. "Their experiences instill in them a passion for innovation. Ultimately these students become empowered to be more independent."

Behm, a support member of the NTID engineering studies department, says, "NTID has a vision of creating learning partnerships among students, faculty, and external partners that will respond to future challenges and shape future opportunities with innovation. The CAT Lab holds a central place in this future."

Walking into the CAT Lab in NTID's Lyndon Baines Johnson Hall, visitors see evidence of the work that has gone on inside. Several large posters used in exhibits and conferences describe some of the new products being developed and tested there. A sampling:

Smart Cane: This prototype of a Smart Cane features tactile feedback to help guide individuals who are deaf and blind.

Face Mask: A see-through face mask is being developed at NTID's Center on Access Technology Lab. Its purpose is to enable deaf individuals to read lips and see facial expressions of those wearing the mask in hospital or clean room settings.

- **The See-through, Life-sized Interactive Monitor** (SLIM) allows engagement of teaching by allowing teachers to face their students while writing on the board. It features two large monitors placed back-to-back. Teachers can face their students in the classroom and write on a screen without turning away. What they "write" on one screen is reversed on the other while at the same time, allowing them to see what's on the other side of the screen. A prototype at last year's Imagine RIT: Innovation and Creativity Festival won a ribbon and sponsor award for the emerging technology from Texas Instruments.

- **Smart Cane Prototype for the Deaf-Blind**, a new project receiving seed funding from RIT's Effective Access Technology Program. The goal is to design and develop a low-cost, lightweight "Smart Cane" prototype that will aid deaf-blind persons in navigating surroundings via real-time tactile and directional force feedback and guidance. A proposal was submitted to the National Institute on Disability and Rehabilitation Research for a workable prototype.

- **Low-vision Glasses**, in the proof of concept stage with a goal of integrating with a miniature camera installed on the bridge above the nose; uses a smartphone to capture images beyond the user's field of vision. The images are condensed and displayed on a lens on the subject's field of vision. This is particularly helpful for people with Usher Syndrome, a condition some deaf people are born with that can result in tunnel vision in young adulthood. Low-vision glasses provide a wider field of vision, which allows users more engagement in classroom settings and enables them to see who is talking.

- **See-through Face Mask**, patented with prototypes being tested. Developing the perfect plastic polymers will allow it to be flexible and strong enough to work as an efficient mask while enabling deaf or hard-of-hearing coworkers to read lips and facial expressions in an emergency room or a manufacturing clean room. Similar

Members of the Deaf STEM Community Alliance Leadership and Development Teams have created a model of a virtual academic community for college students who are deaf or hard of hearing by implementing remote tutoring and remote mentoring on a one-to-one or small-group basis. Seated from left to right: Lisa Elliot, James DeCaro, Samuel Georgeo (RIT student), William Clymer, and Roseline Okpara (RIT student). The left computer screen shows Kathy Earp connecting into the meeting from Camden County College (Blackwood, NJ). (Photo: Ben Rubin, NTID)

masks have been developed by others, but they proved to be inefficient and often fogged up due to respiration.

Virtual Academic Community

NSF grants RIT/NTID has received over the years involving remote technology led to a summit in 2008 to look at remote services that could address the access needs for deaf and hard-of-hearing STEM students. That led to an enrichment grant to investigate different remote video relay systems for deaf and hard-of-hearing students, and to a five-year, $1.6 million grant from the National Science Foundation's Research in Disability Education program to establish the Deaf STEM Community Alliance, creating a model virtual academic community for college students who are deaf or hard of hearing.

"Rather than having an interpreter in the same room as your students and teacher, you can provide that service over the Internet," Clymer says. "But it's not done in the classroom much yet. We're also trying to provide the best ways to provide the service, such as seeing if Chromebooks or laptops can be used. The challenge is to find a video technology proficient for deaf audiences. Having that visual connection is very important."

Currently the project is implementing remote tutoring and remote mentoring on a one-to-one or small-group basis. Participants are using Google applications (such as Google+ Hangouts) for the video platform. Members of the community are also using social media to create a community of practice that shares ideas and resources about STEM that are accessible to deaf and hard-of-hearing audiences.

Although being piloted in the Northeast, the project seeks to implement a model that will be shared throughout the country.

Project Director Lisa Elliot, senior research scientist in the Center on Access Technology, says there are more than 30,000 deaf and hard-of-hearing students studying at colleges across the country. "Our goal is to see that they receive the best access and support services possible."

"Lisa's and Bill's efforts demonstrate the logical, thoughtful, and systematic approach being taken by the center to develop solutions that people who are deaf have access to education on par with their hearing peers," DeCaro says.

The Future

A working relationship with those who teach pre-college students in ASEAN countries (represented in the Association

Pre-College Education Network (P-CEN): NTID has focused on improving the utilization of technology and sound teaching and learning practices to improve education for people who are deaf and hard of hearing in pre-college programs, primarily in Asia. NTID President Gerry Buckley (left) and CAT Director James DeCaro (right) visited Moscow in September to talk about the NTID-developed C-Print, a classroom note-taking system. (Photo by E. William Clymer, NTID)

of Southeast Asian Nations) has begin and continues with P-CEN. Workshops, exchange visits, and technology used in classrooms is being discussed, and the 40-plus years of experience NTID has in teaching deaf and hard-of-hearing students is being shared with countries seeking to meet NTID's standards.

Last fall, a P-CEN delegation from NTID visited Moscow to meet with educators and government officials to share development of voice-to-text systems such as the NTID-developed C-Print application.

And a symposium for the summer of 2014 is in the planning stages to bring people from around the world together to discuss voice-to-text technology, and how it may be integrated to benefit deaf and hard-of-hearing college students.

CAT officials have also been consulted to assist officials at the Greater Rochester International Airport to provide accessible information for travelers, New York Gov. Andrew Cuomo's staff in developing accessible communications during emergencies, and even officials in Japan who are seeking best communication practices after dealing with the aftermath of natural disasters.

"We're probably the most involved in this kind of work with communication for deaf and hard-of-hearing individuals of any other academic institution," Clymer says.

Although the center has been successful at securing funding for its research, DeCaro says grants aren't as plentiful as they once were and are more competitive. But he's optimistic more will come. One current proposal calls for postdoctoral students who are deaf to come to Rochester. Once in town, the students will work 75 percent of the time in a research lab at the University of Rochester, and 25 percent of the time at RIT to learn how to teach other students in the field of health care.

DeCaro hopes that as a direct result of the 2012 findings from the Task Force on Health Care Careers for the Deaf and Hard of Hearing, RIT's Institute of Health Sciences and Technology will help sponsor a program to send top graduates who are deaf or hard of hearing and have completed a bachelor's degree in Science, Technology, Engineering, or Mathematics to RIT to pursue a master's degree program, then continue on to the University of Rochester to pursue a doctoral degree in health sciences.

On the Web

Center on Access Technology
www.rit.edu/ntid/cat/

Pre-College Education Network
www.p-cen.netid.rit.edu

Cisco Systems Establishes a Research Presence at RIT

Bill Clymer

James DeCaro

Rochester's first Cisco TelePresence Center was unveiled in December 2011 at Rochester Institute of Technology's National Technical Institute for the Deaf, enabling high-quality, real-time video conferencing.

Cisco TelePresence Centers are located around the world—including The White House—and offer high-definition videoconferencing that makes it seem as though everyone is seated in the same room, at the same table. Most are used by executives who find it a less expensive and more immediate option than traveling to meetings.

Cisco Systems, headquartered in San Jose, Calif., donated the equipment, installation, and engineers to create the customized 14-seat room at RIT/NTID, ensuring the audio and lighting match that in other TelePresence Centers. The TelePresence room, the largest between Toronto and Albany, is filled with three 65-inch monitors placed next to each other. Additional monitors are above the main monitors and can be used for captioning. A smaller TelePresence system was also donated and is based in another location at RIT/NTID. The donation was made to RIT/NTID as part of a one-year Cisco research grant funded by Silicon Valley Community Foundation so that research and recommendations can be given to Cisco to help improve its technology to work effectively for deaf and hard-of-hearing individuals.

