

R·I·T



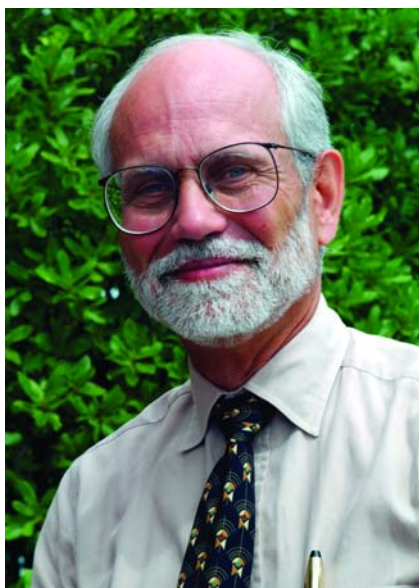
## RIT RESEARCH PROGRAMS 2003 ANNUAL REPORT

ROCHESTER INSTITUTE OF TECHNOLOGY

# RIT RESEARCH PROGRAMS

## “PARTNERSHIPS” AT RIT

### ASSOCIATE PROVOST'S REVIEW



By way of introduction to the RIT Research Programs Annual Report, let me provide a bit of history. RIT began in the 1820s to provide vocational education for local industry, progressed to undergraduate education in the 1960s, and now in its third century offers graduate education with two cross-disciplinary Ph.D. programs. Our partnerships span all areas of the United States as well as European and Asian industrial and government agencies. Soon to celebrate its 175th anniversary, RIT is nevertheless a relatively new research player. Having taken a major step in that direction only five years ago, we are particularly proud of our accomplishments in that period of time. Our research focus is in line with RIT's tradition of industrial partnerships, experiential learning, and applied research and education in emerging technologies. RIT's mission is focused on developing its students for careers over a lifetime.

As an example of our partnership approach, in the early 1900s, C. B. Neblette, a Kodak researcher, began teaching part time at the then Mechanics Institute and eventually persuaded his management that he should work full time to establish a College of Photographic Technology. 100 years later, we have the leading photography program in the nation thanks to that collaboration. Over that same time, Eastman Kodak has hired more than 12,000 graduates and co-ops from RIT to the benefit of all.

Our co-op program began in 1912 and is a key to RIT experiential education and the starting point for many of our industry partnerships. RIT now has the fourth oldest and one of the largest co-op programs in the world, annually placing 2,600 students in co-op positions with 1,300 employers. Many of these students find their first post-graduate employment with companies that first hired them for a co-op assignment.

In 1998 President Albert Simone created the First in Class program to invest in emerging technologies that would strengthen RIT's ties to industry and government partners. His vision was expressed as: "RIT intends to be first in that class of universities that forms real, effective and meaningful partnerships with industry and government." With support of First in Class investments, RIT is creating emerging technology research and education programs that respond to our partners' strategic directions. These programs create a positive return for our partners, ensuring their competitiveness while adding to the value and uniqueness of an RIT education. Through First in Class we develop with our partners:

- Applied research in emerging fields
- Targeted education programs
- New facilities and capabilities

