RESEARCH at RIT

The Rochester Institute of Technology Research Report

Spring/Summer 2008

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IMAGING

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RESEARCH at RIT

The Rochester Institute of Technology
Spring/Summer 2008

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Innovation and Creativity

Welcome to the first edition of *Research at RIT*. This magazine represents a new phase in the reporting of Rochester Institute of Technology's research programs. For the past decade the university has worked to expand its research efforts in a number of disciplines and this endeavor now includes a significant portion of RIT faculty and students. During this seven-year period, our externally sponsored research funding has grown from $14 million to $40 million and the participating principal investigators have increased from 120 to over 300.

Our new President, Dr. William Destler, has challenged the RIT faculty to continue this significant growth to achieve $100 million in external funding in the coming years. This goal is based on the President's challenge for RIT to become the Innovation University, the top school in a new category of schools. Attaining these goals requires RIT to build on its unique programs within the National Technical Institute for the Deaf and its collection of strong science, engineering, and business programs with its recognized strength in the creative arts. In addition, we are expanding our real-world applied education initiatives, including multidisciplinary undergraduate and graduate research that integrates the knowledge and creative skills from numerous programs.

In each edition of this magazine we will highlight work from four research and creativity areas with a feature story and several related short stories from each field. For this inaugural issue we are featuring research from our imaging science and microsystems programs as well as leading innovative work from creative arts, and access and learning technologies for the deaf and hard of hearing. This combination of scientific advancement, creative arts, and new learning technologies is what makes RIT unique in the world of academic research.

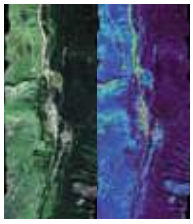
On top of its teaching and dissemination objectives, an important element of academic research is the contribution it can make to society. Research results that are not disseminated are of little use. In each issue of *Research at RIT* we will summarize the technologies, honors, and innovations that have come out of RIT's work as well as identify new startup businesses emerging from these efforts, many of which are hosted in the RIT Venture Creations Incubator.

As we continue our journey to grow RIT's research and innovation, we value your feedback and your partnership. We can be contacted through the RIT Research home page at www.rit.edu/research. Please read on to learn more about the innovative research and creative arts programs now being undertaken at RIT.

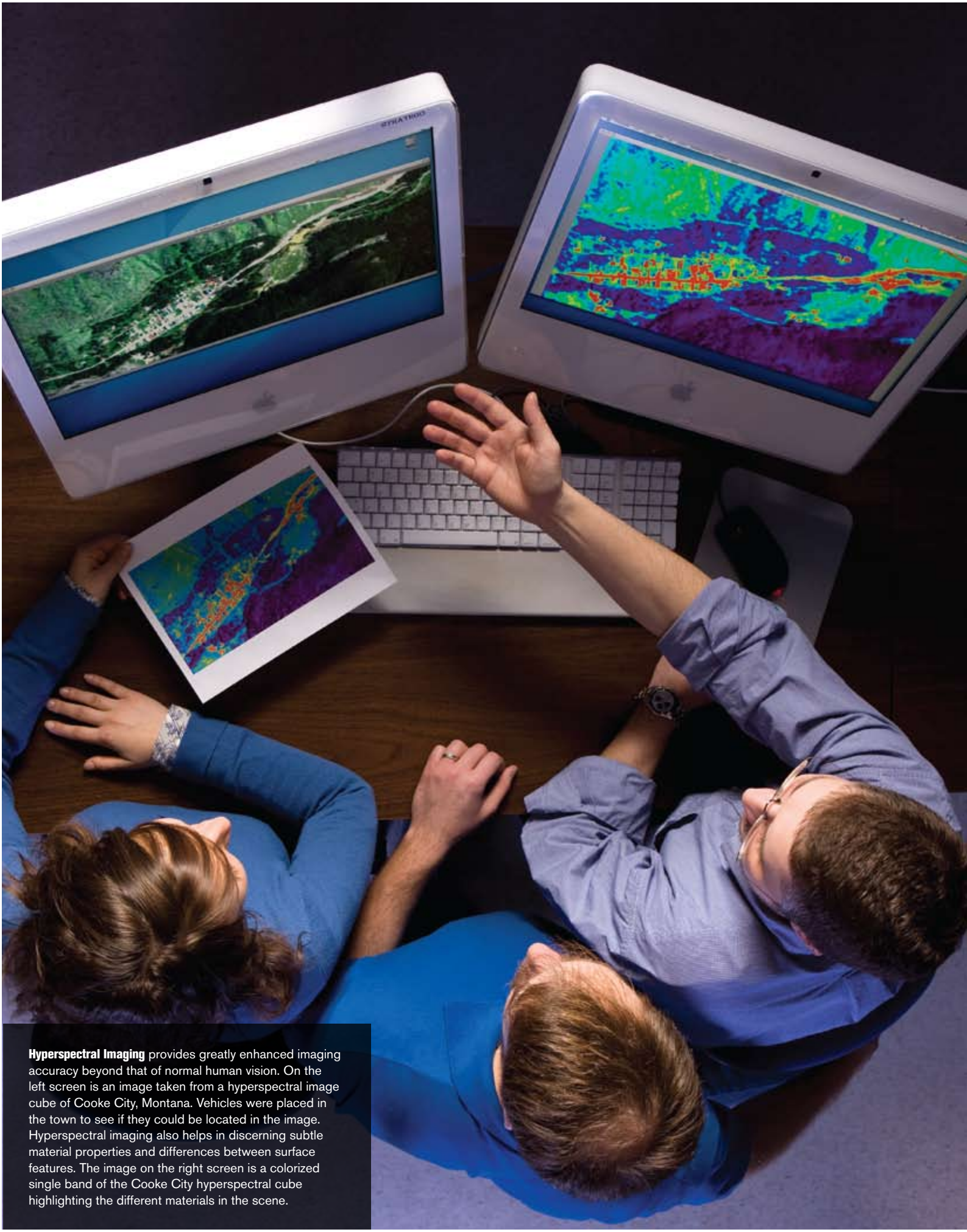
Best regards,

Donald Boyd, Ph.D.
Vice President for Research

Inside this Issue



On the Cover
Two overhead views of Cooke City, Montana, used by RIT researchers to examine the possible uses of Hyperspectral Imaging involving suburban and urban environments.



Hyperspectral Imaging provides greatly enhanced imaging accuracy beyond that of normal human vision. On the left screen is an image taken from a hyperspectral image cube of Cooke City, Montana. Vehicles were placed in the town to see if they could be located in the image. Hyperspectral imaging also helps in discerning subtle material properties and differences between surface features. The image on the right screen is a colorized single band of the Cooke City hyperspectral cube highlighting the different materials in the scene.

At the Cutting Edge:
Digital Imaging and Remote Sensing

by William Dube

Rochester Institute of Technology is one of the world leaders in the development and study of imaging science: the generation, analysis, and visualization of images. A longtime research and education partner of some of the world's foremost imaging companies, including Eastman Kodak, HP and Xerox, RIT also created one of the first research centers dedicated to the field: the Chester F. Carlson Center for Imaging Science.

One of RIT's First Research Programs

The Chester F. Carlson Center is named after the longtime Rochester resident and inventor of xerography. In addition, the university developed the first doctoral programs in both imaging science and the related discipline of color science, with these doctoral graduates now holding key positions in a wide variety of federal agencies and businesses, including Kodak, Xerox, Hewlett-Packard, NASA, and the National Geospatial Intelligence Agency.

Today, the use of digital imaging and modeling is becoming increasingly important for homeland security, disaster management, medical diagnostics, and satellite deployment. Research in the field will assist in creating the next generation of technology that will revolutionize the use of imaging applications over the next decade. RIT will play a major role in this development through the work of a number of state-of-the-art laboratories, including the Carlson Center's Digital Imaging and Remote Sensing Lab.

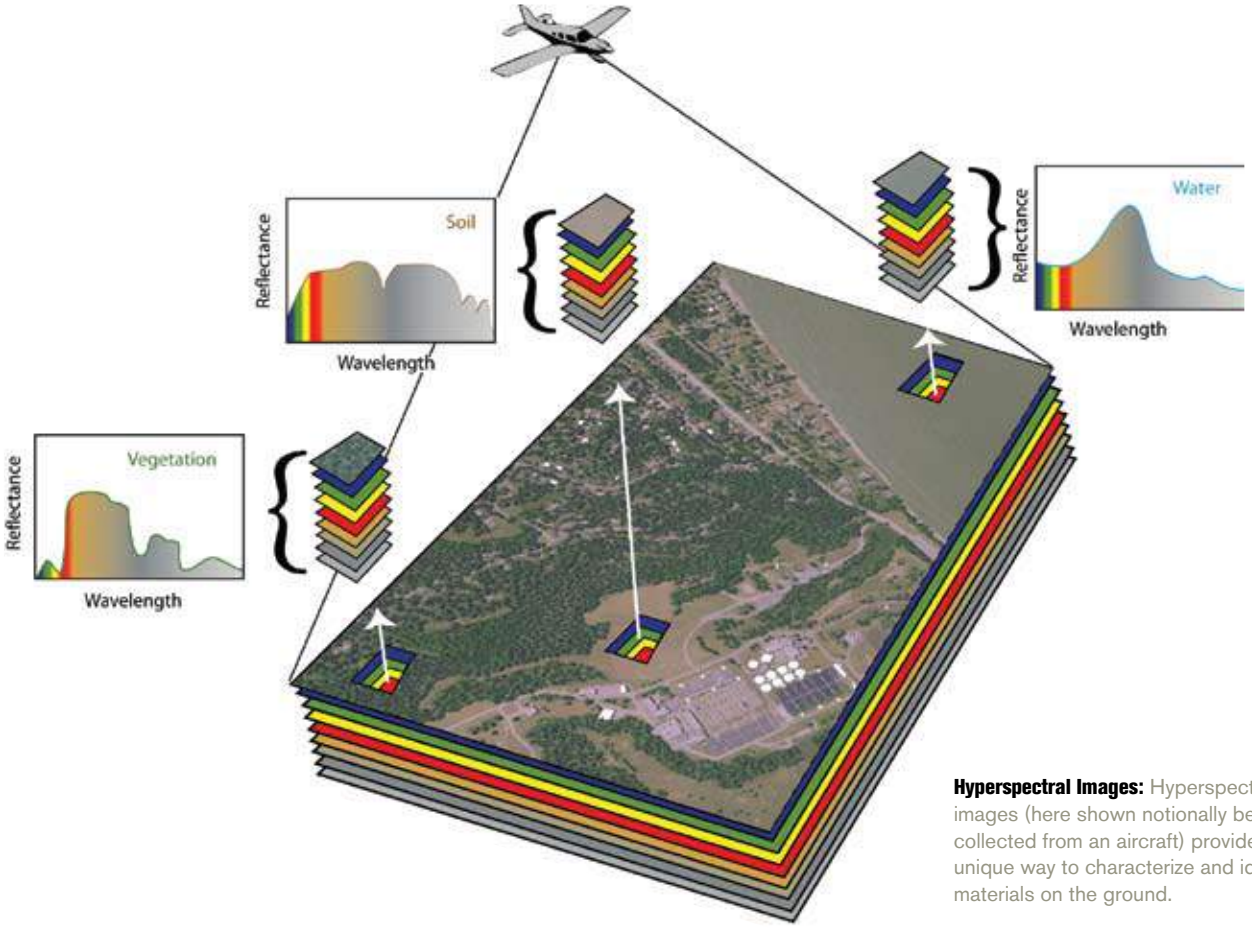
The imaging science subfield of remote sensing can be defined as the capture and collection of information from an object using equipment and sensors that are not in direct contact with that object. The field focuses on two main areas: passive sensing, which collects data from the radiation reflected off objects, similar to digital photography; and active sensing, in which energy is emitted by controlled sources, and sensors record the reflection or effect of that energy on the intended target, such as RADAR. Both techniques are currently used in a host of applications from satellite imaging to wildfire detection to technologies such as Google Earth.