The bulk of the reseach has involved how the center is best used to accommodate participants who are deaf or hard of hearing to ensure TelePresence Centers are fully accessible. The technology enables interpreters to be miles away from a deaf person attending the teleconference meeting. The impact could allow businesses and classrooms to be more inclusive, especially in areas where sign language interterpreters may be hard to find. It could also be used for distance learning programs.

During their research, NTID found it wasn't easy to determine where interpreters needed to be situated in order to be effective and not obstructive.

Christine Monikowski, a professor in NTID's American sign language and interpreting education department, said interpreters appreciated being part of the research process. "We wanted interpreters to help determine best practices for our field. We needed to actually have them here to ensure that the data collected —including appropriate placement and visual access—was accurate."

TelePresence: RIT, with support from CISCO, is accessing the use of the advanced Cisco TelePresence system so that recommendations can be given to Cisco to help improve its technology to work effectively for deaf and hard-of-hearing individuals. Although the high-resolution visual environment supports sign language communication, NTID researchers found it wasn't easy to determine where interpreters needed to be situated in order to be effective and not obstructive. NTID's work continues to ensure that appropriate placement and visual access for the interpreters is optimized.

The TelePresence Center also was put to practical use during the 2012 NTID Job Fair after Cisco engineer Shraddha Chaplot suggested attending the fair via TelePresence. Dozens of RIT/NTID students sat at the table for interviews by Chaplot in California. Cisco previously hired RIT/NTID students for summer co-ops in the summer of 2011.

After the year of planned research ended, a meeting was held to determine what was learned.

"I can envision the technology used in tutoring, mentoring, and remote interpreting," says E. William Clymer, associate director of NTID's Center on Access Technology. "We envision the day an interpreter won't come into this office, but would link to a TelePresence Center on a laptop."

The center at RIT/NTID has enabled interactions with other universities with similar technology in India. The technology has also spurred interest by Gov. Andrew Cuomo and officials in Japan who were developing reports on emergency communications.

"This really ties into our mission," says James DeCaro, director of the Center on Access Technology. "This is the future. There aren't going to be 5,000 students here. It's us reaching out to them and our becoming a national center."

Chaplot, who led the effort on the TelePresence donation and research grant, said she is proud of Cisco's partnership with RIT/NTID.

"From the research they did regarding TelePresence uses for deaf and hard-of-hearing individuals to the summer interns we brought to Cisco, it has been an eye-opening experience in every way," she says.

Chaplot said Cisco plans to incorporate the recommended best practices into the company's user guides for TelePresence. "Our partnership with RIT/NTID is strong and we will continue researching TelePresence to determine how we can make it more accessible for those who are deaf or hard of hearing. By doing so, I am sure we will enhance an experience that is usable by and benefits everyone."

Gary Behm, an assistant professor in NTID's engineering studies department and director of NTID's Center on Access Technology's Innovation Lab, says the collaboration between Cisco and RIT/NTID "provides excellent opportunities for the development team review to meet deaf and hard-of-hearing students' needs in the educational environment as well as for our students and faculty to perform their scholarship work."

Plans are to continue research with the center to develop an avatar that can use and understand sign language.

Innovations using Braille: Stephanie Ludi, associate professor of software engineering, is working on a project with first-year software engineering student Michael Timbrook called AccessBraille: Improving Access to Braille Literacy for Visually Impaired Children. They are developing apps for the iPad and iPad mini to increase the percentage of low-vision students learning and using braille. Ludi received seed funding from RIT's Office of the Vice President for Research as part of its effective access technology initiative.

Accessibility in Computing

by Kelly Sorensen

People with disabilities often face challenges with everyday tasks. To empower these individuals through greater independence and improved access to both educational and employment opportunities, RIT is focusing on accessibility research in computing. Researchers are approaching these issues from a broad range of perspectives, looking at the physical, cognitive, and perceptual issues that people face.

Creating New Experiences for the Blind and Visually Impaired

Stephanie Ludi, associate professor of software engineering and the program's graduate director, is visually impaired. She has dedicated her research efforts to creating new experiences and opportunities for students who are blind and visually impaired.

In 2007, Ludi, along with RIT software engineering professor Tom Reichlmayr, started ImagineIT, a one-week summer camp that brought middle and high school students with visual impairments to RIT from all over the country. A grant from the National Science Foundation funded the five-year project aimed at increasing participation in computing among students with low vision. The students got hands-on experience in building LEGO robots and assembling computers. During the camp's five-year tenure, it traveled to university campuses in California, Arizona, and Maryland.

"The students we worked with over the course of five years were very happy with the experience," says Ludi. "They got to work with robots and program them to do different tasks, which for many students was the first time they got to do something like that. On another level they got to learn about all the different things you can do with technology. Thirdly, it gave students the opportunity to get to know other students who are visually impaired and make friends their own age."

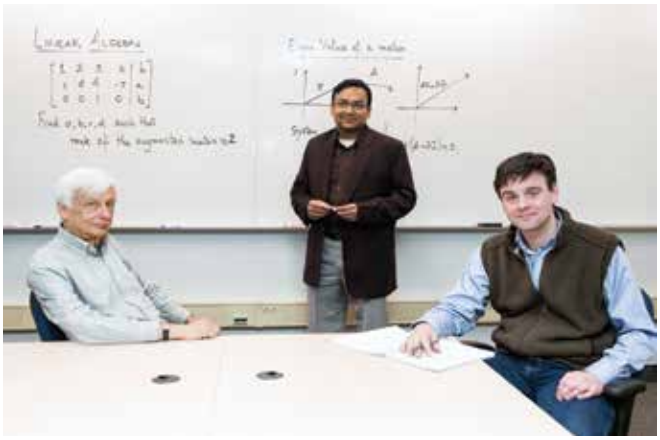
ImagineIT has evolved into Computer Science or CS Academy. The CS Academy is part of a curriculum that Ludi customized called Inclusive Exploring Computer Science, or IECS, which is funded by the National Science Foundation. IECS is based on an established Exploring Computer Science (ECS) curriculum developed at UCLA. ECS is used in schools nationally, but it's not a program that's accessible to people with disabilities. The goal of IECS is to increase the level of participation of visually impaired students in university-level computing degree programs.

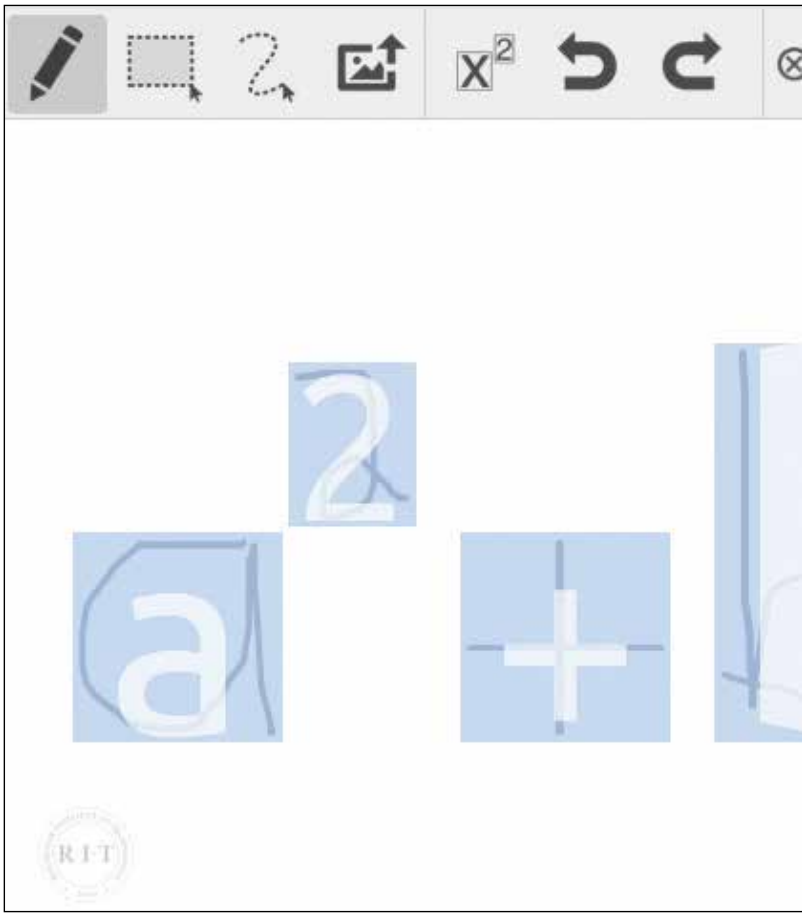
"We've taken the idea of accessible activities in robotics and turned it into a curriculum that will have a greater impact by extending the curriculum's original scope to include those with visual impairments," says Ludi.