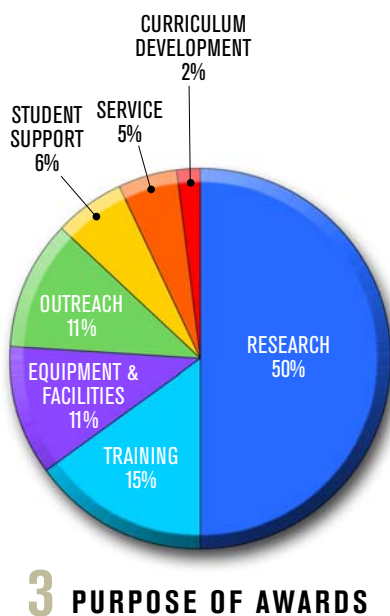
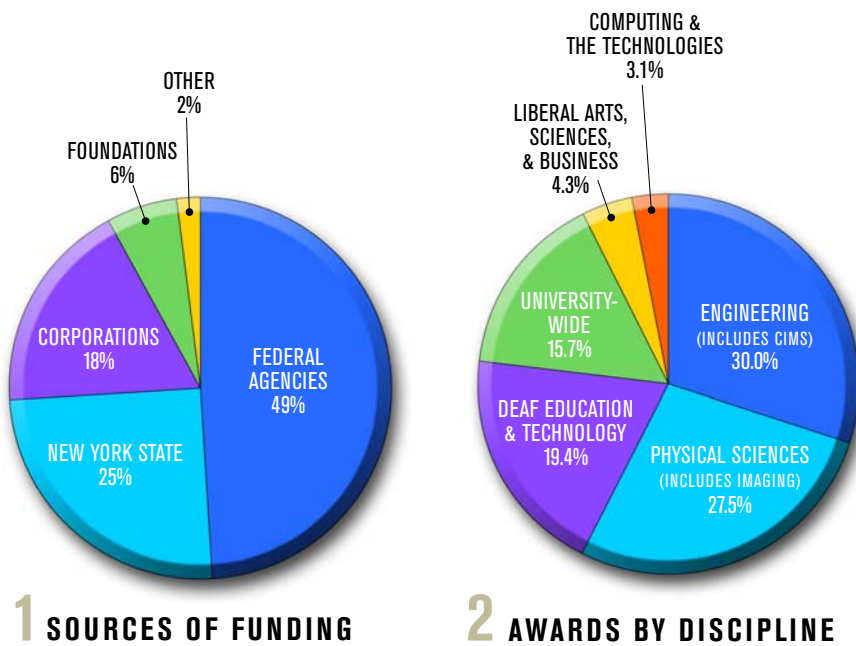
The theme of this year's report is "Partnerships at RIT." The feature story is on the establishment of the *IT Collaboratory*, a NYSTAR\*-designated Strategically Targeted Academic Research (STAR) Center involving collaboration among university and industry research teams. We have also highlighted results achieved through partnerships in key research programs that cut across our eight colleges and many academic and research centers. I hope that our 2003 Report whets your appetite to learn more about RIT's research programs, collaborating laboratories, and partnership opportunities.

**Donald L. Boyd**

*Associate Provost for Outreach Programs  
Director of First in Class  
[www.rit.edu/apop](http://www.rit.edu/apop)*



## RESEARCH FINANCIAL SUMMARY



All figures represent a five-year total of awards (1998-2003).

### 1. Sources of Funding

Since the establishment of the grants and contracts office in 1998, over \$109M in externally funded sponsored research and outreach has been awarded to RIT. The federal government has been the largest funder, with major sponsorship provided by the Office of Naval Research, the National Science Foundation, the National Institutes of Health and the National Imagery and Mapping Agency. New York State has supported the growth of research at RIT through the New York State Office of Technology and Academic Research and New York State Energy Research and Development Authority, among other agencies. Corporations have also played a major role including Eastman Kodak Company, Xerox Corporation, Hewlett Packard, Canon, and many others with active collaborative research programs underway.

### 2. Awards by Discipline

RIT is a worldwide leader in engineering, imaging science, and deaf education. Engineering, which includes the Center for Integrated Manufacturing Studies, RIT's leading industry research collaborator, works with manufacturers to increase their competitiveness through innovative technology deployment. In the physical sciences, the Chester F. Carlson Center for Imaging Science, a world leader in remote sensing technology and color science, with the College of Imaging Arts and Sciences collaborates with private and public sector partners to advance the fields of imaging and printing. Since 1968, the National Technical Institute for the Deaf's groundbreaking research on deaf education and technology development has advanced communications and education for the deaf and hard-of-hearing.

### 3. Purpose of Awards

Externally sponsored funding for research has remained at 50% of all funding since 1998. Over this five-year period, overall sponsored funding has increased dramatically to over \$30M annually. Research funding is increasingly important in supporting the growing number of master's and Ph.D. programs and students and in funding research conducted in centers and laboratories across the campus. At the same time, faculty have expanded their expertise in writing successful peer-reviewed proposals. Also important at RIT are training and outreach activities, the next largest purpose for RIT-sponsored work. This mix of education, research, and outreach is in keeping with RIT's 175-year history of partnerships with the community, industry and government.