The Digital Imaging and Remote Sensing Laboratory at RIT, also known as DIRS, was originally founded in the 1980s thanks to the efforts of John Schott, who now serves as the Frederick and Anna B. Wiedman Professor of Imaging Science. A leading international expert in the field, Schott has written numerous journal articles and books on remote sensing topics, including *Remote Sensing: The Image Chain Approach, 2nd Edition*, published by Oxford University Press in 2007.

Student Involvement: Assistant research professor David Messinger (left) is advising Ariel Schlamm (right), a second year Ph.D. candidate in Imaging Science, on her Ph.D. thesis on hyperspectral imagery. The research will help develop methods to identify areas of manmade activity in large-area coverage images.

"DIRS originally grew out of my own interests in remote sensing and the desire to more actively involve my students in hands-on research projects," notes Schott. "RIT's well-known expertise in imaging science and its strong relationships with a host of national and international imaging leaders made it a perfect fit for this type of applied research center."

Beginning with a small project base centered on Schott's activities, DIRS now includes 14 full-time staff members and over 35 student researchers who account for over $2 million in funding annually.



Hyperspectral Images: Hyperspectral images (here shown notionally being collected from an aircraft) provide a unique way to characterize and identify materials on the ground.

The lab collaborates with faculty and staff throughout RIT's eight colleges while also partnering with numerous government organizations, companies, and not-for-profit agencies on over two dozen separate research projects. Those organizations include the National Science Foundation, Los Alamos National Laboratory, and Boeing Corporation. Results from these efforts have appeared in a host of peer-reviewed journals, such as *Applied Optics, Optical Engineering and the International Journal of Remote Sensing* and also have been presented at international academic conferences hosted by the Institute for Electrical and Electronics Engineers and SPIE, the International Society for Optical Engineering, among others.

The DIRS team has worked with SENSIAC, The Military Sensing Information Analysis Center, to improve the rapid collection and processing of imagery using a multiband sensor.

"DIRS's researchers were able to quickly collect the imagery, adjust its apparent resolution as needed, and segment the image for further processing and analysis," says David Shumaker, SENSIAC's director. "This type of rapid and innovative execution is very rare in the remote sensing field and showcases the lab's tremendous expertise and capabilities."

DIRS also has served as a major research outlet for RIT's doctoral programs in imaging and color science, housing over 20 Ph.D. candidates and post-doctoral fellows annually. The lab also includes over a dozen undergraduate and master's degree students, all of whom provide essential assistance for the lab's numerous remote-sensing projects. While this learning-centered environment does provide important experience for RIT's student population and gives graduates a key advantage when they enter the work force, it also provides the lab with a steady conduit of talented engineers and scientists, many of whom continue on at RIT following completion of their studies.

David Messinger originally came to the lab as a post-doctoral fellow in 2002 and ultimately accepted a full-time position as an assistant research professor, focusing on multispectral and hyperspectral image exploitation. He also is serving as the interim director of DIRS for the 2007-2008 academic year.

"My experience as a fellow was invaluable in helping me become a better scientist and researcher, particularly given the level of involvement DIRS provides its students," adds Messinger. "As interim director of the lab, I now work to continue our long-term goals of providing cutting-edge research and education that enhances RIT's mission as well as the advancement of the remote sensing field."

Nationally Recognized Results

The current research activities being conducted at DIRS focus on three main areas of remote sensing:

- measurements and phenomenology
- remote sensing system modeling and simulation
- image analysis algorithm development

The first area focuses on data gathering on real objects from distances, such as imaging landscapes from an airplane and characterizing material optical properties. The second deals with simulation of sensing systems for equipment performance studies and algorithm testing. The third area aims to advance methods used to extract information from images. All three areas use passive and active sensing techniques, RIT's efforts have centered on the development of new equipment, software, and processes for use in these fields.

DIRS's phenomenology research has included the development of a host of sensor system packages covering the visible and infrared regions of the electromagnetic spectrum. These devices have been implemented with algorithm-based software packages to enhance image capture, quality, and spectral range, allowing scientists and operators to obtain and analyze images in ways that have not previously been possible. For example, DIRS developed the Modular Imaging Spectrometer Instrument (MISI) for use in hyperspectral imaging, which captures images beyond the sensitivity of the human visual system. The technique allows for image capture in up to 200 single wavelength bands or "colors" and provides greatly enhanced imaging accuracy, including the ability to better discern subtle material properties and differences between surface features.

Ground Truth: Imaging Science undergraduate and graduate students participating in a field campaign to collect ground truth for an experiment using airborne hyperspectral imagers.

DIRS projects in the area have included a collaboration with NASA and Eastman Kodak to more accurately assess water quality utilizing orbiting satellites. They also have worked to implement hyperspectral imaging in the related field of earth observation, using satellites to more properly monitor global anomalies such as climate change.

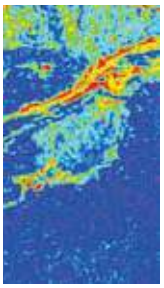
Currently, Messinger, along with Bill Basener, associate professor in the School of Mathematical Sciences at RIT, is combining the lab's phenomenology and algorithm development research to improve hyperspectral imaging quality and increase areas of application. Here, mathematical models and algorithms are developed and implemented using imaging devices to locate areas where previously unknown human activity is taking place, as opposed to zeroing in on a specific object, such as a tank or a truck. The team believes the process can be used to identify activity where it was not previously known to exist, which would then cue a higher resolution sensor to collect more data. The technology could greatly increase the efficiency of satellite detection devices and have a major impact on the global war on terror. Messinger's team was recently awarded a grant from the U.S. Department of Defense to test the technology and ultimately transition the capability to the government for further testing and evaluation.

"Hyperspectral imaging often requires incredibly complex data computations, which reduce the robustness of the system and its ability to pinpoint specific targets," says Messinger. "The approach being

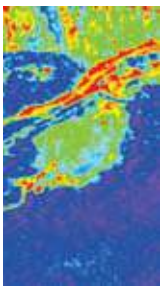
Hypercube: A hyperspectral image of the metropolitan Rochester area collected by the Hyperion sensor on board the NASA Earth Observing-1 satellite. The image demonstrates the concept of a spectral image "cube": two spatial dimensions show the usual spatial content in the scene while the third "depth" dimension of the cube shows the spectral (or color) information in each pixel.

Material Identification through Spectral Imaging

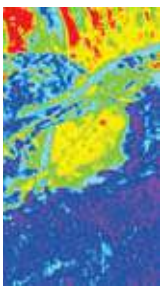
Hyperspectral imaging divides the electromagnetic spectrum into hundreds of individual "slices," allowing researchers to better identify materials based on their unique, spectral signatures. The circular area in the middle of the images below highlights the spectral signature of grass over four different parts of the spectrum (in these images red represents bright and dark blue represents dark).



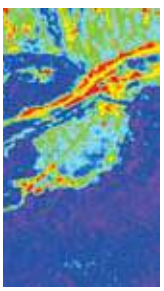
Here, the grass is darker than both the road above it and the range land at the top of the image. The spatial pattern in the grass field possibly indicates a pathway, or drainage pattern.



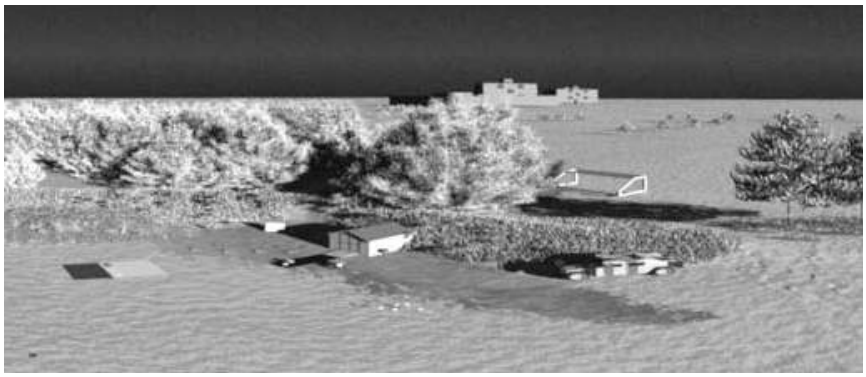
In this spectral band, the road is the brightest object in the scene, but the range land and grass are similar in magnitude. More spatial structure can be seen in the forest at the bottom of the image.



Here, the grass is very bright, but the brightest parts of the image are different vegetation on the hillsides just above the road.