ImagineIT Workshop: Visually impaired students from all over the country have come to RIT since 2007 for a summer workshop as part of a National Science Foundation grant aimed at increasing participation in computing. The program, called ImagineIT, was held at RIT as well as university campuses in California, Arizona, and Maryland. Pictured above is a visually impaired student who participated in the program in Arizona.

For two weeks in the summer, the CS Academy will bring high school students from around the country to work on modules, including in robotics and human-computer interaction. The students will use robotics-programming software that RIT has built called JBrick. The programming is text-based and is compatible with screen readers, commercial software that reads what's on the screen to the user.

While here at RIT, the students will live in the residence halls to experience on-campus living. New to the CS Academy will be an online component after the camp's completion. Ludi says the online follow-up is critical so that students don't feel isolated following their shared-group interactions.





Integrated Video to Improve Math Access: Roger Gaborski, Anurag Agarwal, and Richard Zanibbi (from left to right) are the co-principal investigators on the project "AccessMath: Improving Math Lectures for Low Vision Students through Integrated Video, Note-Taking and Search." For the project, Agarwal is creating course notes and content for lectures on linear algebra. Zanibbi and Gaborski, experts in computer vision and computational acoustics, are enabling the system to recognize the mathematical algorithms in the lectures.

Prototype Could Equal Ease of Use in Math Lecture

Ludi also recently received a grant from the National Science Foundation for a project titled "AccessMath: Improving Math Lectures for Low Vision Students through Integrated Video, Note-Taking and Search."

Anurag Agarwal, professor in the School of Mathematical Sciences, and Roger Gaborski and Richard Zanibbi, professors in the Golisano College's department of computer science, are co-principal investigators on the grant.

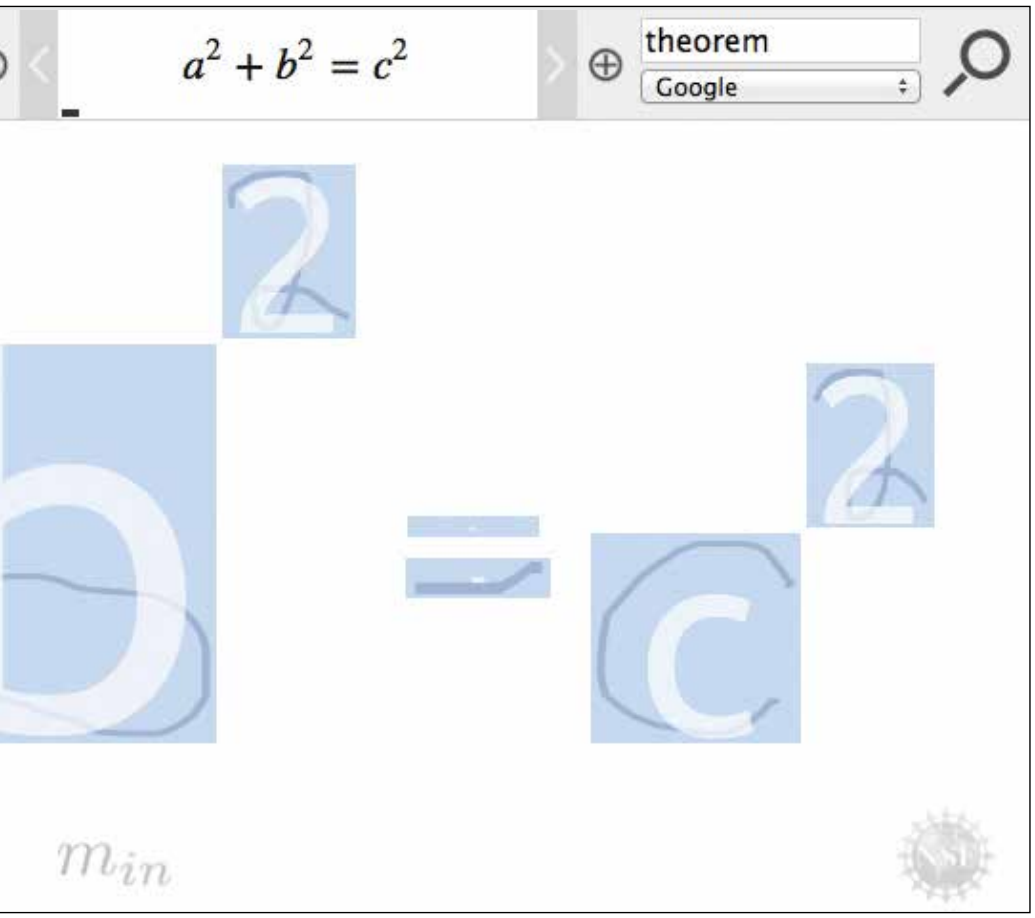
The goal is to make math lectures more accessible to students with low vision. Initially, it will be tested on university-level students but the application could be used at any grade level. Here's how it works: The commercially sold product Mimio captures text as it's written on a white board that's connected to a magnetic bar. The pens are encased in sleeves that act as transmitters. When the pen is pushed against the whiteboard, the Mimio tracks the location of the pen and records a digital "stroke." The pen strokes will be captured on a server along with the video and audio from each lecture. Simultaneously, the lecture is broadcast in real time on the students' iPads.

"It's a very exciting project to be part of," says Zanibbi. "For students with low vision it's not easy to search through large amounts of visual information. We are trying to develop algorithms to search through on recorded videos and pen strokes as well as course notes using images from lecture videos and handwritten sketches as queries to better support the students' participation both during and outside of lecture."

Zanibbi's and Gaborski's expertise in computer vision and computational acoustics is needed to develop algorithms that index and search the video data.

Agarwal, who teaches linear algebra courses to first- and second-year students, is creating course notes and content for lectures on linear algebra. For example, if a student were to search for the Pythagorean theorem, $a^2 + b^2 = c^2$, the theorem could be retrieved from the database of archived lectures.

The next phase of the prototype is to roll out some mock-up lectures to low-



Computer Recognition of Hand-written Equations: To assist low-vision students, pen strokes on an interactive board are captured and recognized by the algorithms developed by Stephanie Ludi, Roger Gaborski, Anurag Agarwal, and Richard Zanibbi. If a student were to enter the Pythagorean theorem, $a^2 + b^2 = c^2$, the theorem could be recognized as a mathematical algorithm, not just characters, and it would be used to search the database of archived lectures.

vision students for their feedback on the proof of concept's design and usability.

Increasing Braille Literacy Among Blind and Visually Impaired

It may be a surprising statistic that only 10 percent of children with low vision use and learn braille. Learning braille can be beneficial to build spelling, writing, and general literacy skills. Receiving information purely by ear with the use of a screen reader doesn't enable students to learn concepts like punctuation and spelling.

Ludi obtained seed funding in December from the Effective Access Technology Program offered through RIT's Office of the Vice President for Research to launch the project, Access-Braille: Improving Access to Braille Literacy for Visually Impaired Children.

"Braille literacy is shown to correlate to later success in attaining education and employment," says Ludi. "With AccessBraille we want to create a suite of mobile apps that will facilitate braille literacy along with the students' vocabulary and writing skills."