# RIT RESEARCH PROGRAMS

## FACULTY RESEARCH AND SCHOLARSHIP

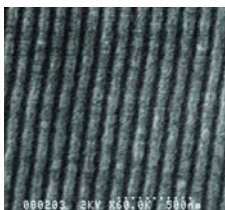


Laser photo courtesy of the Institute for Lasers, Photonics and Biophotonics—University at Buffalo.

### IN THE SPOTLIGHT: The IT Collaboratory

The IT Collaboratory is an RIT-led research consortium of collaborating laboratories, including the University at Buffalo's Institute for Lasers, Photonics and Biophotonics, the NY State College of Ceramics at Alfred University, and RIT Laboratories addressing nanomaterial science, microsystems, photonics, remote sensing systems, and other information technologies. Work at RIT includes microsystems engineering (micro-

### Immersion Lithography Pioneering

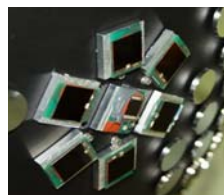
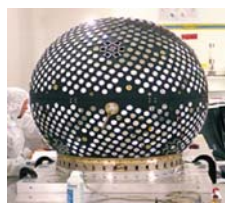


A SEM micrograph of 50nm photoresist images produced using a 193nm wavelength ArF excimer laser.

Professor Bruce Smith is pioneering micro- and nano-lithography research to shrink semiconductor and related device geometry toward nanometer levels. By pushing the

limits of optical imaging, his group carries out the fundamental studies required to meet the needs of semiconductor technology for five to ten years into the future. Current projects include the use of ultraviolet and vacuum ultraviolet excimer laser sources combined with modified illumination, phase shift masking, and liquid immersion imaging to achieve small feature resolution  $\frac{1}{5}$  the size of the exposure wavelength (and  $\frac{1}{15}$  the wavelength of visible light). Research is supported by various industrial, government, and university partners. Professor Smith's research has resulted in the modification of the 2005-2010 lithography projections of the International Technology Roadmap for Semiconductors (ITRS).

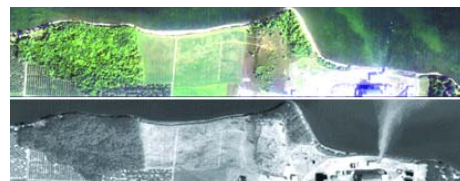
### Nanopower Research at RIT



The Starshine 3 satellite being prepared for launch and detail of the Integrated Power supply deployed.

The NanoPower Research Labs under the direction of Dr. Ryne P. Raffaele, Physics, and Dr. Thomas Gennett, Chemistry, have been working with the NASA Glenn Research Center on the development of next-generation power devices. Their work is focused on the use of nanomaterials (i.e., single wall carbon nanotubes and quantum dots) in devices such as high specific power lithium ion batteries, proton exchange membrane fuel cells, and thin film polymeric solar cells. Recently they helped develop an integrated power system for the Starshine 3 satellite which was launched by NASA to help study the Earth-Sun connection in regards to drag in the upper Earth atmosphere.

### Digital Imaging & Remote Sensing Group



Satellite images at different wavelengths reveal details of scenes not available in single spectra images.

The Digital Imaging and Remote Sensing group (DIRS) at RIT,

led by Dr. John Schott in the Chester F. Carlson Center for Imaging Science, is focused on the capture, processing, and presentation of remotely sensed data that may be used in a variety of applications. An area of specific research is spectral remote sensing, which involves the interrogation of the electromagnetic spectrum in discrete wavelength bands and the integration and interpretation of this multi-spectral data. Numerous projects in applying the DIRS technology are underway including:

- FIRES Research Project [NASA]—research into the fundamental phenomenology of wildland fires
- Wildfire Airborne Sensor Program (WASP) [NASA]—development of an advanced airborne wildland fire detection sensor
- Physics-based Hyperspectral Algorithm Development Program [Office of Naval Research]—development of new approaches for processing hyperspectral sensor data

fabrication, design, analysis, test, packaging, and integration), applied sciences (materials, sensors, biotechnology, and photonics), imaging sciences (digital imaging, remote sensing, spectral analysis, integration) and applied computing. The IT Collaboratory was established with a \$14M capital facilities grant in 2001 from the New York State Office of Science, Technology, and Academic Research (NYSTAR) to form a Strategically Targeted Academic Research (STAR) Center. The grant is used to increase the capabilities of these

laboratories with new equipment and facilities.