Now the grass is again darker, although the spatial patterns are different than the top image, possibly indicating at least two types of grassy vegetation in this region. These differences can be used to differentiate between the various types of vegetation and other materials in the scene.



A near-infrared simulation of the DIRSIG MicroScene 1: A small test range on the RIT campus was produced by the DIRSIG model to enhance evaluation of hyperspectral images.

developed here at RIT will utilize the best aspects of the technique in consort with advanced mathematical methods to greatly enhance the overall quality of imagery-based detection systems."

Similarly, DIRS researchers are making major advancements in the area of modeling and simulation, enhancing their use for sensor and algorithm performance evaluation techniques, which seek to increase the quality of sensor and image production while also enhancing training in the field. The lab has developed a state-of-the-art simulation tool, the Digital Imaging and Remote Sensing Image Generation model, or DIRSIG, to assist in assessing sensing performance.

John Kerekes, associate professor of imaging science, is utilizing DIRSIG, in partnership with ITT Space Systems, to analyze the quality of hyperspectral images. The work utilizes simulated images produced by DIRSIG and compares the quality predictions developed by the Forecasting and Analysis of Spectroradiometric System Performance (FASSP) spectral imaging model to the product produced by human analysts assessing the same image. The process will enhance the performance of quality prediction modeling and assist in improving training of human image analysts. The work also is part of Kerekes' larger effort to utilize DIRSIG to improve the overall quality of hyperspectral imaging systems.

"This research is designed to provide additional data for enhancing the success of imaging systems from both an equipment and an operator perspective," adds Kerekes. "It also augments DIRS's phenomenology efforts in hyperspectral imaging and will ultimately increase the uses of the technology in a host of applications."

The DIRS Impact

RIT's central role in the development of research and education in imaging science and remote sensing has earned the university numerous awards and recognition. RIT was selected to host the International Congress of Imaging Science in 2006, and nine faculty members have received the Raymond C. Bowman award from the Society for Imaging Science and Technology, one of the organization's highest honors. But what is more important to the members of the Digital Imaging and Remote Sensing Lab is the knowledge that their work has made a lasting impact on the discipline and RIT's students.

"We are all very proud of the strong reputation DIRS and RIT have in the imaging science community," notes Messinger. "However, what is really gratifying is the ability we have had, in a small way, to make the world a better place and enhance the skills of our next generation of scientists."

Related Research

Printing Systems Modeling

Jon Arney

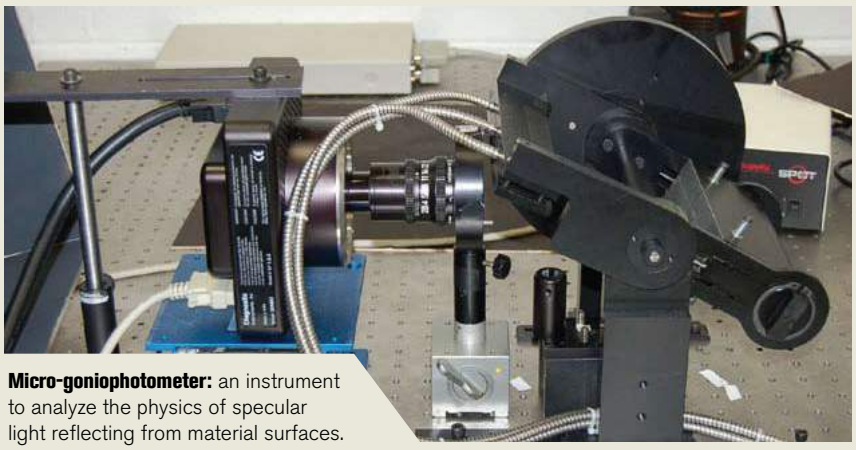
Marcos Esterman

Juan Cockburn

Susan Farnand

A cross-disciplinary team including Marcos Esterman and Juan Cockburn from the Kate Gleason College of Engineering and Jon Arney and Susan Farnand from the Chester F. Carlson Center for Imaging Science have created a laboratory to relate hardcopy output characteristics to system parameters that are relevant to end users. This laboratory, the Print Research and Image Systems Modeling (PRISM) Laboratory, was created to aid technical decision-makers with models of printer systems. The work currently underway, sponsored by the Hewlett-Packard Company, on Gloss and the Measurement of Specularly Reflected Light, exemplifies this mission.

Gloss is a visual effect (actually several visual effects) governed by the physics of specular light reflecting from material surfaces. A complete analysis requires the measurement of reflected light as function of color, magnitude, angle, and spatial location. The PRISM laboratory has applied imaging technology to develop a simple, yet effective, instrument that does a complete analysis of specular light. The instrument, called a micro-goniophotometer (Micro-G), provides more complete information than commercially available gloss meters. Research has shown the instrument to be radiometrically accurate, and psychometric analysis shows that it correlates well with the many visual characteristics of gloss. RIT's innovative Multidisciplinary Senior Design program is developing the next generation of the instrument, an important step toward providing a complete description of gloss characteristics of a material at the push of a button.



Micro-goniophotometer: an instrument to analyze the physics of specular light reflecting from material surfaces.

WASP Multispectral Mapping System

Don McKeown

Harvey Rhody

RIT, under the Integrated Sensing Systems Initiative (ISSI) sponsored by NASA, has developed an airborne multispectral mapping system called WASP (Wildfire Airborne Sensor Platform). Covering multiple spectral bands in the visible and infrared, the WASP system provides real-time day-night mapping capability with high spatial resolution. RIT has made substantial progress on this program, including numerous flight demonstrations to users in the fire and disaster response community. RIT has flown the instrument over wildfires in Montana and Idaho for the U.S. Forestry Service, provided near real-time geo-referenced imagery in support of a nuclear power plant disaster drill for the Monroe County Office of Emergency Preparedness, and delivered a near real-time flood plain map to a major utility company. During one demonstration, the RIT system was used to map a river area that was flooded the previous year. During the flood, it took three days to produce a map of the flooded area. The RIT system demonstrated that it could generate a map of the same area in two hours for emergency response and damage control.

RIT real-time mapping system captures and processes infrared and visible imagery from an airborne platform.

Providing Deaf Education Around the Globe: James DeCaro, director of PEN International, with the Hong Kong skyline in the background. DeCaro led a PEN team that partnered with educators at the Chinese University of Hong Kong to enhance the implementation of new technologies in deaf education programs offered by the university. The project included training staff of the Center for Sign Linguistics and Deaf Studies in documenting sign languages using off-the-shelf software packages.

Globalization of Access and Learning Technology

by Kathy Smith

Dr. James J. DeCaro believes that technology can make the world a smaller—and better—place for people who are deaf. Through Postsecondary Education Network (PEN)-International, which is housed at RIT/NTID and funded by The Nippon Foundation of Japan, DeCaro has found a unique opportunity to bridge cultural, geographic, social, and economic differences on the way to creating genuine change in deaf education worldwide.

Putting Experience to Work

Much of PEN's work draws upon DeCaro's accumulated experience at the National Technical Institute for the Deaf (NTID). Joining the college as a civil engineering technology instructor in 1971, just three years after NTID opened as one of two federally sponsored deaf education institutions, DeCaro was part of the institute's exciting early years, during which myriad technologies emerged to help deaf students learn in new and different ways. DeCaro oversaw the development and utilization of many of these technologies, so when he stepped down as dean of the college in 1998, he began thinking of ways to share NTID's and RIT's technological know-how on a larger scale.

In 2000, he approached The Nippon Foundation of Japan, a major grant-making organization interested in programs that support full participation in society for physically and socially handicapped people. DeCaro's vision of improving educational access for deaf people through the global power of technology touched a chord at the Foundation, which provided $1 million in 2001 to form the Postsecondary Education Network-International. Since then, the Foundation has awarded PEN more than $8 million.

From North America to the Far East:
Dr. DeCaro observes a demonstration of real-time captioning during a PEN trip to South Korea. PEN currently has 16 international partners in 13 countries including Russia, the Czech Republic, the Philippines, and Japan.

PEN-International's Mission

PEN's three-pronged mission is staggeringly simple: to train faculty members from colleges and universities in developing countries how to use technology to better educate deaf students; to provide them with multimedia centers and cutting-edge technology to support that learning; and to both humanize and widen the program's impact through cultural exchanges and leadership opportunities for students from partner universities.

DeCaro began by targeting several Asian and Pacific Basin countries to assess existing educational programs for deaf students. Partner institutions were chosen based on four characteristics:

- The university had a program for postsecondary education of deaf students.
- Administrators at a selected program strongly supported deaf education.
- The program for deaf students was recognized for its quality and commitment to continuous improvement.
- Each program had as its goal to prepare deaf students to enter careers that would allow them to fully participate in the workplace and in society in general.

PEN has formed partnerships with Japan's National Tsukuba University of Technology; China's Tianjin University of Technology, Beijing Union University, Changchun University, and Zhongzhou University; the College of St. Benilde in the Philippines; and Russia's Moscow State Technical University, Novosibirsk State Technical University, Vladimir State University Center for the Deaf, and the Academy of Management at Kazan. Affiliate programs later emerged in the Czech Republic, Thailand, Vietnam, Hong Kong, and South Korea. In all, PEN has 16 partners and affiliates in 13 countries, with two more being added next year.

PEN worked with each partner institution to assess its needs

and offered in-depth alternatives/solutions to its educational challenges. While many of the solutions are based on NTID's experience, DeCaro notes that partners are expected to adapt, adjust, or even reject some of the suggestions.

"If we have something they want, they can use it," he says. "If they have their own ideas, we'll work collaboratively to develop them with them."

Partner institutions have built new multimedia labs with PEN support and PEN offers training at RIT and in each home country, usually by RIT faculty members from NTID and other colleges. The labs all have smart classrooms used for teaching courses, faculty training, curriculum development, and videoconferencing. Students also use the facilities after class to study, do homework, and access the Web.

More than 500 computers have been installed in PEN-sponsored labs since 2001; they are used, on average, 60 hours per week.

Multimedia labs at Bauman Moscow State Technical University "have accelerated changes in the [educational] situation at the university, in Moscow, and in the country as a whole," says Alexander Stanvesky, director of Bauman's Center on Deafness.