She is working with software engineering undergraduate students Michael Timbrook and Piper Chester to develop apps for the iPad and iPad mini. The apps include Flashcards, a spelling game and an app in which students can share braille stories and writings with others. The apps will use the iPad touch screen that mimics a braillewriter, enabling users to designate where on the screen they want to type.

iPad Replaces Braillewriter: Using the iPad touch screen that mimics a braillewriter, users can put their fingers on the screen wherever it's most comfortable for them to type their braille letters. The screen will read back to them what letters and words they've typed.

Focusing on Computer Accessibility: Andrew Sears, dean of RIT's B. Thomas Golisano College of Computing and Information Sciences, is chair of the Association for Computing Machinery's (ACM) Special Interest Group on Accessible Computing (SIGACCESS). SIGACCESS runs the annual ASSETS conference, an international conference that focuses on accessibility and computing. Rochester will host the conference in 2014.

Assistive Technologies in Computing To Take Center Stage in Rochester

The design, evaluation, and use of assistive technologies like these in computing will be the focus of an international conference, ASSETS, to be held in Rochester, N.Y., in Oct. 2014. The Association of Computing Machinery (ACM) special interest group SIGACCESS focuses on accessibility and computing and runs the annual ASSETS conference. Andrew Sears, dean of RIT's B. Thomas Golisano College of Computing and Information Sciences, is chair of the SIGACCESS group.

"It's exciting that Rochester is hosting the annual ASSETS conference in 2014 because it brings together researchers, practitioners, and students from around the world," says Sears. "With the conference in RIT's backyard, we hope to get the community of attendees to come to campus to see what research we are doing in this area of effective access technology."

Human-Centered Computing Expert Leading RIT's Computing College

Sears, who's been involved with SIGACCESS for more than a decade, joined RIT as dean of the Golisano College in Aug. 2011. He is an expert in human-centered computing and information technology. His primary interest is accessibility but his research has also explored issues in the areas of mobile computing, health information technologies, interface design, and speech recognition.

"What's most exciting from my perspective is that we have a number of people not just within the Golisano College but across the university who are looking at these access issues from a variety of perspectives," says Sears. "When you look at RIT and the history of the university with NTID, it's hard to imagine an environment that is a better fit for building research in the accessibility area."

Sears' current research with a doctoral student at the University of Maryland, Baltimore County, examines cognitive impairments and cognitive decline in elderly people by looking at how and what they type when using computers for everyday tasks such as e-mail. Characteristics like the timing between keystrokes and the types of words used offer a great deal of information about a person's cognitive state.

"When you put these different cues together, you can do a reasonable job of recognizing a temporary change in an individual's cognitive status. You can also detect differences between older adults who do not have any known cognitive impairments and older adults who have a very mild cognitive impairment."

A Holistic Approach

Sears believes that RIT needs to take a holistic approach to helping people with disabilities and the elderly. He has found that research in this area is often done by individual researchers in isolation, so the resulting approach is to tackle a relatively narrow slice of the problem. "One of the big challenges for people doing research in this area is identifying the real problems and finding real users that can help us define and evaluate new solutions," says Sears.

Working with Rochester area agencies that serve children and adults with special needs gives RIT a broader perspective that simultaneously considers the physical, cognitive, and perceptual issues of people with disabilities. As a result, we can develop more effective and robust solutions that will empower these people.

On the Web

Software Engineering at RIT
www.se.rit.edu

Association for Computer Machinery–SIGGACCESS
www.sigaccess.org

Video Games Help Treat Lazy Eye

A team of RIT game designers, software developers, and artists are working with scientists in Rochester and California to create a video game that helps improve the treatment of amblyopia, also known as lazy eye, for adults.

Treatment of the vision disorder, caused by abnormal binocular interaction early in life, has long been thought to be effective only in children. According to research from Daphne Bavelier, a professor in the department of brain and cognitive sciences at the University of Rochester, and Dennis Levi, a professor and dean of the School of Optometry at the University of California, Berkeley, both children and adults with amblyopia can improve their perceptual performance through extensive practice on a challenging visual task, such as a first-person shooter video game.

"I was tasked to create a video game that gives different images to each eye, with some game objects only seen by the amblyopic eye," says Jessica Bayliss, an associate professor in the School for Interactive Games and Media at RIT. "Thirteen undergraduate students have worked with me to bring the project to fruition and now the software is being used by subjects successfully."

Replacing the Eye Patch: By changing the brightness and degrading contrast of certain targets for left versus right eye, the game provides more stimulation to the lazy eye and forces it to work harder to adapt.

The video game treatment is a far cry from traditional treatment, where an eye patch covers the good eye for hours during the day, forcing the brain to use the bad eye. While video games may be a more fun and less disruptive option, there is a definite learning curve for patients who are not familiar with first-person shooters.

"A problem we encountered was that too much detail in the graphics would cause players to get lost and nauseated," Bayliss says. "By creating several training sequences and less detailed textures on the walls, players were eventually able to navigate the world without feeling sick."

The team is continuing testing and hopes the game can someday be played in-home at the patient's convenience. The team is also working on a family-friendly version of the game that incorporates cartoon characters, bright clean textures, and weapons that shoot orbs and spells.

The amblyopia treatment is funded by the National Eye Institute, the McDonnell Foundation, and the Office of Naval Research.

Electro-active Polymers Help Lymphedema Patients

Gordon Goodman

Cancer treatments are often a blessing that extend the lives of patients for years. But for many, the treatments can also result in damage to the lymphatic system that causes swelling and pain known as lymphedema, a condition for which there are limited treatments and no known cure.

When a family member of Gordon Goodman, a professor of gaming in RIT's School of Interactive Games and Media, was stricken with cancer and then lymphedema, he wanted to harness his passion for making things to create a better treatment.

"The lymphatic system is responsible for moving waste products from cells out through the lymph nodes," says Goodman. "When radiation therapy or lymph node sampling damages the lymphatic system, the viscous motor-oil-like fluid begins to pool in the affected limb, causing swelling, pain, and disfiguration."

At the onset of lymphedema, patients can often drain the fluids by elevating the affected extremity, but as the condition progresses this becomes ineffective and more formal treatment is required. Specially trained physical therapists can treat the swelling through a light massage technique or patients can also control the pooling themselves using compression bandages or pneumatic compression pumps.

For many, these treatments are not ideal or effective as the disease progresses. Goodman began looking for alternatives when he learned about electro-active polymers, or EAPs, flexible materials that can change shape when exposed to electric current.