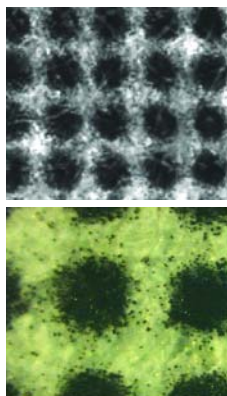
The mission of the IT Collaboratory is to create key technologies, knowledge, and capabilities to design and integrate next generation information technology systems with two strategic focuses:

- enabling the emerging technologies of photonics, microsystems and nanomaterials
- integrating remote sensing system applications

*"Capabilities enable applications; applications demand improved capabilities."* Dr. Donald L. Boyd

Using our experience in building imaging systems that capture, process and transmit remotely sensed data, we apply microsystems and photonics to create a novel class of IT systems call Integrated Remote Systems. Using new technologies and capabilities for designing, fabricating and integrating microsystems with new sensors,

### Halftone Algorithm Research



SEM photographs of ink dispersion used in optimizing print quality.

Dr. Peter Anderson of the Laboratory of Applied Computing at the Golisano College of Computing and Information Sciences with Dr. Jonathan Arney of the Chester F. Carlson Center for Imaging Science are collaborating with Hewlett

Packard and Purdue University to improve printer output quality. The research applies genetic algorithm techniques to identify optimal fit algorithms for half tone production and applies quantitatively predictive models of the intrinsic non-linear characteristics of the printing processes. To achieve such models, new techniques are being developed to measure physical and optical characteristics of printed samples on a micro-scale. A new technique of micro-densitometry has been developed that provides a quantitative map of the micro-distribution of toner mass on printed samples. Work with HP has lead to several breakthroughs and patents in the application of half tone image compression.

### Printing Industry Center



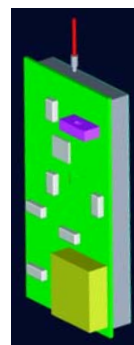
Print applications research is conducted to improve printing industry competitiveness.

Photo courtesy of Marten Czamanske Photography

Dedicated to the study of business environment influences in the printing industry brought on by new technologies and societal changes, the Printing Industry Center addresses the printing industry's concerns

through applied research and educational outreach. Directed by Frank Cost, from the College of Imaging Arts and Sciences, and Patricia Sorce, from the College of Business, the Center was selected by the Alfred P. Sloan Foundation to become a Sloan Industry Center. The center is also supported by 15 leading industry firms including Heidelberg, Xerox, HP Indigo, IBM and Adobe—a testament to RIT's long history of excellence in and commitment to graphic arts education and research. Recent research on digital printing identified and communicated four critical business strategies of companies successful in adopting digital printing technology.

### Optoelectronics Packaging Research



A computer model of an integrated optical/electrical device.

RIT's Center for Electronics Manufacturing and Assembly (CEMA), led by S. Manian Ramkumar, in collaboration with ASE Instruments Inc. and the Infotonics Technology Center Inc., are researching the optoelectronics packaging process and the integration of electronics and free space optics onto a single substrate. The research is focused on the

characterization of assembly materials, substrates and processes for packaging that combines optics and electronics into integrated devices. A key objective is to investigate the use of the existing surface mount technology assembly equipment to accomplish passive alignment of optics. The outcome of this research will be the development of an Optical Channel Monitor (OCM) to study the infrared signal characteristics of these integrated devices. Recently we have developed a unique packaging scheme for the InGaAs array sensor, for ease of assembly and reduced cost.



algorithms and system structures, we design and build the next generation of remote sensing systems. These two themes drive one another—capabilities enable applications; applications demand improved capabilities.

By combining complementary expertise and experience of the collaborating universities, industries, and agencies, the IT Collaboratory will generate the innovative technologies, skills and applications that will result in creating new businesses, stimulating new

products, and generating economic growth in New York and beyond.

Since November 2001, the partners of the IT Collaboratory have engaged in 36 research programs valued at \$20M from 11 federal agencies, three industry research consortiums, and 11 corporations. Researchers of the IT Collaboratory have been awarded five patents and have filed 14 patent disclosures.