Faculty members from each country are expected to share their new technological knowledge with fellow teachers. This teacher training is part of PEN's strategy to move its partners from being "importers" of knowledge to becoming "self-sufficient" to becoming "exporters." Last year, 14 of PEN's 16 partners conducted workshops or training in their countries on topics such as educational technology, instructional technology, and distance learning.

Disseminating Knowlege in Both Directions: Hong Kong residents demonstrate real-time video technology that allows for signing by cell phone. The innovation is currently not available in the U.S. and PEN is working to advance its implementation here in the United States.

Research in China

PEN's biggest research initiative to date is a three-year study on the state of postsecondary education for deaf people in China. *Postsecondary Education for Deaf People in China: Issues, Roles, Responsibilities, and Recommendations* by DeCaro and his spouse, Patricia Mudgett-DeCaro, retired RIT faculty member in the NTID graduate level teacher education program, is a comprehensive review of the state of the art in China and offers recommendations on how to improve deaf education in the country.

China faces the same challenges that exist worldwide when it comes to deaf education in developing countries, but on a much larger scale. Legislation was passed in the mid-1980s to allow students with disabilities to attend college, resulting in two national university programs for deaf students and a high

Creating Multimedia Laboratories to Enhance Research and Knowlege Transfer: DeCaro and NTID Dean Alan Hurwitz at the remote opening of the PEN-International Lab at Changchun University, China.

Multimedia Lab at Bauman Moscow State Technical University: The lab provides a high-tech training center for deaf students, enhances professional development of Russian deaf educators, and serves as a PEN-Russia training facility for collaboration activities.

percentage (80 percent) now receiving at least nine years of compulsory education. But while the number of deaf students receiving an education has increased, doubts remain about the quality.

The DeCaros interviewed 38 teachers and administrators of secondary and college programs serving deaf students, government administrators of the China Disabled Persons' Foundation, and deaf college students and graduates. Their recommendations include improving both the quality and diversity of education (art and computers are the majors currently offered), better access to mainstream courses and programs, improved pre-college education, more partnerships with employers, more opportunities for student leadership development, improved communication competencies, and a sweeping need to change the country's perceptions of deaf persons.

DeCaro believes that this research not only will have an impact on teaching and learning in China, but also will have a positive impact on public policy, a sensitive undertaking requiring diplomacy as well as mutual trust and respect.

"How a recommendation for improvement is stated is as important as the content of the recommendation itself," DeCaro notes.

PEN-China Research: PEN and its partner universities in China collaborated on the production of multimedia materials to enhance instruction at collaborating institutions.

Speech to Text:
The PEN-China partnership is testing the application of speech recognition software as a technique for providing speech-to-text services.

Integrating Deaf Students in University Programs:
An acupuncture program at Changchun University that is now offered to deaf students.

Interpreter Training and Development:
PEN has developed cutting-edge interpreter training programs that are now being implemented in numerous partner universities.

Officials from the China Disabled Persons' Foundation visited RIT in May 2006 to discuss the report and have pledged to begin addressing the recommendations in 2008. They will start by establishing interpreter education programs acrossthe country.

Changing the World

PEN's accomplishments over the past seven years have not gone unnoticed. The program was named a 2006 Education and Academia Laureate by the Computerworld Honors Program, recognizing its efforts to use information technology to promote positive social, economic, and educational change.

DeCaro has been named Honorary Professor at Tianjin University of Technology and received the HaiHe Award of Honor for outstanding service to better the circumstances of deaf people in China. He also has been awarded an honorary doctoral degree from Bauman Moscow State Technical University. Additionally, Mr. Y. Sasakawa, chairman of The Nippon Foundation, received an honorary doctoral degree from RIT in 2007.

PEN continues to change existing stereotypes about deaf education worldwide.

"We know that attitudes and philosophies in partner countries differ from those that prevail in the United States," DeCaro says, "so we are careful not to impose our attitudes or solutions on faculty members we are training. However, we also like to challenge people's way of thinking about education and people who are deaf."

During one training session, PEN used a deaf female RIT/NTID student from a participating country as a teaching assistant. She was studying information technology, a major that was not available for deaf students in her country. Faculty members were, therefore, presented with a conundrum—they were being trained in a skill set they did not possess by a student from their country who could not receive such an education in her own country.

PEN officials have a saying that they apply to trainers and trainees alike: "If you participate in a PEN-sponsored event and do not have your sensibilities challenged, we have not been successful."

Enhancing Deaf Education: William Clymer, PEN Associate Director, conducts a deaf education workshop at Korea Nazarene University. PEN has worked to disseminate instructional practices developed at NTID to partner universities and the international deaf community as a whole.

Related Research

Bringing Technology to the Streets… and Fields


Michael Stinson

Fifteen years after its creation, the C-Print™ real-time speech-to-text system developed by NTID Professor Michael Stinson continues to evolve to meet the demands of 21st century technology.

The original C-Print system was created as an access service option for deaf and hard-of-hearing students in secondary and college-level environments. The basis of the system is printed text of spoken English displayed in real time, which is a proven and appropriate means of acquiring information for some individuals who are deaf or hard of hearing. The name reflects the real-time provision of text that can be seen (the sound of the letter C corresponds to the word "see").

Stinson's latest endeavor is a remote speech-to-text assistive technology system that allows deaf students, including those with low vision, to view real-time transcription in remote/nontraditional settings, such as field trips, using handheld devices like cell phones or PDAs. A designated server receives input from a C-Print captionist, whose typed text then is displayed in an accessible Web applet on such devices.


Field demonstration of the spoken word, entered on a wireless PC and displayed in real time on wireless PDAs for deaf students.

With a grant from the National Science Foundation, Stinson will evaluate how much the service aids students' communication access and learning in such nontraditional environments.

Preparing Deaf Students for Careers in Information Technology


Donna Lange


Myra Pelz

To create a pathway for deaf and hard-of-hearing students across the country to transition from high school to associate degrees, baccalaureate degrees, and beyond in the area of information technology, RIT's National Technical Institute for the Deaf (NTID) has undertaken a major NSF project: *Pathway to an IT Education for Deaf and Hard-of-Hearing Students.*

This pathway project will allow deaf and hard-of-hearing high school students to earn college credit while they are still in high school. Five high schools across the country will partner with NTID to pilot these dual-credit (for both high school and college credit) courses. This three-year project will serve as the framework for a larger national program.

Principal investigators Myra Pelz and Donna Lange of NTID's information and computing studies department are working with schools in New York, Florida, Texas, and California, each with a significant population of deaf or hard-of-hearing students, to offer dual-credit RIT computer courses offered through the college of NTID. The project also offers summer professional development for high school teachers and guidance counselors that includes best teaching practices and training for hearing teachers who work with mainstreamed deaf students.


RIT creates a "pathway" to encourage deaf high school students to pursue a college education and career in the IT field.

"Such courses can help reduce barriers and ease the transition from high school to college for deaf and hard-of-hearing students," said Pelz. "NTID's course materials and career information will help move students from high school to college and on to careers in information technology, where deaf individuals are underrepresented."

Cutting-Edge Research and Student Engagement: Professor Santosh Kurinec explains the process known as Aspect Ratio Trapping (ART) to Richard Roney, an RIT undergraduate student in microelectronic engineering, who is holding an ART wafer, which incorporates a germanium layer on silicon. Kurinec and Sean Rommel are leading a faculty-student team that is partnering with AmberWave Systems to enable the use of ART technology in advanced germanium, III-V semiconductors on silicon development.

Innovation in Microelectronics

by William Dube

The development of integrated circuits and semiconductor devices has revolutionized our society from communication to information storage to transportation and media. The creation and implementation of a wide variety of digital devices central to our daily lives would not be possible without these technologies. Given the continued demand for micro and now nano electronics, researchers are working to further enhance the speed and storage capacity of these next-generation devices.

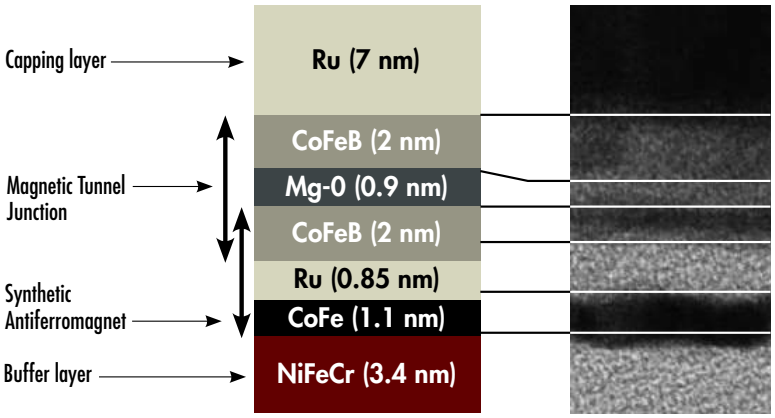
A Leading Innovator

"By increasing the functionality of micro and nano electronics, we can improve quality and performance while opening up new avenues for microelectronics applications," notes Santosh Kurinec, head of the department of microelectronic engineering at Rochester Institute of Technology. "These efforts will ultimately have major implications for a wide range of disciplines including medicine, transportation, entertainment, and energy management."

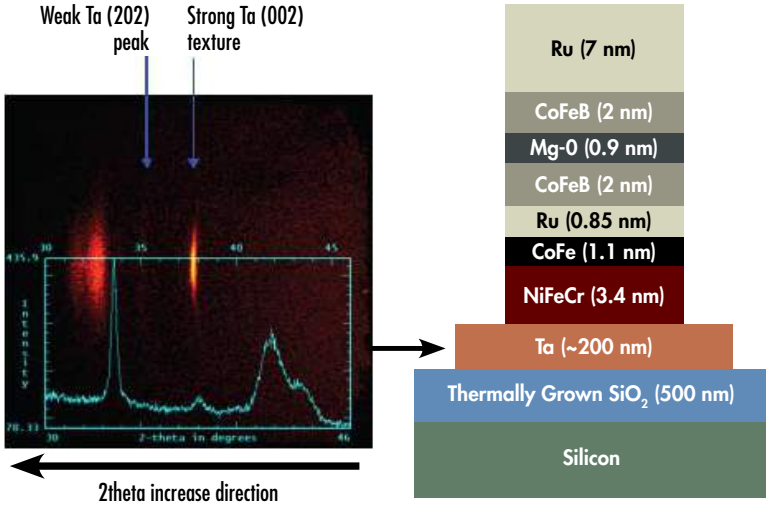
These innovations require new devices, novel materials, and innovative fabrication methods to accomplish improvements in microelectronics as well as more skilled engineers and researchers to make it happen. There are very few academic institutions that have a stronger background and skill set in this area than RIT. The university was the first in the nation to create a department devoted to microelectronic engineering, which celebrated its 25th anniversary in 2007, and also the first to create a doctoral program in microsystems engineering. Research conducted at RIT has advanced numerous technologies, including quantum devices, nanolithography, and nanomaterials. In addition, graduates of the program are now employed by nearly every major semiconductor company working in the field, including Intel, IBM, and Micron. "RIT has a long history of success in micro and nano electronic education and research, and has made a major contribution to the field's development over the last quarter century," adds Kurinec. "Our current efforts build on our commitment to grooming researchers for the ever-evolving microelectronics industry."

