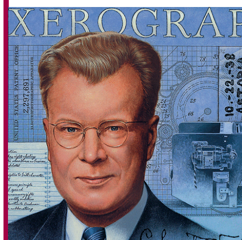
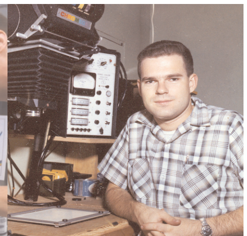
Imaging Connection





The Newsletter of the Chester F. Carlson Center for Imaging Science Spring 2002

Naval Research Lab Partners with Center for Imaging Science

Graduate students Jason Babcock and Roxanne Canosa outfit imaging science professor Jeff Pelz with RIT's wearable eye tracker.

Imagine an ordinary pair of racquetball goggles souped up with high tech gadgetry — two tiny cameras, an infrared light source, a dentist's mirror, and a braid of wires running to a backpack full of electronic equipment. Now put these goggles on and the device will track what you are looking at and record how you move your eyes to take in information. This unique piece of equipment—known as a wearable eye tracker—was designed and built at RIT's Chester F. Carlson Center for Imaging Science to study how people use vision in everyday life.

For over a century, scientists have used eye movements to study vision in laboratory settings, but they lacked a way to study these movements in realistic environments outside the lab. This was the impetus behind the development of the wearable eye tracker.

"Knowing how people move their eyes in the laboratory tells us almost nothing about how people search for things in the real world," says Jeff Pelz, associate professor of imaging science and director of the Center's Visual Perception Laboratory, where the device was designed and built.

Now the U.S. Naval Research Laboratory is partnering with CIS to update the system and to develop the next generation of wearable eye trackers: lighter, hardier, wireless headgear that will work in any environment.

While the current research in the Center is focused on fundamental questions about how people use visual perception during complex tasks, researchers at NRL are interested in using the eye tracking technology to learn how experts locate difficult-to-find objects in natural scenes. The three-year, $420,000 project gives the Visual Perception Laboratory a chance to blend pure science with applied research.

Locating small objects in cluttered scenes seems effortless, yet scientists have been unable to create flexible computer vision systems that rival our visual abilities in natural environments. Once it is understood how humans solve this seemingly easy task, researchers hope to apply

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Color Imaging Enhances Art Conservation

Has time flattened Van Gogh's palette? Were his blue backgrounds once purple and his white roses, red? An imaging system that can showcase the original condition of a painting—reversing centuries of grime and deterioration—while reproducing its true palette is an art conservator's dream.

RIT, the National Gallery of Art in Washington, D.C., and The Museum of Modern Art in New York are partnering to create the next generation of conservation-science technology that will change how museums around the world reproduce and archive artwork.

A research team led by CIS color scientist Roy Berns is creating a unique imaging system that will record and reproduce art work not as the human eye sees it subject to different lighting, but based on a painting's true optical properties—its own unique spectral fingerprint. Berns' research will introduce new techniques, better accuracy and will give museums a cost-effective and practical way to create their own spectral archives. His team includes RIT color scientists Francisco Imai, Mitchell Rosen, Lawrence Taplin, and graduate students Ellen Day and Collin Day.

The three-year project is supported by funding from the National Gallery of Art and The Museum of Modern Art with a $110,000 grant in the first year. Berns, the Richard S. Hunter Professor of Color Science, Appearance and Technology in RIT's Munsell Color Science Laboratory is designing the new imaging system to improve upon European advances in conservation science.

In the last decade, museums in London, Munich and Florence took the lead in digital imaging of artwork, developing costly, custom-built systems. Berns envisions an affordable, practical imaging system that will include capture, archival storage, web capabilities and large-format multi-ink printing, all taking advantage of spectral information. His imaging system will combine off-the-shelf hardware with highly sophisticated software that is patent pending. The system will be the first of its kind to document and reproduce artwork that matches the original under any light source.