Visit us online at [www.rit.edu/ITColl](http://www.rit.edu/ITColl).

RIT performs applied research and outreach

### Imaging Science

- Chester F. Carlson Center for Imaging Science
- Laboratory for Advanced Spectral Sensing
- Laboratory for Image Algorithms and Systems
- Laboratory for Sensor Research
- Munsell Color Science Laboratory

### Community and Economic Development

- RIT High Tech Incubator
- Northeast Neighborhood Alliance
- National Technology Training Center
- Upstate Alliance for Innovation

### Environmental Effects on Literature Archives



Archive monitor and analysis system applied to collection preservation.

The Image Permanence Institute (IPI), under the leadership of Director James M. Reilly, in RIT's College of Imaging Arts

and Sciences, has developed and successfully field-tested revolutionary approaches for assessing the effect of storage environments on library, archival, and museum collections. Consisting of new hardware for data gathering as well as software incorporating novel analysis algorithms, IPI's technology is now in use in hundreds of US cultural institutions, including the Library of Congress, the National Archives, and the Metropolitan Museum of Art. Most notable is the ability of the IPI software to quantify the rate of decay of organic materials and to predict the likelihood and severity of mold growth. Development of this technology was supported by the National Endowment for the Humanities, the Institute for Museum and Library Services, and the Andrew W. Mellon Foundation.

### International Center for Hearing and Speech Research



Hearing research underway to address early onset hearing loss.

Dr. Robert Frisina leads the International Center for Hearing and Speech Research at RIT. This center, funded by the National Institute for Health, conducts multidisciplinary biomedical research on hearing, speech and deafness by linking interests of

the National Technical Institute for the Deaf at RIT with those at the University of Rochester's School of Medicine and Dentistry, and other universities including SUNY Buffalo and Syracuse. This program on aging focuses on the auditory system as a probe to the central nervous system. Its immediate goal is to characterize and to determine the neural and genetic bases for hearing loss with the ultimate goal being to prevent, arrest, and/or reverse hearing loss or deafness at any age.

### Systems Modernization & Sustainment



Field deployment of a prognostic sensor system.

The Systems Modernization & Sustainment Center led by Dr. Nabil Nasr, CIMS Director, has been working with the Office of

Naval Research, the Marine Corps Systems Command and the Naval Air Systems Command on asset health management and material and structural aging, using RIT's Life-Cycle Engineering and Economic Decision Systems (LEEDS™). The center developed diagnostic and prognostic indicators and data compression protocols for configuring critical light armored vehicle and humvee data, including prototype optical and radio frequency transmission devices. The center also developed analysis techniques for material stress, fatigue and fracture modes leading to a structural analysis of key EA-6B aircraft flight control components and redesign of these sub-systems, enhancing flight safety and extending airframe life. Diagnostic and prognostic algorithms and key life-cycle indicators are under development for Navy shipboard application in the LEEDS™ system, which will lead to improved condition assessment, life-cycle management and lower total ownership costs.

## Laboratories and Research Centers at RIT

in partnership with industry and government in a number of fields and from a number of laboratories and centers:

### Microsystems Technology

- Nanopower Research Laboratory
- Semiconductor and Microsystems Fabrication Laboratories
- Center for Electronic Manufacturing and Assembly
- RF/Analog/Mixed Signal Laboratory
- Thermal Analysis and Microfluidics Laboratory

### Printing and Graphic Media

- Printing Industry Center
- Printing Applications Laboratory
- Image Permanence Institute

### Center for Integrated Manufacturing Studies

- National Center for Remanufacturing and Resource Recovery
- Center for Excellence in Lean Manufacturing
- Systems Modernization and Sustainment Programs
- Sustainable Systems Research Center
- Manufacturing Technologies Program
- Imaging Products Laboratory

### Computer and Information Sciences

- Laboratory for Applied Computing

### Biotechnology

- Laboratory for Evolutionary and Comparative Genomics
- Center for Biotechnology Education and Training
- International Center for Hearing and Speech Research

### Multidisciplinary Centers

- Center for Quality and Applied Statistics
- The IT Collaboratory
- Center for Multidisciplinary Studies

## Northeast Neighborhood Alliance



Northeast Neighborhood representatives and RIT students meet to review results of an entrepreneurial program on urban gardens.