Professor Kurinec's team is adding to this body of research through groundbreaking work in the area of silicon integration. This effort focuses on looking for new methods to integrate disparate materials onto traditional silicon chips, enhancing functionality, memory, and speed. These have included luminescent phosphors, high-permeability magnetic cores, and spin-based junctions. To pursue these initiatives Kurinec has partnered with Surendra Gupta, professor of

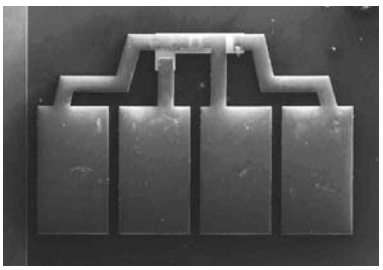
Improving Silicon Technologies:
An engineer examines the photolithography process performed on a silicon wafer to ensure proper exposure and alignment of mask levels. A typical semiconductor device may consist of numerous layers, each defined by a precise mask design.



Spintronics Enhancing Memory and Speed: The Magnetic Tunnel Junction (MTJ) device shown above is being integrated with silicon electronics at RIT. The left shows a cross sectional schematic. The right shows a transmission electron micrograph that illustrates a variety of nanoscale thickness materials being integrated on a wafer. MTJs are spin-based devices as opposed to silicon MOS transistor devices, which are charged-based.



A Bruker D8 Discover High-Resolution X-Ray Diffractometer Analysis: Advanced characterization of different layers becomes a critical component of research involving integration of dissimilar materials on silicon. As an example, the X-ray diffraction analysis seen above (left) is aimed at understanding the crystalline integrity of the tantalum layer that forms the bottom electrode (right).



Magnetic Tunnel Junction device on silicon fabricated at RIT. The micrograph shows the top view of a four-terminal Magnetic Tunnel Junction (MTJ). This device is utilized to study the resistance-area product with and without the application of magnetic field–in other words, whether it turns on or off with the application of a magnetic field.

mechanical engineering, in establishing a state-of-the-art nanocharacterization facility that includes a Bruker D8 Discover High-Resolution X-Ray Diffractometer and a Multimode Atomic Force Microscope. Currently, Kurinec and collaborator Sean Rommel, associate professor of microelectronic engineering, are working to monolithically integrate silicon nanoelectronics with charge- and spin-based tunnel devices.

Spintronics and Next-generation Microelectronics

Spintronics, or magnetoelectronics, utilizes ferromagnetic materials—compounds with an inherent magnetic behavior—to capture the spin state of the electrons. The process is now used in the development of mass storage devices and magnetic random access memory (MRAM), which utilize spintronics to greatly enhance the amount of data that can be stored. Scientists are now testing devices that can compress data down to one trillion bits per square inch. Eventually, researchers hope to use the method to create spin-based transistors powered by magnetic semi-conductors that require little external energy and greatly improve memory capacity over traditional devices.

Kurinec and Rommel are working with Veeco Corporation and the Naval Research Laboratory to integrate magnetic tunnel junctions, a spintronics device, with resonant tunnel diodes, which utilize the quantum effect generated by different compound semiconductors to create an electromagnetic wave that can be used in high-speed circuitry. The combination of the two technologies in a traditional Complementary Metal–Oxide–Semiconductor (CMOS) integrated circuit could greatly increase the tunneling magnetoresistance ratio, which is used to measure how effectively the magnetic charge is being transferred. Kurinec and Rommel believe the technique can increase the quality and reduce the costs associated with the process and ultimately enhance the utilization of spintronics methods, such as MRAM, for use as storage methods for electronic devices.

"Currently, MRAM chip technologies require a relatively larger amount of

Loading a Wafer for Ion Implantion for Doping Silicon: Silicon is implanted with impurities such as boron and phosphorus to change its conductivity and type. Combined with photolithography this process selectively places impurities to create layers of varying conductivity in order to build integrated circuits for microelectronics production.

energy to operate, which increases the cost and reduces the effectiveness of these devices for smaller, low-power applications," says Rommel. "Through the combination of magnetic tunnel junctions and resonant tunnel diodes on a CMOS circuit, we hope to increase the efficiency of the process and expand the uses for MRAM in a host of areas."

Kurinec and Rommel's work in the field builds on more than a decade of research conducted by Kurinec's team, which has made major strides in the implementation of additional semiconductor materials besides silicon, for use in transistors and integrated circuits. For example, in 2000 Kurinec partnered with the Ohio State University to integrate silicon-germanium-based semiconductors, using the technique known as MBE (molecular beam epitaxy), onto CMOS-integrated circuits. This was the first time that MBE grown semiconductors had been successfully incorporated into a CMOS device, and the data and knowledge the team developed on the project led to their interest in integrating magnetic tunnel junctions with CMOS circuits.

"The previous successes we have had in materials integration serve as building blocks for our current and future research efforts," states Kurinec. "The diversity of materials and techniques we have worked in allows the team to apply our knowledge to a wide variety of applications within the integration arena. This environment not only increases the quality of our work but also further promotes RIT's microelectronics capabilities for research with government, academia, and industry."

Kurinec's current major research effort grew out of a senior undergraduate project leading to a master of science thesis by Michael Latham involving fabricating devices on strained silicon wafers donated by AmberWave Systems. Subsequently, Kurinec, Rommel, and fellow microelectronic engineering faculty member Karl Hirschman partnered with AmberWave to receive NSF funding for integrating III-V materials onto silicon-based devices.

III-V materials, so named because of their location on the Periodic Table, have been used for years in niche markets that require extreme high-speed performance, optical properties, and/or radio frequency properties. However, they have seen little market penetration for more mainstream applications due to high costs and difficulty in integration with conventional, inexpensive silicon electronics.

This new research partnership will seek

Students Designing Advanced Microelectronics
Students such as microsystems engineering Ph.D. student Ivan Puchades and undergraduate microelectronic engineering student Yusuke Takahashi design and model novel devices as part of their academic programs.

Electrical Testing of Fabricated Tunneling Devices
Professor Santosh Kurinec and Ph.D. microsystems engineering students David Pawlik and Archana Devasia performing electrical tests as part of their doctoral research in microsystems engineering.

to develop the use of Aspect Ratio Trapping, or ART, an innovation created by AmberWave Systems to enhance the use of III-V materials in a number of applications. The team will test the quality of the process and work to develop a prototype manufacturable system incorporating III-V and silicon devices together.

"The joint venture between RIT and AmberWave is an example of our interest in cultivating technology from the ground level up," notes Richard Faubert, president and CEO of AmberWave. "We are extremely enthusiastic about what the partnership will bring to the advancement of semiconductor devices."

Two Goals: Innovation and Educational Excellence

The partnership with AmberWave Systems, like all of Kurinec's projects, will also include significant student involvement, including undergraduate and graduate researchers. This training component exemplifies the hands-on, educational approach that complements the microelectronic engineering department's research efforts. Kurinec believes this process not only benefits RIT's students but also provides future employers with engineers who already have significant real-world experience prior to joining the workforce. A doctoral student who assisted with the Ohio State project in 2000 was ultimately hired by Intel to carry out Intel's semiconductor research and development.

"Throughout my time at RIT I have focused on the dual goals of advancing technology in the microelectronics field, while also promoting the skills and capabilities of our students," says Kurinec. "We believe strongly in experiential learning and feel our extensive inclusion of undergraduate, master's degree, and Ph.D. students in our research efforts enhances our education initiatives while ultimately creating better engineers." This innovative educational approach in microelectronics has earned Kurinec's team a major National Science Foundation award for Leading Microelectronic Education to New Horizons.

"The ability to take my classroom training and apply it to real-world problems while I am still in school will be invaluable in enhancing my skill set and increasing my future employability," adds Raymond Krom, an RIT microelectronics student who will be working on the AmberWave project. "It also is incredibly gratifying to be working on cutting-edge technology that will ultimately lead to new innovations in the field."

Krom also was recently selected for an International Research and Education Experience (IREE) award from the National Science Foundation, which is allowing him to spend six months as a student researcher with IMEC, a university-industry research consortium based in Brussels, Belgium.

It is a testament to RIT's ability to meet the dual goals of innovation and education that many past graduates have returned to the school as professors and researchers. Karl Hirschman, who received a bachelor's degree in microelectronic engineering from RIT and subsequently received his Ph.D. in electrical and computer engineering from the University of Rochester, now serves as an associate professor in the departmentas well as director of the Semiconductor and Microsystems Fabrication Laboratory (SMFL)—RIT's 13,000-square-foot clean room.

"RIT's focus on 'education by doing' is a major asset not only for students but also for professors and researchers," Hirschman notes. "Students bring new ideas and a fresh perspective to problems that assist in making our research better."