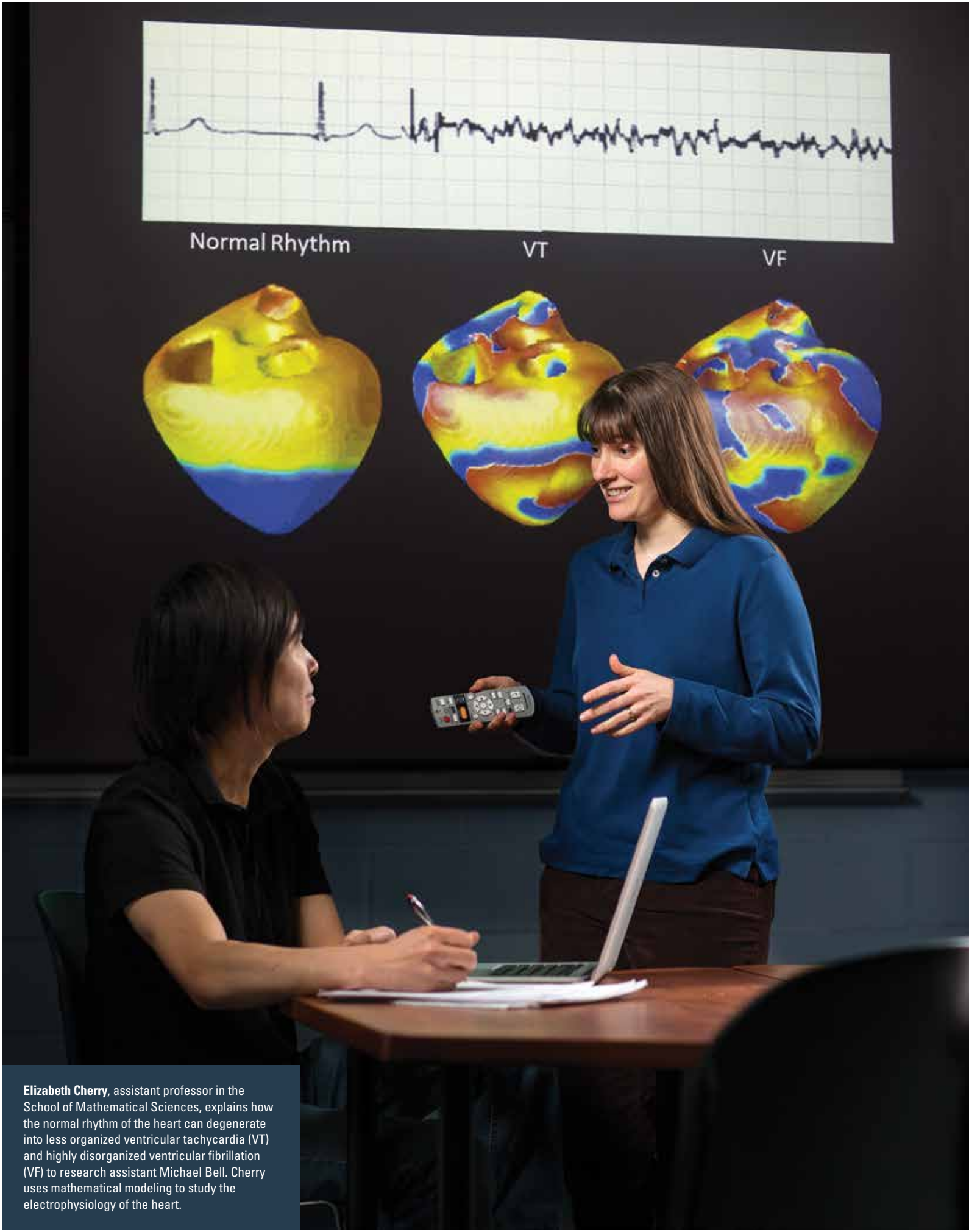
"These polymers can act like an artificial muscle that externally supports and augments the lymphatic system," says Goodman. "EAPs could be used to make a comfortable expanding and contracting garment that would help alleviate the pooling of fluids in the lymph nodes."

Goodman created a design and assembled the Lymphedema Engineering Group—including Dan Phillips, director of the biomedical engineering program, Wayne Walter, a professor of mechanical engineering, Kathleen Lamkin-Kennard, a professor of mechanical engineering, and Ankur Chandra, a vascular surgeon at the University of Rochester Medical Center—to explore the feasibility of the design. William

Electroactive Polymers (EAP): Gordon Goodman and the Lymphedema Engineering Group at RIT are researching the use of EAPs to make comfortable and expanding/contracting garments to address swelling. A sample is being tested for tensile strength in a stress gauge in order to characterize the material for further use.

Spath, a microsystems engineering doctoral student, also works with the team, helping to optimize the configuration of the EAPs for integration into a garment.

"EAPs contain many special properties, including the ability to be used as measuring devices for research and to generate their own power, making them self-sustaining devices," says Goodman. "It will be exciting to see where we go from here."



Elizabeth Cherry, assistant professor in the School of Mathematical Sciences, explains how the normal rhythm of the heart can degenerate into less organized ventricular tachycardia (VT) and highly disorganized ventricular fibrillation (VF) to research assistant Michael Bell. Cherry uses mathematical modeling to study the electrophysiology of the heart.

Exploring the Heart

by Kathy Lindsley

About 600,000 Americans die of heart disease every year–that's one in every four deaths, or one death every minute, according to the Centers for Disease Control and Prevention. It remains the leading cause of death, ahead of all forms of cancer, respiratory disease, stroke, and accidents. At Rochester Institute of Technology, researchers in many colleges and centers have joined the fight against this indiscriminate killer. Following are a few examples of work in progress.

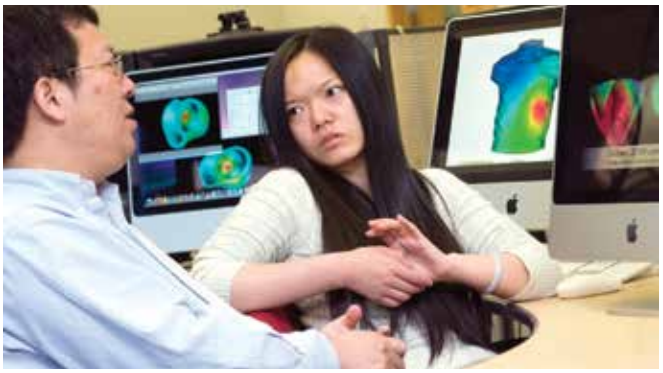
Computational Cardiac Modeling—
Golisano College of Computing and Information Sciences

The heart is an electromechanical organ: Simply put, electrical signals cause the heart muscle to contract, pumping blood throughout the body. Technical breakthroughs in imaging modalities have led to an explosion in the quality and quantity of data on cardiac mechanics, says Pengcheng Shi, director of RIT's Ph.D. program in computing and information sciences.

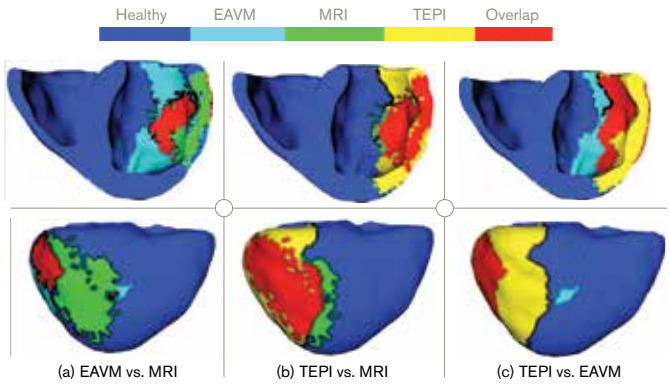
More work is needed on imaging the electrophysiological aspects of the heart, says Shi, and that's a focus of the computational biomedicine research team in RIT's B. Thomas Golisano College of Computing and Information Sciences. The team, which includes Ph.D. students, postdoctoral researchers, and faculty, has published extensively and received recognition from groups including the Medical Image Computing and Computer Assisted Intervention Society (MICCAI) and Computing in Cardiology (CinC). Team members also collaborate regularly with researchers around the globe.

For example, GCCIS assistant professor Linwei Wang, GCCIS associate professor Huafeng Liu, and Shi have collaborated on work involving aspects of transmural electrophysiological imaging (TEPI) with researchers at Johns Hopkins, University of Rochester Medical Center, the Chinese Academy of Sciences, Dalhousie University in Nova Scotia, and the French national computer science research organization INRIA.

One promising development of the team's work is in mapping myocardial scar tissue deep inside the heart—a common cause of arrhythmia that can lead to fatal heart attacks when the scarring blocks electrical signals and causes the heart to beat too fast, too slowly, or erratically. Physicians are exploring non-surgical treatments for reducing scar tissue, but efforts have been hindered because of the difficulty in accurately mapping the scarred area. Using the method of transmural electrophysiogical imaging with noninvasive information from EKG and MRI, the researchers have had improved outcomes in studies using pig hearts. One tremendous advantage of the imaging technologies is that they are noninvasive and, therefore, less risky for the patient than



Electrophysiological aspects of the heart: Imaging electrophysiological aspects of the heart is the research focus of the computational biomedicine research team in RIT's Golisano College of Computing and Information Sciences. The team includes Pengcheng Shi (left), director of RIT's doctoral program in computing and information sciences, and assistant professor Linwei Wang.