With the support of a three-year grant from the Corporation for National and Community Service, RIT has established a partnership with the Northeast Neighborhood Alliance, a citizen-driven planning initiative serving three

Rochester neighborhoods. Over the past three years, more than 250 RIT faculty, students, staff and community members have worked on projects that have furthered economic development in these neighborhoods. Projects have included business plans for the neighborhood urban agriculture initiative, photos and writing for the neighborhood news magazine, design plans for building renovation, and data collection and land use maps for neighborhood redevelopment using geographic information systems (GIS) technology.

## Project Lead The Way

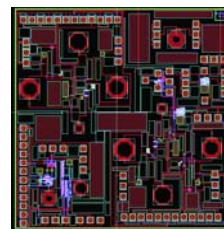


Middle School technology teachers from around the nation learn new techniques in computers and robotics.

RIT's National Technology Training Center, under the leadership of Director Guy Johnson, has joined Project Lead the Way, Inc. (PLTW), a not-for-profit organization that promotes pre-engineering courses for high school students. The program's mission is to create dynamic

partnerships with the nation's schools to prepare a more numerous—and more diverse—group of students to pursue technology degree programs. The PLTW program has expanded to 640 schools in 413 school districts in 38 states. RIT oversees a college credit program in which students' PLTW courses can be counted as transcripted credit, giving them a head start on an engineering-related degree program leading to a career in a technology field.

## RF/Analog/Mixed Signal Research



RF Integrated Circuit for the front-end of a GHz range receiver.

The RF/Analog/Mixed Signal Laboratory (RAM-LAB), under the direction of Dr. P.R. Mukund, professor of electrical engineering, conducts research in design method-

ologies for RF, analog and mixed signal circuits. The National Science Foundation (NSF), the Semiconductor Research Corporation (SRC), the Microelectronics Design Center (MDC), Harris Corporation and several industrial partners fund research at RAMLAB. NSF-SRC funds research in integration of the chip and package into a single design unit—the chip-package co-design (CPD). CPD includes design of “package-aware” RF and mixed signal circuits, characterization of package parasitics and their mutual dependencies. In the analog-mixed signal area, a current mode CMOS Imager Array was designed to have a marked improvement over its voltage mode counterpart. MDC and Harris Corporation has funded RF research at RAMLAB in the form of a RF front-end wideband amplifier design for next generation radios for military applications.

# RIT OVERVIEW



## First in Class



First in Class is an RIT strategic initiative to invest in emerging technologies that will provide our partners, students, faculty and the community with the technology to be successful in a rapidly changing world.

### Through First in Class, RIT:

- Creates education and research programs in emerging technologies
- Prepares our graduates with tools they need for successful careers in these fields
- Supports our partners with technology, resources and people they need to remain competitive
- Fosters economic growth by creating the workforce of the future

### RIT's First in Class concentrations are:

- Imaging Systems
- Computing and Information Sciences
- Microsystems Technology
- Sustainable Design
- Biotechnology and Bioinformatics
- Printing and New Media

More information on the First in Class program can be found on our Web site at [www.rit.edu/firstinclass](http://www.rit.edu/firstinclass) or by contacting:

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## RIT at a Glance

- Founded in 1829 and emphasizing career education, RIT is a privately endowed, coeducational university.
- The campus occupies 1,350 acres in suburban Rochester, the third largest city in New York State.
- The RIT student body consists of more than 15,000 full- and part-time undergraduate and graduate students in 360 career-oriented programs.
- Enrolled students represent all 50 states and 90 countries.
- RIT alumni number more than 85,000 worldwide.
- Cooperative education provides career-related work experience in many degree programs, annually placing 2,600 students in co-op positions with 1,300 employers.

- The *U.S. News & World Report: America's Best Colleges* 2004 survey ranked RIT seventh overall in Master's level universities in the north and second in academic reputation while also ranking RIT in the top 10 "best value" schools in this class.

### RIT is home to eight colleges

- College of Applied Science and Technology
- College of Business
- Kate Gleason College of Engineering
- B. Thomas Golisano College of Computing and Information Sciences
- College of Imaging Arts and Sciences
- College of Liberal Arts
- National Technical Institute for the Deaf
- College of Science