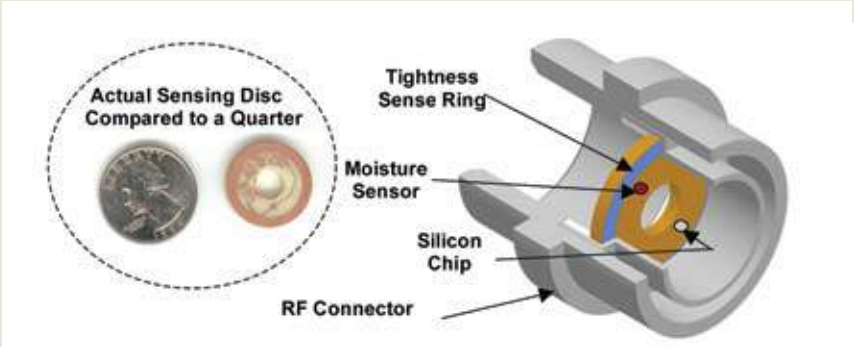
Related Research

Smart Connector Technology

Robert Bowman

The RF (radio frequency) coaxial connector is an electrical connector designed to work at radio frequencies. RF connectors are typically used with coaxial cables and are designed to maintain the electrical shielding of the coaxial system. The telecommunications industry uses millions of coaxial connectors every year to interconnect sections of RF cables. Coaxial connectors that have become loose or that suffer from moisture ingress eventually result in loss of the communication signal. RF connector failures continue to plague the industry and cost the telecommunications industry over $1 billion annually.

Research conducted jointly between PPC, Inc., headquarters in Syracuse, N.Y., and Robert Bowman of the RIT Analog Devices Integrated Microsystems Laboratory focused on understanding the nature of failure modes in RF connectors and developing micro-transducer technology to monitor and report these conditions.



Smart RF Connector With Disc Insert

RIT Smart Connector technology emerged from this collaborative effort.

The RIT Smart Connector incorporates sensing devices that detect the dominant failure mechanisms and a telemetry technology that reports the integrity and unique identification of each connector to a central dispatch location. Degrading quality in a connector can be detected and corrected before catastrophic failure occurs. Smart Connector technology includes a non-contact connector tightness sensor and a thin film polymer moisture sensor fabricated onto a small polystyrene disc. The disc is inserted in the RF connector body at the time of manufacture. Also placed on the disc is a small integrated circuit (silicon chip) that harvests power from the cable system, processes the alarm signals, and transmits the alarm status and connector ID to a central location. Smart Connector represents the first self-diagnostic technology for the RF connector industry.

Biomedical Device Innovation

Steven Day

The mechanical requirements of the human heart are extreme; it must beat more than 30 million times per year to forcefully, yet delicately, propel blood. Artificial circulatory support devices used to assist an ailing heart have similarly extreme design requirements. Implantable pumps that assist, rather than replace, the native heart are frequently used on a short-term basis to maintain circulation until a transplant is available. Even so, heart disease remains the number one cause of death in the United States. Steven Day of the mechanical engineering department in the Kate Gleason College of Engineering has partnered with doctors at the Utah Artificial Heart Institute on an NIH-funded project to design a next-generation Left Ventricular Assist Device. This novel rotary pump uses magnetic bearings to suspend and rotate an impeller, the single moving part. Eliminating mechanical bearings minimizes blood damage and gives the pump a design life of 15 years, significantly longer than currently available pumps. Day's team of graduate and undergraduate engineering students uses computer models and bench-top experiments of the fluid flow, magnetic fields, and blood damage for design and validation of the pump. Animal trials are planned for later this year.

Very low friction rotary pump impeller for implantable heart assistance device

Everthing Old is New Again: In the past, printing was available only for the elite due to equipment and expense. The digital age opened up online publishing to the masses. Now, new technologies have further broken down the barriers to personal publishing. People can create true self-published books. At RIT, professor Frank Cost, director of the Printing Industry Center, is developing innovative printing and computer technologies to further the advancement of self-publishing. Through this research, the "old" technology of book publishing is now cutting edge. Analog is the new digital.

Analog is the New Digital

by Staff Writer

As virtual worlds grow more sophisticated and lifelike with each passing day, it is easy to forget that material reality is still where we live our physical lives, and that virtual digits must in most cases be transformed into physical things before they have any meaning or value. Nicholas Negroponte, in a famous statement at the beginning of the Internet Age, declared that "the future is about bits, not atoms." But people are made of atoms, and atoms still constitute the stuff that remains our greatest desire.

In the Beginning

For thousands of years people have expressed themselves through the creative arts, finding ways to channel their ideas into material form by the skillful exercise of craft. The simplest technologies, such as pencil and paper or paint and canvas, have been available to anyone who might wish to use them. But technology-intensive media such as print, film, radio, and television were never accessible to any but tiny elites. So their use was restricted to one-way broadcast of tightly controlled messages from the few to the many. This was true for hundreds of years, from the time of Gutenberg to just a few short years ago.

Then the revolution came

The combination of digital media creation tools and the Internet has removed the financial barriers and enabled anyone with a computer to become a publisher. The age of ubiquitous publishing is upon us. The first wave of creative energy has been channeled into new online media such as blogs, podcasts, and video. Web-based publishing platforms such as Blogger and YouTube make it easy to instantaneously publish text, graphics, and video content and make it available globally.

But while these new electronic media have become simple to use, the oldest medium—print—has remained beyond the reach of most people. Print is complex and expensive, and

The Contributions of Johannes Gutenberg
This painting by the artist Robert Thom depicts the 15th-century printer Johannes Gutenberg in his shop, surrounded by the tools of his trade. Gutenberg's singular place in graphic arts history is well deserved since he was the first to develop a reliable system for the mechanical reproduction of books. Here he is shown casting a piece of type in an adjustable hand mold, probably his single most important invention. This is one in a series of 24 paintings commissioned by the Kimberly-Clark Corporation and completed in 1971. Called "Graphic Communications Through the Ages," the collection was later donated to RIT, where it is now on view in the Cary Graphic Arts Collection and the adjacent Cary Graphic Arts Press.

Moveable Wooden Type Revolutionizes Bookmaking
Johannes Gutenberg invented the printing press in 1436. The technology included the use of replaceable/moveable wooden or metal letters, and is credited for a revolution in the mass production of books, and for fostering rapid development in the sciences, arts, and religion through the distribution of texts. Gutenberg also is credited with printing the world's first book using movable type, the 42-line Gutenberg Bible.

unlike electronic media it must be physically produced and distributed before it can effectively communicate anything. So while electronic publishing formats have been embraced by millions of new users around the world, print remains largely the domain of traditional capital-intensive businesses.

But what if print were as easy to use as Internet blogging and video publishing? What new forms of ubiquitous print publishing would emerge? These questions have been inspiring research and experimentation in RIT's College of Imaging Arts and Sciences for the past five years. The Printing Industry Center, an Alfred P. Sloan Foundation Industry Studies Center, has focused on the emergence of radically new print communication models based on digital print and the Internet. These new models are at the core of a new industry described in the 2005 book *The New Medium of Print: Material Communication in the Internet Age*, written by Frank Cost,the center's co-director. This book was the first in a new series about the printing industry authored by researchers in the center and published by the RIT Cary Graphic Arts Press. The second book in the series, *Data Driven Print: Strategy and Implementation*, by Patricia Sorce and Michael Pletka, explores new uses of print as an adjunct to Internet-based marketing. A third book, by professor Twyla Cummings, concentrating on new directions in print distribution will come out this year.

We know the future of print

RIT also has been at the forefront of technical research that is essential to the new models of print communications. One area of particular strength is in ensuring the accuracy of color. In a globalizing economy, half a world can lie between the design and production of printed products. For the colors intended by designers in one part of the world to be accurately rendered on products manufactured in another requires the highest level of process control and rigorous digital workflows that communicate the subtlest nuances of color design intents. RIT's Printing Applications Laboratory, drawing on expertise from the university's School of Print Media, works with major suppliers of digital technology and advanced materials like Kodak, HP, Xerox, Adobe, ExxonMobil, Sun Chemical, and most of the major paper manufacturers to develop methodologies and workflows that guarantee the required color accuracy.

Once produced, some printed products will be consumed and recycled within days or hours, whereas others will be expected to endure for decades and even centuries. The durability and permanence of printed products is a major focus of

Ensuring the Accuracy of Color
A key component in digital printing is the assessment and accuracy of color reproduction. Allison Ucci (above), a master's degree student in the College of Imaging Arts and Sciences, runs a test on an HP Indigo digital color press in the Printing Applications Laboratory (PAL). PAL is involved with research to enhance color print assessment and optimization, as well as the management of the color reproduction process.

Partnering with Leading Innovators in Digital Printing
High-speed digital color presses manufactured by HP, Kodak, Xerox, and others are used for a variety of applications where data is streamed continuously from the Internet onto a wide range of custom products. Using these systems, a single copy of a book can be printed, bound, and packed for shipping in only a few minutes, with almost no wasted material.

study for RIT's Image Permanence Institute. The durability of printed images is important because many of them pass through the postal system where they must endure the physical stresses of handling while retaining the messages they carry until they arrive safely at their destination. Often the need for greatest durability is for messages that will live only for a few minutes or hours once they arrive in the mailbox. At the other end of the spectrum, some printed products will become keepsakes and family heirlooms and must be stable and permanent. For example, family photo albums are expected to endure for generations. So digital processes used for these applications must produce printed products that possess the necessary archival qualities. The Image Permanence Institute uses a number of accelerated aging techniques to determine the life expectancy of printed products.

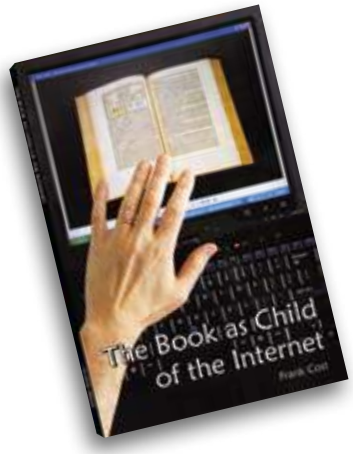
Although most of the print media-related research at RIT is relevant to established applications such as publishing, marketing communications, and packaging, it is the new applications serving entirely new markets that are most exciting. This is where inventors and entrepreneurs are building new technologies and systems to create altogether new business opportunities. One area of particular interest to faculty and students in the visual arts is the digital book. Among the partner companies of the Printing Industry Center are several that make technology that is revolutionizing the way books are produced. These include manufacturers of digital print production technology, digital substrates, and product design software.