Transmural electrophysiological imaging (TEPI): Linwei Wang, Huafeng Liu, and Pengcheng Shi have collaborated on work involving many aspects of TEPI. In these images the superimposed post-infarction myocardial scars are localized by the TEPI method (yellow) versus the electroanatomic voltage mapping (EVAM, light blue) and the magnetic resonance imaging (MRI, green). The overlap of these imaging methods is shown in red. Note that TEPI detects the scar across the depth of the heart muscle and shows a higher consistency than the MRI or EAVM methods.

Institute Hall: A major new academic and research facility has just opened: Institute Hall. It includes biomedical engineering, chemical engineering, chemistry, institute classrooms, and laboratory space for funded research projects. This new facility connects to the Center for BioScience Education and Technology (CBET).

RIT's New Biomed Engineering Program Has Deep Roots

Dan Phillips

From imaging and monitoring devices that reveal the inner workings of the human body to mechanical replacements for deteriorated joints, the field of medicine is an increasingly high-tech arena. Specially trained engineers are needed to design, build, and manage the vast array of modern medical technology. RIT's biomedical engineering program, launched in 2010, is aimed at filling that need. The five-year BS degree program emphasizes engineering fundamentals and their application to the health and well-being of the complex system known as the human being.

"Engineering is about finding creative and reliable ways to apply science, mathematics, and technology to solve problems and address challenges for the benefit of humankind," says Dan Phillips, director of the program. "It would seem logical that there are seemingly endless opportunities for applying basic engineering principles to biology and medicine."

Phillips earned bachelor's, master's, and doctoral degrees in electrical engineering, but his interest in the biomed field began during his undergraduate years at the University of Buffalo. He had the opportunity to take physiology courses with students in the medical sciences and obtained a part-time job working in a vision research lab developing electrical devices to facilitate the experimental procedures. Phillips went on to enroll in a graduate program in biomedical engineering through the Hartford Graduate Center in Connecticut, which included his employment as a systems engineer at St. Francis Hospital in Hartford, Conn.

"I learned firsthand how medical equipment is used in life-and-death situations and the crucial importance of considering the needs and concerns of all of the participants in the delivery of health care and the development of new techniques and equipment to improve that care."

Subsequent positions working on medical equipment for HP and as a systems engineer at Yale-New Haven Hospital further focused his interest in engineering applications in the medical field. Shortly after joining the faculty at RIT's Kate Gleason College of Engineering, Phillips was asked to develop a biomedical option in electrical engineering, which began in 2003. A few years later, RIT President Bill Destler asked Kate Gleason College of Engineering Dean Harvey Palmer to develop a new biomedical engineering program, and Phillips was enlisted to spearhead the effort. The program currently has more than 130 students and the first are expected to graduate in 2015.

"The amazing and gratifying result of initiating the biomedical engineering program is that some of the BME students are already impacting people's lives and impressing both clinicians and scientists they have had the opportunity to work with," says Phillips. "I really believe this is a testament to RIT as an institution—including students, faculty, and administration—that provides the type of environment and opportunities that allow real and tangible contributions to society."

procedures involving the insertion of a catheter into the heart.

"This has the potential to become a great screening tool for physicians," says Shi, who started heart-imaging research work as a doctoral student at Yale in 1990. When he began, his focus was on imaging the motion of the heart, which was not well understood at that time. But over the succeeding years, Shi says he has become increasingly interested in "personalized computational medicine"—developing biomedical uses for computer science technology.

"I was working with a physician who said, 'You don't understand my problem,'" Shi says. "I realized we are just being technical nerds. We were doing great work in imaging, but it wasn't what the doctors needed."

RIT, with its tradition of applied technology, can be a center for such "use-inspired research," Shi believes. "We want to do real, fundamental research on real problems."

There is growing worldwide interest in the area of computational biomedicine research, says Shi. That means more competition for research funding, but it also means there's more chance for discoveries that could benefit humanity.

In the area of cardiac disease, Shi feels that revolutionary advances in treatment are possible.

"The technology is highly advanced. We need to do more work with physicians.

"I think we are at the cusp. A little nudge—that's all we need."

Mathematical Modeling of Cardiac Arrhythmia—College of Science

Elizabeth Cherry, assistant professor in the School of Mathematical Sciences, has pursued her interest in studying the electrophysiology of the heart through mathematical modeling for more than a decade. She began the work as a doctoral student in computer science at Duke University, and later as a researcher at Cornell's department of biomedical sciences. She's continued the work since she joined the faculty at RIT in 2010.

"It just captured my interest," she says.

"I find it really rewarding."

In October 2012, Cherry received a three-year grant from the National Science Foundation for a project titled "Intramural Forecasting of Cardio-electrical Dynamics." Matthew Hoffman, assistant professor of mathematics, is co-principal investigator, and Flavio Fenton, associate professor in the School of Physics at Georgia Tech, is also collaborating.

The researchers hope the project will better illustrate mechanisms underlying cardiac arrhythmias, which result from the disruption of normal electrical wave propagation in the heart. They aim to demonstrate the effectiveness of state estimation techniques for studying cardiac electrical dynamics and other 3D systems where little or no depth information is available.

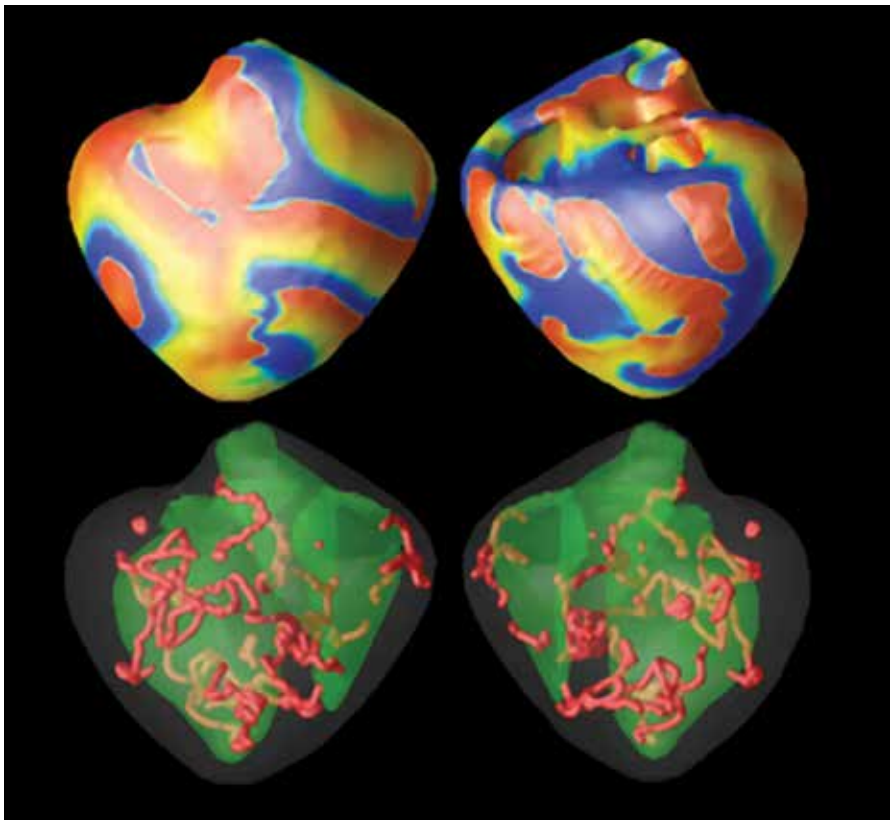
"The heart has inner and outer surfaces," explains Cherry, "and it's possible to get information about what's happening on these surfaces. But it's difficult to get data from inside the tissue. We hope to adapt forecasting methods—like those used in weather—to generate more accurate models of the electrical waves in the heart."

In addition to the potential to advance treatment for cardiac arrhythmias, the work could also have uses in a variety of fields where three-dimensional observations are difficult to obtain, including understanding the spread of brain cancer and the dynamics of the ocean.