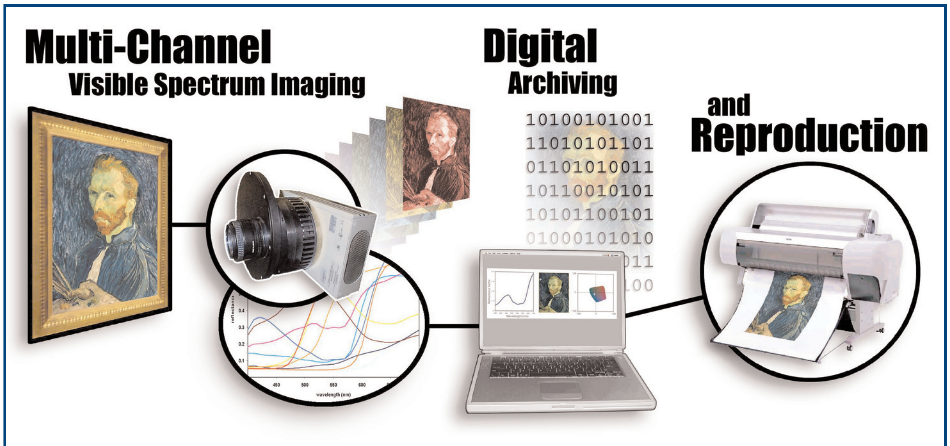


Illustration by Jason Babcock, graduate student in color science.

While the most successful imaging systems currently used by museums mimic the human visual system, Berns' research will record the optical properties of the paint. This is significant because color values change under different light sources due to the way the eye processes light.

"When we see color, we see integration," Berns says. "Wavelength information gets combined into three signals—red, green and blue. With digital photography you get color information, not information about spectral data because the camera is working the same way as the human eye."

What does this mean for museums? By focusing on the spectral data, Berns' system will more accurately reveal a painting's optical properties, giving conservators information about the physics and chemistry of a work of art.

More specifically, spectral information can tell conservators and art historians if a painting's surface has been altered over time, what materials might have been used, and provide valuable information during restoration. In addition, spectral data can show what the painting would look like if cleaned, almost always a costly, controversial venture. Berns anticipates that his imaging system will safely simulate the original condition of a painting, giving conservators important information before a final decision is made to clean the artwork.

The majority of Berns' research will be done at CIS, with periodic visits to each museum to test the new imaging system. In the final phase of the project, the CIS team will create a spectral-based digital imaging facility at the National Gallery of Art and The Museum of Modern Art.

For more information visit Dr. Roy S. Berns' web site at: www.cis.rit.edu/people/faculty/berns/

Local Students Learn About Traditional Imaging

Students from around Rochester are getting their first "exposure" to imaging science through a new educational module on pinhole photography. This module, "developed" by members of the CIS recruiting team, lets students as young as eight years old experience traditional chemistry-based imaging in RIT darkrooms.

Student prepares to make an exposure with the pinhole camera.

"The image-forming property of a small hole was first recognized by the ancient Chinese," said CIS Associate Director Joe Pow. "It's a very simple phenomenon to demonstrate, which makes it perfect for introducing younger students to imaging science."

With the help of their science teacher, the students start by getting classroom instruction at their own school on the properties of light and the principles behind the pinhole camera. After that, they go on a field trip to RIT where they can actually see those principles in action.

