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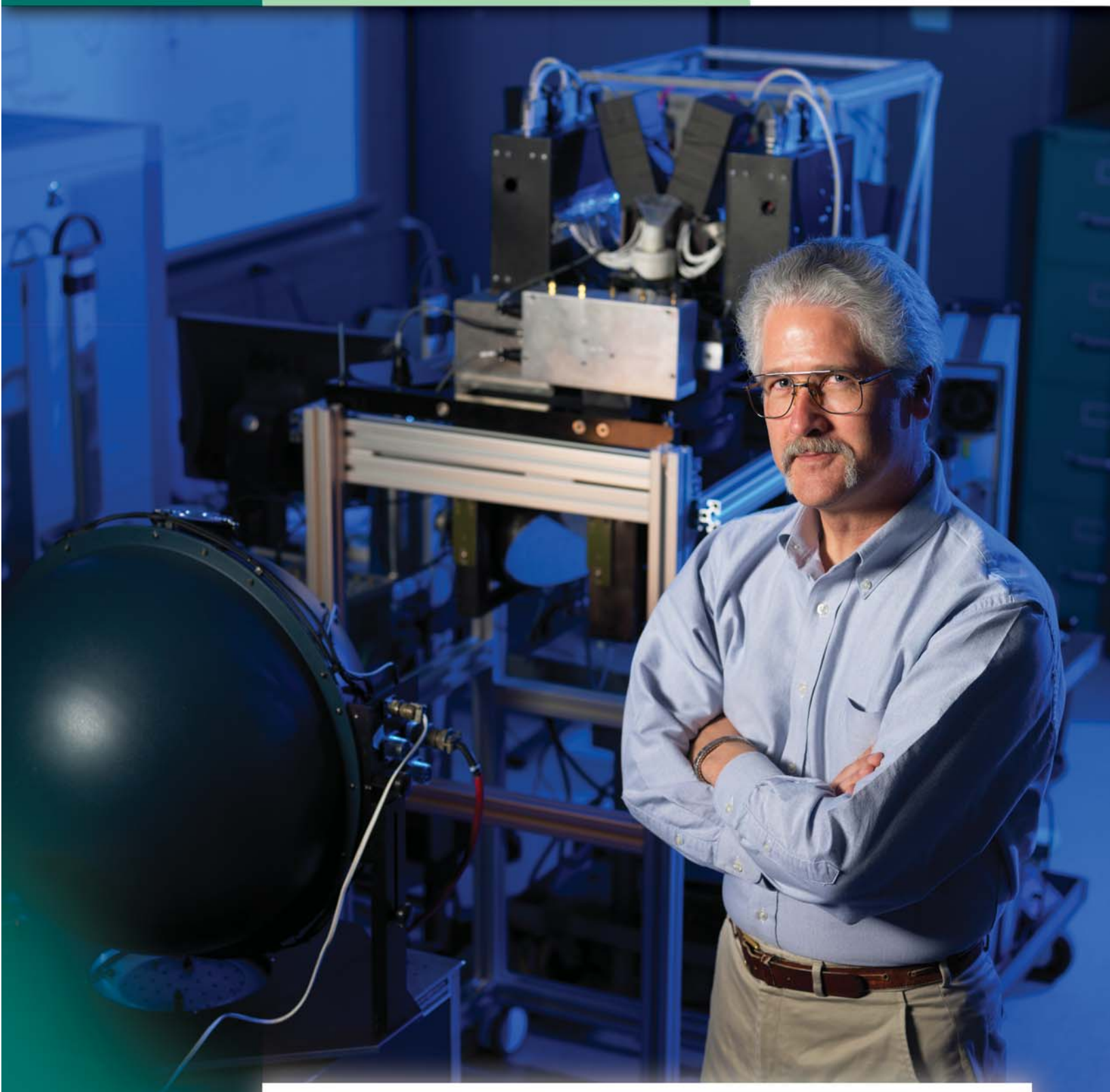