Cherry and Fenton are also part of an international group of researchers who have developed a low-energy alternative to controlling arrhythmias such as fibrillation. Their findings were published in the journal *Nature* in July 2011.

The work involved applying a series of electrical pulses, rather than a single large shock, to make the heart's state more synchronous. The results of mathematical modeling as well as in vitro experiments proved promising, Cherry says.

"It does appear to work with much lower energy than conventional defibrillation." This is significant, considering that defibrillation is the primary treatment for ventricular fibrillation, the most deadly form of arrhythmia.



Mathematical Modeling of Arrhythmia: Posterior (left) and anterior (right) view of a snapshot in time of ventricular fibrillation. Upper plots show fractionated scroll-shaped electrical waves (red/yellow) propagating into quiescent (blue) tissue. The disorganized electrical waves give rise to an uncoordinated and ineffective mechanical contraction, which compromises the pumping of blood. Lower plots show transparent views of the same wave pattern by indicating the structures around which the scroll waves circulate in red. The interior and exterior surfaces of the ventricles are shown in green and gray, respectively.

At RIT, Cherry is enlisting students, including undergraduates, in the research efforts. Students can contribute in a variety of ways, she says, including developing and writing computer code to solve mathematical equations describing cardiac cells and tissue, analyzing simulated and experimental data, and contributing to a highly informative website she and Fenton created, TheVirtualHeart.org.

Improving Cardiac Blood Pumps—
Kate Gleason College of Engineering

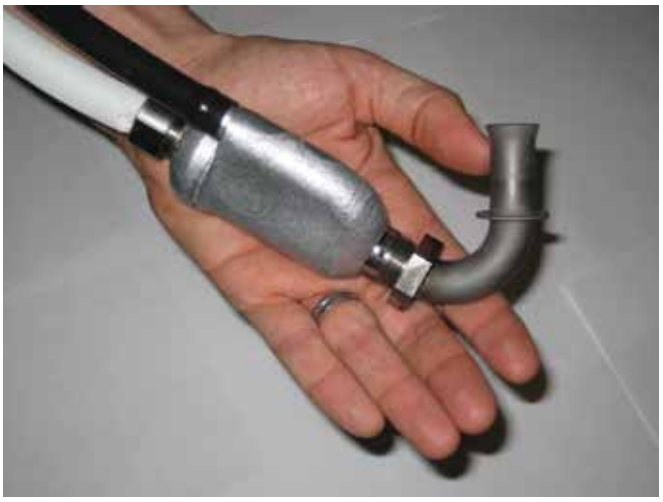
"It's easy to pump blood," says Steven Day, associate professor of mechanical engineering. "It's hard to pump blood without destroying it."

That's one reason why it has been so difficult to produce a mechanical device to replace the heart function. However, progress toward that goal is being made.

Day has been applying his expertise in fluid mechanics to this area of research for more than a decade, beginning as a doctoral candidate at the University of Virginia. He has continued working with collaborators at the Utah Artificial Heart Institute at the University of Utah on development of a magnetically levitated left ventricular assist device, which uses magnetic bearings instead of mechanical bearings.

A ventricular assist device (VAD) is a mechanical pump that supports heart function and blood flow in people with weakened hearts. VADs can be used on a

LVAD Clinical Testing: Steven Day (front left) and colleagues from the Utah Artificial Heart Institute have completed prototype development of the hybrid magnetic axial flow Left Ventricle Assist Device (LVAD) and carried out initial clinical testing of the device on live bovines. Further animal testing is the next step in the development process.



Novel Blood Pump: Clinical results have demonstrated that the use of rotary pumps as assist devices is effective in maintaining normal physiological conditions in heart patients. All rotary pumps approved for clinical use have some type of mechanical bearings and considerable design effort has been put into designing these bearings, to reduce mechanical wear and to reduce hemolysis (cell damage) in pumps with mechanical bearings. This idealized axial flow pump has a simple, unobstructed single blood flow path and novel hybrid magnetic bearings that overcome the strong axial forces on the impeller without compromising the idealized flow path.

temporary basis before and after various types of heart surgery, in patients awaiting heart transplants, or longer term for some patients who are not candidates for a transplant.

Results of the University of Utah project have been promising. "We had reached the animal-studies stage," says Day, noting that the cost to continue is about $1 million per year. "Now, we're trying to figure out what to do next, to submit a new proposal to the National Institutes of Health or a foundation, or find commercial sponsorship. We haven't given up."

Meanwhile, at RIT two teams of students are working with Day as part of the Kate Gleason College of Engineering's multidisciplinary senior design program. The current projects focus on wireless power and cable connectors for heart pumps.

"Over the past few years we've done six or more senior design projects related to the blood pump," Day says. More than 60 students have been involved in design projects or as co-ops or on master's degree thesis projects.

Day also collaborates with the University of Rochester Cardiovascular Engineering Lab (www.urmc.rochester.edu/labs/Cardiovascular-Engineering-Lab/), which brings RIT researchers and students together with UR physicians including Karl Q. Schwarz, professor of medicine and director of the Echocardiography Laboratory and Mobile Cardiovascular Imaging Service at the UR Medical Center.

Schwarz has sponsored several heart-related research projects over the past decade. Students built an artificial heart simulator device to use as a tool for cardiovascular research—for example, to test the performance of artificial heart valves.

"For me, in terms of access to technology, it's like a candy store here," says Schwarz of Day's lab in RIT's mechanical engineering department, where he is a frequent visitor. "The RIT students are very goal-oriented, task-oriented. We're getting some good research done and forwarding the education of students. It benefits everyone."

On the Web

The Virtual Heart
TheVirtualHeart.org

Biomedical Engineering
www.rit.edu/kgcoe/biomedical

Computing and Information Sciences Ph.D.
phd.gccis.rit.edu

Improving Design of Artificial Hips


Steve Boedo

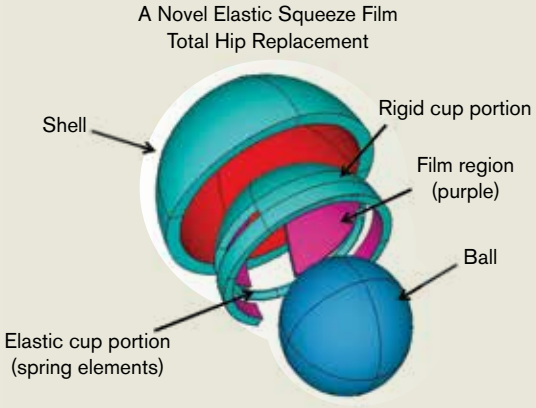
Hip replacement surgeries are often a result of a variety of arthritis-related conditions or of a secondary condition developed from diabetes or long-term steroid use.

As the baby-boomer generation approaches retirement, the number of cases involving total hip joint replacement is expected to rise significantly.

Stephen Boedo, associate professor of mechanical engineering, is working with a team from Cornell University to better meet the needs of this growing population through the development of a novel hip joint design that will more directly utilize the human gait cycle and reduce overall wear on the device. "Current designs involve a spherical ball and cup geometry composed of ceramic, metal, and plastic materials, and synovial fluid produced in a membrane surrounding the artificial joint provides lubrication," Boedo says. "Unfortunately, this design tends to increase the potential for excessive wear of the articulating surfaces and can often require revision surgery seven to 10 years after replacement."

Boedo's design, developed in partnership with John Booker, professor of mechanical engineering at Cornell, utilizes ellipsoidal cup geometry and elastic spring elements. The ellipsoidal cup geometry distributes the synovial fluid pressure more evenly over the surface of the joint during the load-carrying (stance) phase of the gait cycle. The spring elements separate ball and cup surfaces during the load-free (swing) phase of the gait cycle. Initial analysis indicates a substantial improvement in lubricant film thickness and reduction in lubricant film pressure, both of which are indicators of reduced wear. The team is now planning initial prototyping and has filed a provisional patent.