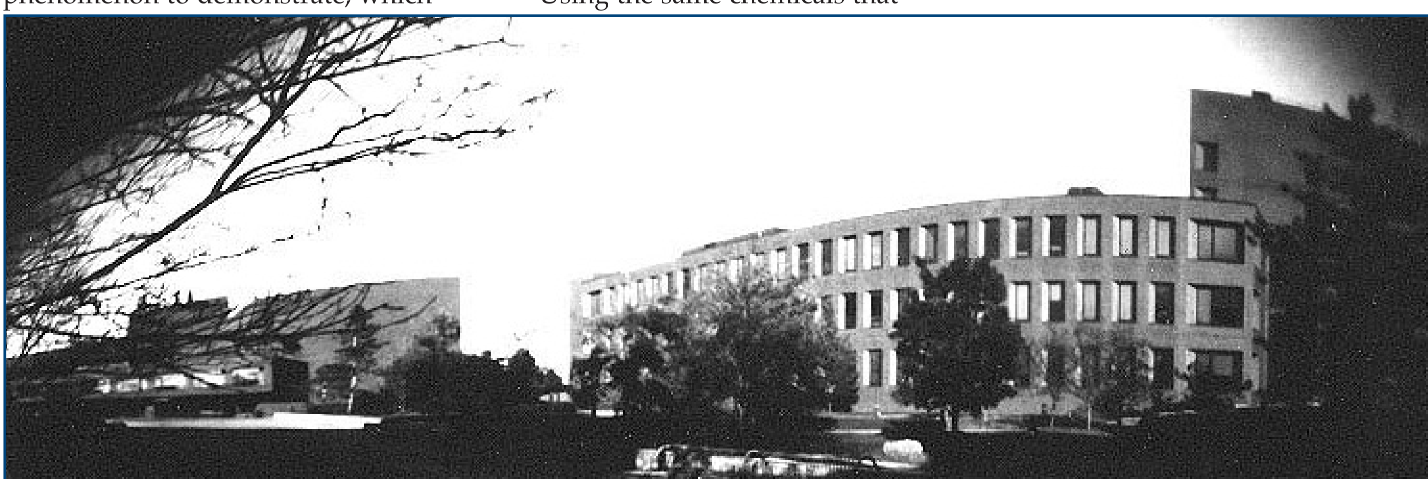
When they arrive at the Carlson building, the students are given their pinhole camera – a simple quart size paint can with a tiny hole drilled in the side. They then proceed to the darkroom where the cameras are loaded with "film" – a single 5-inch by 8-inch piece of black and white photographic paper. The cameras are closed, a magnetic "shutter" is placed over the aperture, and the kids go outside to select a campus scene to photograph.

Depending on cloud cover, exposure times can run from 20-60 seconds, so it's important to find a solid place to set the camera. The image is composed by simply pointing the can in the general direction of the scene to be photographed. When everything is set, the student removes the magnetic shutter from the aperture and counts off the exposure time. The magnet is replaced, and the student returns to the darkroom to develop the print.


Students used CIS darkrooms to develop their pictures.

Using the same chemicals that have been used in black and white photography for years, the students process their paper "film" to produce a negative image. By laying that negative face down on another piece of photo paper, and exposing the two to the light from an enlarger, a final positive image is produced. The resulting pictures are remarkable.

Student reaction to pinhole photography module has been overwhelmingly positive. "You can really feel their excitement when they first see that latent image magically appear on the paper," said Pow. "It's exactly the response we were hoping for." Julia Johnson, a fourth grader at Victor Primary School, said, "I was proud that my very first picture came out really good!" And Becky Allen, another Victor fourth grader, said, "I wish I had a darkroom!"


Pinhole image of RIT's George Eastman building – created and developed by a young photographer.

COS Student Delegate Named

Imaging science major Sally Robinson will represent the College of Science as the student delegate at commencement ceremonies this year.

The student delegate represents the college's graduating class during RIT convocation and is featured speaker at the COS commencement ceremony. Student delegates are selected by faculty and administrators from the college.

A native of Broomfield, CO, Robinson has maintained a near perfect grade-point average. She is an RIT Presidential Scholarship recipient (1998-2002), a Chester F. Carlson Scholarship winner (2000), and a National Merit scholar. Last summer, Robinson was one of eight college students nationwide who spent 12 weeks doing astronomical research at the Kitt Peak National Observatory under the sponsorship of the National Science Foundation's Research Experiences for Undergraduates (REU) Program.

At CIS, she worked with Assistant Professor Elliott Horch on research involving binary stars.

Imaging Science Saturday at RMSC - A Success!

RIT's imaging scientists hit the road March 16 for Science Saturday at the Rochester Museum and Science Center (RMSC), where students, faculty and staff at the Chester F. Carlson Center for Imaging Science manned more than 16 booths and exhibits introducing children to a new world of light. The overview of imaging science included hands-on-activities for children to discover such concepts as color contrast and color separation, remote sensing and remote learning, microgravity, eyetracking, optics, astronomy and medical imaging.

The surrounding pictures are evidence of the fun and excitement had by all!