In addition to these companies, RIT has established relationships with leading innovators in digital book production. One of the world's leading companies in this space is ColorCentric, a Rochester-based company that produces books on demand for Internet customers. ColorCentric currently produces and ships more than half a million books each month in order quantities of less than two books on average. The quality of the books produced using digital print production machines, made by Xerox, HP, and Kodak, is indistinguishable from that of traditionally produced books. But ColorCentric can manufacture and ship a single book from an online order in a matter of hours. This enables ColorCentric's customers to completely eliminate the traditional upfront costs of book publishing. This in turn is launching a revolution in book publishing by removing barriers and allowing millions of new publishers to enter the game.

You are the future of print

One result of this revolution is having a profound impact on the way RIT professors and students in the visual arts express themselves through media. It is now possible, for example, for professors of photography, graphic design, print media, and illustration to require their students to publish finished books of their work on a regular basis. Frank Cost started what he calls his "Instant Book" project in January 2006 to inspire faculty and students to think of the book in radically new ways. Each of the dozens of books in the series contains content produced and published in only a few hours. In some cases the content of a book is captured in a matter of minutes or even seconds, thus demonstrating an extreme new frontier for a medium that has always demanded much longer periods of time for its products to come into existence.

With these examples as inspiration,



The Book as Personal Communication
Focusing on the world of new possibilities for books enabled by digital technology, *The Book as Child of the Internet,* by Frank Cost, chronicles a lifetime pursuit of the book as a form of personal communication.

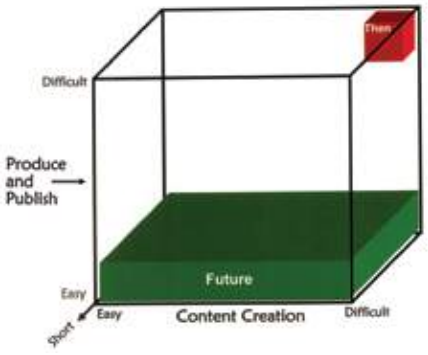
The Value of Material Forms of Communication in a Digital Age
Frank Cost, an internationally respected expert in digital publishing and evangelist for the promotion of self-publication, collaborates with the Printing Applications Laboratory at RIT, conducting research to further improve the quality of self-publishing and dispense with the notion that print is difficult and expensive to produce.

faculty and students are pioneering many innovative uses for books across the university. Student work that would otherwise languish in isolated portfolios is coming together into impressive collections that are much more valuable, in some cases, than the sums of their parts. As this trend grows, new ways to streamline workflows to make it even easier to publish books are being discovered. The greatest barriers are now in the creative process itself, where knowledge of design software is often required. This has led to the creation of a new virtual laboratory in the School of Print Media called the Open Publishing Lab. OPL is a collaborative effort between the School of Print Media and RIT's Wallace Library, with startup funding from the Printing Industry Center and a small grant from Hewlett Packard to support RIT's participation in a global research initiative called the HP Digital Publishing University Community. OPL is dedicated to enabling the wider world to use digital publishing to create new opportunities for creative expression.

One of the first groups of OPL projects is the creation of toolsets for people who wish to publish content in book form with minimal experience or time to devote to the endeavor. One tool under development allows for the publishing of automatically formatted and elegantly designed printed books from selected Wiki content. Another project employs a team of software engineering seniors, under the guidance of Fernando Naveda in RIT's department of software engineering and Frank Cost, and is building a Web-based service for K-12 classroom teachers to quickly and easily publish collaborative books with their students. This project draws upon faculty and student expertise in two RIT colleges, HP, ColorCentric, and the East Irondequoit School District in suburban Rochester.

Analog is the New Digital

The printing world, and the computing devices that drive it, are evolving at an incredible pace. RIT's vision for the future of print media in the Internet Age is that it must become a channel of communication as accessible and easy to use as the Internet itself. It must be instantaneous, it must be accessed from any wireless device at any required speed, and it must print images, text, and mixed media from all sources including the Web. Making atoms work as efficiently and instantaneously as bits will be the greatest challenge facing RIT and the print industry in the decades to come.



The New Book
For centuries we have lived in a world where books were difficult to produce and expensive to publish. This restricted our thinking about what books could be. After so much time living in a little box, it is hard to imagine that there are any other possibilities. The new book, produced with digital tools and automated digital printing processes, opens itself for all kinds of new uses.

Related Research

Art Innovation in Glass from the School for American Crafts


Robin Cass

Robin Cass has been a faculty member in the glass program at the School for American Crafts for the past 10 years. She serves on the board of the Glass Art Society and has been invited to lecture at the Corning Museum of Glass, Dublin National College of Art, the Kookmin University in Seoul, Pilchuck Glass School, and the Tacoma Museum of Glass, among many other places. She is the co-chair of the RIT glass program and a notable artist. Robin provides an introduction to her great work and instructional approach:

I have always loved getting my hands dirty and creating, but it took a while to realize that art was the profession where I belonged. As a sculptor, I find I can follow my curiosity wherever it leads me as I develop ideas for new artwork. Research also is central to the courses I teach. Students delve deeply into a diverse range of topics in order to refine their aesthetic and conceptual concerns as they develop original work.

I choose to work mainly with glass because I enjoy the interplay between idea development and technical experimentation that comes with focusing on a primary material while making art. In addition to being rich with metaphorical associations, glass has an intriguing ability to assume a wide range of shades, forms, and translucencies. It is the ultimate sculptural medium.

I travel the world to lecture, exhibit my work, and teach. During these trips I forge connections with people and places that enrich my creative process as well as the educational experiences of my students. These glimpses of distant places and people flood my mind with new possibilities and feed the development of my work.

My current sources of inspiration include ancient Roman perfume ampoules, the botanical photographs of Karl Blossfeldt, and Aesop's fables. These sources percolate through the alchemical process of individual creativity, and emerge as new sculptures. In the resulting works, I try to explore the tension between a state of desire and the possibility of fulfillment; the transition from "deprived" to "satisfied."

"Allegory" (detail) by Robin Cass - from the collection of the Tacoma Museum of Glass and Center for Contemporary Art. Please explore more of Robin's work at www.robincass.com

Virtual Theatre: Live Performance in a Virtual Space


Tina Chapman DaCosta


Joe Geigel


Marla Schweppe


Walter Wolf

Imagine a live performance where, rather than having to go out to a physical theatre, you can experience the action in a virtual world. The actors are all avatars; the sets and lights are virtual; and the show is viewed on a computer screen and performed live by people located around the globe.

Is it possible to enable this kind of theatrical experience, and if so, how would the experience compare to a show on a real stage? These are some of the questions that are being explored by Joe Geigel from the B. Thomas Golisano College of Computing and Information Sciences (GCCIS) and Marla Schweppe from the College of Imaging Arts and Sciences (CIAS) as part of the Virtual Theatre project, a collaborative effort between the department of computer science (GCCIS) and the School of Design (CIAS).

With recent funding by a three-year grant from the National Science Foundation, Geigel, Schweppe, and their colleagues Walter Wolf and Tina Chapman DaCosta, both from GCCIS, will set out to create theatre in 3D virtual space, where actors, crew, and audience share, from different physical locations, a single theatrical experience over the Internet. A variety of virtual reality devices, including a full body motion capture system, are employed in controlling actors and stage elements on the virtual stage.

Human Performance and Internet Avatar - Tina Chapman DaCosta wears a full body motion capture suit preparing to control the motions of an avatar on the virtual stage. The avatar in the computer image follows her motion in the performance.

Photo by Walter Wolf. 3D models by Marla Schweppe and Ning Su.

Innovation and Entrepreneurship

by William Dube

From its earliest days, RIT has placed a significant emphasis on the creation and advancement of businesses.

Development and Fundraising Expertise for Startups
RIT's Venture Creations Incubator, just off campus, is the home of the Simone Center for Innovation and Entrepreneurship. Jerry Mahone (left) and Richard DeMartino (right) provide leadership for these programs.

In the 19th century, the Mechanics Institute—an RIT predecessor—was founded to support over 50 Rochester area companies "for instruction in industrial pursuits." Moving rapidly to the 20th century, a more current but equally important cooperative education program was created that currently places over 4,000 students per year in companies to learn the real needs of business and help these companies advance. Now, in the 21st century, RIT is taking the next step in the support of businesses through the creation of small, agile companies with the Albert J. Simone Center for Innovation and Entrepreneurship and the RIT Venture Creations Business Incubator. These new organizations provide the academic and infrastructural support for RIT's faculty, staff, and students to innovate and succeed in new businesses.

The Simone Center, directed by associate professor of management Richard DeMartino in the E. Philip Saunders College of Business, works with both undergraduate and graduate RIT students to provide guidance and support in their efforts to start companies or commercialize research they have developed. Students can receive assistance in creating business plans, applying for government or venture support, or connecting with additional RIT resources. The student ventures that have grown out of the center include My Time Hero, a social networking company aimed at older, less computer-savvy adults, and Valyceum Consulting, which works with a number of regional technology firms, including Impact Technologies, to develop technology commercialization strategies. Another startup, DarkWind Media, is highlighted in this article.

As student, faculty and staff ideas progress and become independent business ventures, they can utilize space and receive support from the university's business incubator, Venture Creations, which currently houses 15 startups and provides development and fundraising expertise to assist new businesses in developing client bases and bringing products to market. The organization, directed by Jerome Mahone, builds on over two decades of business development efforts conducted by the RIT Research Corporation and the High Tech Incubator, which preceded Venture Creations in its 30,000-square-foot off-campus facility. This incubator has produced a number of successful "graduate" companies, including Advanced Document Imaging, an image analysis firm that is supporting development of the 2010 Census, and Geospatial Systems Inc., a manufacturer of high-technology remote sensing systems. Highlighted in this article is another business begun at Venture Creations: the NanoArk Corporation.

The continued development of America's high-tech economy is going to be dependant on the expertise and innovation being generated at our colleges and universities. Through its entrepreneurship efforts, RIT is working to promote the expansion of high-tech innovations and their commercialization for the greater economic benefit of our communities.

NanoArk Corporation

One of the startup firms currently housed at Venture Creations is the NanoArk Corporation, an image archival firm created by P.R. Mukund, Gleason Professor of Electrical Engineering in the Kate Gleason College of Engineering;

Roger Easton, professor of imaging science in the College of Science; and Ajay Pasupuleti, a graduate of RIT's doctoral program in microsystems engineering.