The research results were recently presented at the 2012 International Joint Tribology Conference sponsored by the American Society of Mechanical Engineers and the Society of Tribologists and Lubrication Engineers. "It is our hope this design will increase the longevity of artificial hips and improve the quality of life for individuals with joint-related illnesses," Boedo adds.



Longer Lasting Hip Replacement: Boedo's improved artificial hip design, developed in partnership with John Booker, professor of mechanical engineering at Cornell, utilizes ellipsoidal cup geometry and elastic spring elements, which distributes the synovial fluid pressure more evenly over the surface of the joint and provides ball and cup separation during the swing phase of the gait cycle.

ArcWorks by Design


Stan Rickel

Designers from RIT's industrial design department are collaborating with the design team DS7, short for Daylite Super 7, on a project to produce one-of-a-kind tables called "ants." DS7 is a design team from ArcWorks, the manufacturing division of Arc of Monroe County.

An individual with developmental disabilities makes each ant, which bears a tag telling the story of the product's creation, and the story of the DS7 member who made it. Stan Rickel, associate professor and director of RIT's industrial design graduate program, says that just like the individuals who make them, the ants are each unique.

"It's more than just a product—it's a philosophy," says Rickel. "We've become a disposable society and we want to figure out how to get consumers more invested in what they buy. These products have meaning because you know exactly who made them."

The ants are made from sustainable materials, including rough, spalted maple, and they are not produced on an assembly line, making each one different. The intent is to form an emotional attachment to the products in the mind of the consumer, thereby reducing the chance that they are thrown away and replaced. Rickel and DS7 strive to promote a change in the behavior of consumers.

"Ants": ArcWorks, the manufacturing division of Arc of Monroe County, makes "ants" for sale to the public. "Ants" are benches or tables, each unique, just like the individual who created it.

The long-term goal of the collaboration is to enable ArcWorks to become a viable business that will invite other designers to collaborate with DS7 on new products. There are plans to open an online store soon, where the ants, and future products, will be available for purchase.

"We always wanted to have a sustainable product we could call our own," says Kathy Moylan, senior administrator, transition services at Arc of Monroe. "This is a dream come true."

Faculty Awards and Achievements

by Kelly Sorensen

RIT faculty members are significant contributors to the development of technological innovations and education. Below we highlight their achievements.

RIT will induct its fourth class into the Innovation Hall of Fame on May 3. The 2013 inductees are:

Bruce Smith, director of RIT's microsystems engineering program, professor of electrical engineering and an alumnus of RIT's imaging science program. Smith is a respected leader in the field of nanolithography through invention and innovation. He was recently elected as a fellow of the Optical Society of America.

John Schott, the Frederick and Anna Wiedman Professor in RIT's Center for Imaging Science and one of the founders of the imaging science program. His research has focused on solving problems related to imaging science and remote sensing. Schott is part of the Landsat Science team that provides scientific support to the Landsat 8 satellite.

Lynn Fuller, '70 (electrical engineering), RIT professor, founder of RIT's microelectronic engineering program. He started the internationally recognized program in 1981. Fuller has designed, fabricated, and tested hundreds of different microchips during his 35-year career. These chips range from those for drug delivery to ones for hearing aids. He made RIT's first transistors in 1978.

Paul Taylor, retired faculty from RIT's National Technical Institute for the Deaf. Taylor is a deaf pioneer who was instrumental not only in developing TTY but, more importantly, in helping to create the first TTY network in the world during the mid-to-late 1960s. Taylor helped develop the first telephone relay service, which connected deaf people not only to other deaf people, but also to the hearing world.

RIT alumni recognized:

Jackie Pancari, world-renowned artist and pioneer of glassblowing techniques. Pancari has been a visiting artist at the Museum of Glass in Tacoma, Wash., Seto City Museum in Japan, and RIT. Her work has been exhibited at galleries and museums around the world. Pancari's innovative body of work combines physical prowess and technological mastery.

Robert Fabbio, '85 (computer science), serial entrepreneur and CEO of WhiteGlove Health in Austin, Texas. His company has proven to lower health care costs, improve access to health care, and provide a better experience. Fabbio founded Tivoli Systems, DAZEL Corp., and Ventix Systems.

Lisa Elliot, senior research scientist in RIT's Center on Access Technology, is spearheading a $1.6 million, five-year grant from the National Science Foundation's Research in Disability Education program to establish a virtual academic community for college students who are deaf or hard of hearing in the science, technology, engineering, or math (STEM) fields. The program is designed to increase graduation rates of STEM majors in postsecondary education. Cornell University and Camden County (N.J.) College are partnering with NTID on the project.

In an effort to integrate more deaf and hard-of-hearing individuals into the workplace, NTID professor **Donna Lange** is leading the establishment of an Advanced Technological Education National Center of Excellence. An NSF grant for more than $4.45 million over the course of four years will make this center a reality. It will serve as a resource for high schools and community colleges across the country that educate deaf and hard-of-hearing students in STEM-related programs and for hiring employers.

Marc Marschark, director of The Center for Education Research Partnerships at RIT's National Technical Institute for the Deaf, is the primary investigator on a $2.3 million, four-year project to study sign language, cochlear implants, and learning. The project, "Language, Learning and Cognition among Deaf Students With and Without Cochlear Implants," will help to better understand how to educate deaf students in both public schools and schools for the deaf. The National Institute on Deafness and Other Communication Disorders awarded the grant.

Todd Pagano, associate professor and director of the laboratory science technology program at the National Technical Institute for the Deaf, was named the 2012 U.S. Professor of the Year by the Council for Advancement and Support of Education and the Carnegie Foundation for the Advancement of Teaching. Pagano is the first RIT faculty member to receive the prestigious award. Pagano was selected from more than 300 nominations. The U.S. Professors of the Year Awards Program, created in 1981, is the only national initiative specifically designed to recognize excellence in undergraduate teaching and mentoring.

Callie Babbitt, an assistant professor in the Golisano Institute for Sustainability, has received the prestigious Faculty Early Career Development (CAREER) Program Award from the National Science Foundation. The $400,000 award is over a five-year period. Babbitt will study the sustainable management of lithium-ion batteries that are discarded after use in electric vehicles and modern consumer electronics.

Carlos Lousto, associate professor in the School of Mathematical Sciences and a member of RIT's Center for Computational Relativity and Gravitation, has been elected a fellow of the American Physical Society. According to the society's citation, he was chosen to receive the honor "for his important contributions at the interface between perturbation theory and numerical relativity, and in understanding how to simulate binary black holes."

Margaret Bailey, professor of mechanical engineering and faculty associate to the provost, is the principal investigator on a $3.2 million award from the National Science Foundation called CONNECT: Increasing the Representation and Advancement of Women Faculty at RIT. Connect@RIT focuses on improving conditions for female STEM faculty, with a particular emphasis on women of color and women who are deaf and hard of hearing. RIT's project is part of the foundation's ADVANCE Institutional Transformation Initiatives.

Grover Swartzlander, associate professor of imaging science and physics, has been appointed the editor-in-chief of the *Journal of the Optical Society of America B*. The international scientific publication issues approximately 450 papers per year in the area of optical physics. Swartzlander has served the Optical Society of America in other volunteer capacities, including topical editor of Optics Letters, member of the Publications Council, and member of the Fellows Committee.

About This Section

This listing is a sample of awards and honors that have been received by RIT faculty and staff over the past year. For more information, please visit www.rit.edu/news.

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Rochester Institute of Technology is internationally recognized for academic leadership in computing, engineering, imaging technology, sustainability, and fine and applied arts, in addition to unparalleled support services for deaf and hard-of-hearing students.

For two decades, *U.S. News & World Report* has ranked RIT among the nation's leading comprehensive universities. RIT is featured in *The Princeton Review*'s 2013 edition of *The Best 377 Colleges* as well as its 2012 *Guide to 322 Green Colleges. The Fiske Guide to Colleges 2011* lists RIT among more than 300 of the country's most interesting colleges and universities.

Contact Information

To learn more about research opportunities on campus, contact us directly or through the RIT research website at **www.rit.edu/research**.

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