Imaging Connection is produced by a team of dedicated employees who work with CIS faculty, staff, and students to make this publication possible. Please send comments to managing editor, Colleen M. Desimone at: *desimone@cis.rit.edu* or call 716-475-6783.
Newsletter Team Members: Colleen Desimone, Ian Gatley, Joe Pow, Susan Murphy, Kathy Lindsley, and Tim Gilbert.
Electronic Copies can be found at: ***www.cis.rit.edu***

R·I·T
Rochester Institute of Technology
Chester F. Carlson Center for Imaging Science
54 Lomb Memorial Drive
Rochester, NY 14623-5604

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Naval Research Supports CIS Research

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that understanding to the design of advanced computer vision systems. "Computers are good at many things, but perception isn't one of them yet," says Pelz.

Moving the eyes is a fundamental part of human vision. Peoples' eyes are in almost constant motion, making over 150,000 rapid movements daily. Pelz' eye tracker monitors those movements, displaying on a video monitor exactly where a person is looking. Pelz, who leads the RIT research team, uses this data to study vision in everyday tasks. The wearable eye tracker—Pelz' brainchild—has evolved from an immovable setup of computers, monitors, cameras, eye tracking control unit and video recording equipment to a portable unit that can fit in a backpack.

Jeff Pelz poses in front of the new 50-inch plasma display which will be used for eye-tracking research projects in his laboratory.

For the portable setup, Pelz and graduate student Jason Babcock replaced the eye tracker controller, computers, VCRs and a bulky, fragile headset, with a self-contained system. The controller was replaced by a miniature battery-powered version; the VCRs and monitors were replaced by small digital camcorders, and a palm-sized computer is used to calibrate and set up the system.

The entire system is powered by a bank of light-weight lithium batteries. The major innovation developed at RIT was the new headset that makes it possible to monitor people's eye movements as they are performing everyday tasks in natural environments. Babcock modified the racquetball goggles by installing an infrared-reflecting mirror to illuminate and image the eye, and two micro-miniature video cameras, together weighing less than an ounce.

"We've built a whole system by building one critical piece from scratch—the headgear—and integrating a lot of off-the-shelf equipment," Pelz says. "We didn't invent digital camcorders. We didn't invent the sub-miniature cameras. We integrated them with other components to complement our headgear to support our research."

To meet their needs, the wearable system had to be light and comfortable and resilient enough for the wearer to perform regular tasks. In traditional vision-tracking systems, subjects wear fragile headsets for short periods. While sunshine is still a stumbling point for the eye tracker, the scientists can perform experiments lasting up to an hour, using any indoor part of the world as a lab, Pelz says.

In addition to Babcock, other students in the Visual Perception Laboratory are trained in its use, such as Roxanne Canosa, a graduate student working to improve artificial vision systems. By studying how humans use vision in complex situations, Canosa is designing better vision algorithms for computers. Marianne Lipps, an undergraduate imaging science student working with Babcock and researchers at Eastman Kodak, is using the wearable eye tracker in her research to compare how photographers view scenes before, during, and after taking pictures.

Scientists at the NRL sought Pelz' expertise to design the next generation of wearable eye trackers. Pelz' team will build a new version of the prototype eye tracking system and train researchers at the Naval Research Labs in its use. Together they will collaborate on the next generation of eye trackers — robust, daylight-capable, and wireless — so that even the backpack can be dispensed with.

The RIT/NRL team will conduct a range of visual experiments focused on understanding what strategies people use when searching complex natural scenes. They will begin in the laboratory using traditional eye tracking equipment and a 50-inch plasma display. By the third year of the research project, the team's goal is to perform visual search with the eye tracker in outdoor natural environments.

For more information about Pelz' research, log onto: www.cis.rit.edu/pelz

Career Imaging Scientist Supports CIS

If the Chester F. Carlson Center for Imaging Science had existed when Jerry Hughes arrived at RIT in 1960, he certainly would have studied there. Instead, he majored in what was then called photographic science.

As it turns out, common interests eventually brought Hughes and the Center together. Hughes has become a supporter of CIS students through scholarships, and has funded purchases of equipment. He stays in touch with the Center via the Internet and through visits for the Industrial Associates Meeting and other events. In retirement, his former vocation has remained his avocation. "It's always been an exciting field," Hughes says.