Pasupuleti developed a method for storing documents on silicon wafers as a replacement for standard microfilm and microfiche technologies. This methodology is currently pending a patent. He first worked with Mukund and Easton to store images they had created through a research effort involving the digitization of ancient Hindu manuscripts. The project was so successful that the trio, along with Mike Toth, who recently retired from U.S. Government service, decided to form a company to develop a mass-produced version of the system, including the wafers themselves, a process for archiving the information, and a reader for studying the stored documents. The resulting technology is considerably more durable than standard microfilm, and the document reader allows for searching and magnification capabilities that greatly enhance image examination.

Document Storage on Silicon
P.R. Mukund and his partners started an image archival firm to market research developed at RIT with assistance from Venture Creations.

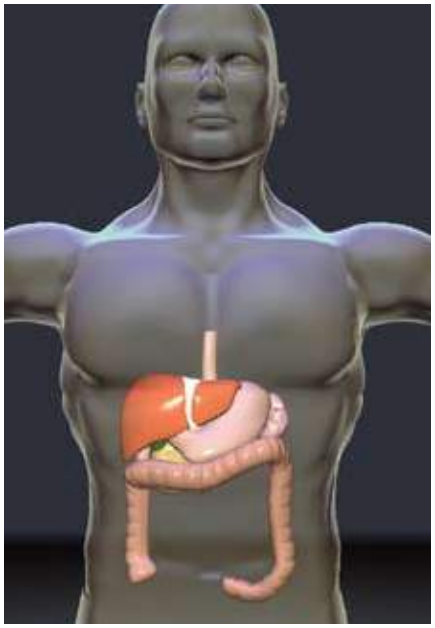
NanoArk has put together initial financing and developed a working prototype. It is currently in the product development phase with the hope of offering its initial products for sale in the summer of 2008. Pasupuleti and partners also are working with the Venture Creations staff and several incubator graduate companies, including Advanced Document Imaging, to develop additional business opportunities.

The firm's success not only enhances the Rochester economy but also continues to provide benefits to RIT faculty and students. NanoArk has utilized a number of cooperative education students and interns on various projects and worked with the College of Engineering and the Center for Imaging Science to enhance their technology development. Mukund also notes that the company recognizes the tremendous assistance they have received from so many in the RIT community, and says that NanoArk is committed to giving back. So far, the firm has donated over $75,000 to different research programs and plans on providing additional assistance in the future.

DarkWind Media, Ltd.

A recent company to join Venture Creations is DarkWind Media, a software development firm started by RIT students Colin Doody and Brian Johnstone. Doody, a master's degree student in game design and development, and Johnstone, a fifth year software engineering major, both in the B. Thomas Golisano College of Computing and Information Sciences, had been interested in developing 3-D programming in conjunction with their own research when they were approached by RIT professors Richard Doolittle, director of biomedical sciences, and Paul Craig, professor of chemistry, both from the College of Science. Doolittle and Craig were looking for assistance in developing a software package for use in their Human Visualization Project (HVP). Doody and Johnstone created a prototype that allowed for rapid 3-D visualization of different organs. It was ultimately incorporated into a virtual tour of the pancreas, which HVP developed and then presented to Merck Pharmaceutical, the National Science Foundation, and numerous other businesses and organizations.

The success of the effort convinced



The Human Visualization Project
DarkWind Media, Ltd., a software company started by RIT students, developed software that was incorporated into a virtual tour of the human pancreas.

Doody and Johnstone that they could create a visualization program that would improve on the current technology available and be usable in a wide variety of applications. They sought help from the Simone Center to begin development of their business idea, and ultimately incorporated in October of 2007. Now located in the Venture Creations incubator, DarkWind has grown rapidly. On top of their continued work with HVP, they are providing software development support to RIT's Digital Imaging and Remote Sensing Lab as well as doing freelance work for the American Cancer Society. The company now has four employees and currently utilizes a co-op student provided by RIT's Saunders College of Business. They also are expanding the development of a proprietary 3-D visualization package and hope to offer products for sale in the near future.

Doody and Johnstone's success exemplifies how quickly a good idea can lead to profit, especially when the infrastructure and support are present to help students take the next step.

Research Awards

RIT values the research contributions of its faculty and staff across all colleges and centers and honors these accomplishments through the Principal Investigator Reception each February, as well as through recognition events hosted by colleges and centers throughout the year. In this annual report we would like to highlight members of the RIT community who have received significant national and international recognition.

Trustees Scholarship Awards

The Education Core Committee of the RIT Board of Trustees awards up to three Trustees Scholarship awards each year to RIT faculty who demonstrate outstanding academic scholarship. In 2007, three RIT professors were recognized with Trustees Scholarship Awards:

Michaël Amy, associate professor in the foundations department in the College of Imaging Arts and Sciences, joined RIT in 2000 and is a scholar of Renaissance art and architecture. He has published extensively in his field, including contemporary art exhibition reviews, journal articles, books, and book reviews.

Amitrejeet (Amit) Batabyal, Arthur J. Gosnell Professor of Economics in the College of Liberal Arts, joined RIT in 2000. His research interests include environmental and natural resource economics, development economics, and international trade theory. He has published five books and 137 articles in refereed journals, and has written 260 book reviews. He also established the Gosnell Lecture Series in Economics at RIT.

Bruce Smith is the Intel Professor of Research and Technology and the director of the Center for Nanolithography Research at the Kate Gleason College of Engineering. Smith is an internationally recognized expert in optical nanolithography who also was elected a fellow of International Society of Optical Engineering in 2007. He holds 18 U.S. patents and has received more than $2.5 million in external research funding. Smith received his BS, MS, and Ph.D. degrees from RIT and joined the faculty in 1988.

Fulbright Scholars

The Fulbright program, established in 1946 and sponsored by the U.S. Department of State, is the largest U.S. international exchange program offering advanced research and teaching opportunities for students and scholars in more than 150 countries worldwide.

Two RIT faculty members have recently received Fulbright awards:

Spencer Meredith, assistant professor of political science in the College of Liberal Arts, specializes in international relations and used his Fulbright fellowship to conduct research in the Republic of Georgia in 2007. Meredith led a team that investigated the role of local Orthodox priests in conflict resolution involving ethnic Georgians who fled from the Abkhazia region following civil unrest in the early 1990s.

Karl Korfmacher, associate professor of environmental science in the College of Science, put his 2006 Fulbright award to work in RIT's affiliated American College of Management and Technology in Dubrovnik, Croatia. Korfmacher conducted research on several coastal environmental threats

in Croatia, including developing methods to control an invasive species of sea grass called Caulerpa, which is causing significant environmental issues along the Mediterranean and Adriatic coasts.

National and International Recognition

David Long, chair of the digital cinema program in the School of Film and Animation in the College of Imaging Arts and Sciences, was part of the Eastman Kodak team honored with an Oscar award by the Academy of Motion Picture Arts and Sciences. While an imaging scientist at Kodak, Long designed system color and image reproduction characteristics for the company's VISION2 family of color negative films, now a standard in the movie industry. The Oscar was presented to Kodak as part of the science and technology ceremony held February 9 in Los Angeles.

Luane Davis Haggerty, assistant professor at the National Technical Institute for the Deaf, was nominated for a 2007 Pulitzer Prize in drama for her play "Windows of the Soul". The production, about the challenges of deaf and hard-of-hearing people living in the same apartment building, was based on Haggerty's extensive research on the deaf experience, including interviews with over 600 members of the deaf community. The play featured a number of RIT students and premiered at NTID in 2006. It was later staged at the Deaf Theatre Festival in New York City.

Mark Fairchild, director of the Munsell Color Science Laboratory in the College of Science, was the 2007 recipient of The Royal Photographic Society of Great Britain's Davies Medal, which is awarded to researchers whose work advances the development of imaging science. Fairchild was recognized for his contributions to the understanding of color perception and imaging as well as color-appearance modeling and image appearance.

James Reilly, the founder and director of the Image Permanence Institute in the College of Imaging Arts and Sciences, received the 2007 HP Image Permanence Award from the Society for Imaging Science and Technology. Reilly was recognized for his contributions in advancing the longevity of photographic and fine arts images.

Michael Peres, chair of the department of biomedical photographic communications in the College of Imaging Arts and Sciences, was the 2007 recipient of the Louis Schmidt Award from the BioCommunications Association of America, the professional society's highest honor. Peres was selected for a number of research and education achievements during his distinguished 25-year career as an academic, photographer, writer, editor, and imaging consultant.

Satish Kandlikar, the James Gleason Professor of Mechanical Engineering in the College of Engineering, was presented with a Dedicated Service Award from the American Society of Mechanical Engineers in 2007. He was recognized for his efforts to create the International Conference on Nanochannels, Microchannels and Minichannels, an increasingly prominent scientific symposium in microfluidics now entering its sixth year.

Nabil Nasr, director of the Golisano Institute for Sustainability, was one of two expert presenters in manufacturing policy selected to speak at the United Nations for the Intergovernmental Preparatory Meeting of the 15th session of the Commission on Sustainable Development, also known as CSD-15. CSD-15 is a policy session set up by the U.N. to explore energy for sustainable development, industrial development, air pollution, and climate change.

About This Section

This listing is a sample of numerous 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.

R·I·T

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The Rochester Institute of Technology
RIT is one of the largest private universities in the world. With a unique blend of rigor and imagination, of specialization and perspective, of intellect and practice, RIT is a vibrant community of ambitious and creative students from more than 95 countries.

Rochester Institute of Technology is internationally recognized for academic leadership in computing, engineering, imaging technology, and fine and applied arts, in addition to unparalleled support services for students with hearing loss. Nearly 16,000 full- and part-time students are enrolled in more than 200 career-oriented and professional programs at RIT, and its cooperative education program is one of the oldest and largest in the nation.

For nearly two decades, *U.S. News & World Report* has ranked RIT among the nation's leading comprehensive universities. *The Princeton Review* features RIT in its 2007 Best 361 Colleges rankings and named the university one of America's "Most Wired Campuses." RIT also is featured in *Barron's Best Buys in Education*.

Contact Information

We conduct research to advance the body of knowledge, enhance student and faculty learning, and build our reputation in the scientific and technical communities while providing positive returns to our sponsoring partners. Please contact us directly or through the RIT research website www.rit.edu/research.

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