His interest in photography started when he was growing up in San Rafael, Calif. "One morning in 1955," he relates, "I went up Mt. Tamalpais to see if I could photograph the atomic testing in Nevada. I pointed the camera in the wrong direction, but still obtained a pretty good picture of the lit-up sky, which they used in San Rafael's Independent Journal."

Before RIT, he spent six years in the Navy Reserve and regular Navy, and was sent for photographic training in Pensacola, Fla. As the Navy still promises its recruits, Hughes saw the world. Assignments took him to the Middle East via most of Europe, and to the Antarctic and up and down the coast of South America.

"I did photojournalism in the Navy," Hughes says, "but I was always attracted to the technical side of photography." He was able to focus on that interest at RIT. After graduating in 1964, he took a job with Itek Corp. in Lexington, Mass. The company had contracts with NASA, the Air Force, and government intelligence agencies that used satellite imagery for military reconnaissance.

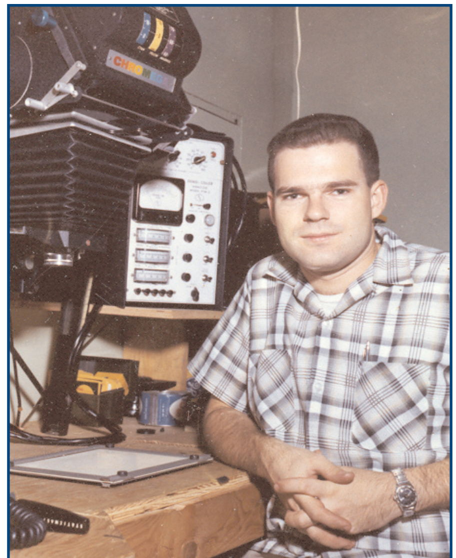
"First we were supporting the U2 (spy plane) program," he recalls, "and later the CORONA Project, which became very big." The top-secret reconnaissance programs were key to U.S. defense during the Cold War era. Today, notes Hughes, people can read all about it on the Internet, or see an exhibit about CORONA – and its Soviet counterpart – at the Smithsonian Institute.

Hughes spent 10 years at Itek (with some time off to sail a boat from Fiji to Australia and a different one from Miami to Boston) and then accepted a job at MTL Corp. in Dayton, Ohio. He moved on to Lockheed Martin Missiles and Space, where he worked 12 years. He did a stint at the Satellite Control Center in Sunnyvale, Calif., before moving into software testing, work that began a new round of world travel.

The traveling has continued since his retirement from Lockheed in the early 1990s. Particularly memorable have been visits to Russia – something his high-security jobs would never have permitted. Through People to People International, a program established by President Eisenhower in 1956, Hughes has traveled to India, Nepal, Tibet, Bhutan, Peru, China, Japan, Uzbekistan and Turkmenistan. As a passenger on a Russian icebreaker, he cruised the Arctic Ocean in 1999.

"We try to go somewhere every year," Hughes says, who currently makes his home in Yellow Springs, Ohio with Martie Jensen, his companion of many years, and their elderly cat, Pancho.

When he isn't traveling, Hughes is busy with a wide variety of interests. He carries a digital camera and a video camera wherever he goes. His computer is on 24/7, and he corresponds via e-mail with people around the nation and the world. He does research online of subjects that interest him – including remote sensing, digital imaging analysis, and image processing.



A young Jerry Hughes, early in his imaging career.

"I never stop studying things," says Hughes. "I may be retired, but my mind isn't."

Attention Alumni

CIS and the RIT Office of Co-op and Career Services need your help.

In an effort to provide current students with useful career planning information the two departments are asking that you please fill out and return the survey included with this newsletter by June 1, 2002. All responses will be kept confidential. The the data will provide students and interested alumni with valuable information on career opportunities in the imaging industry.

If you have any questions about the survey, please feel free to contact CIS Associate Director, Joe Pow, by phone at 585-475-7323 or by e-mail at: *pow@cis.rit.edu.*

Thank you for your help.