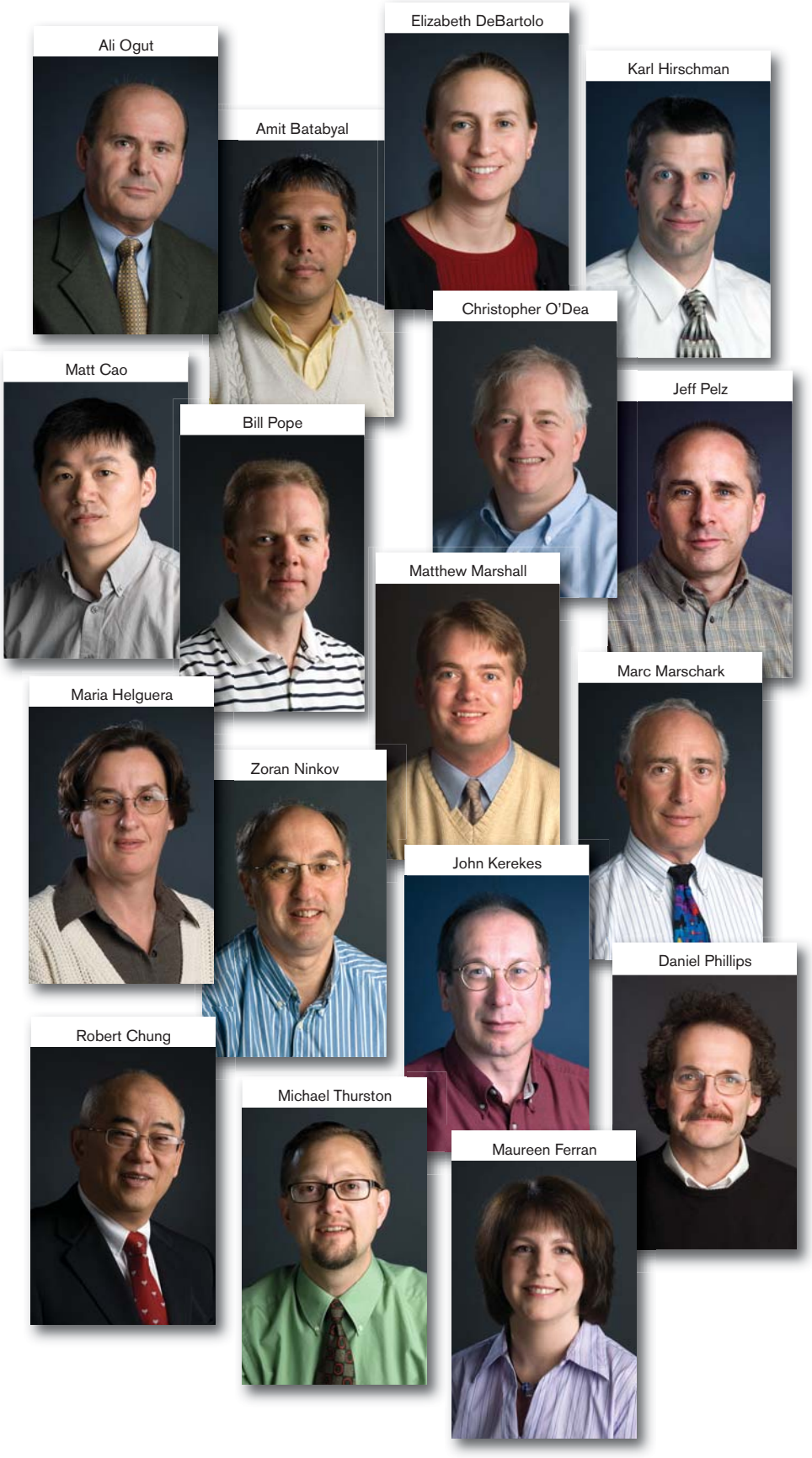


RIT RESEARCH PROGRAMS 2006 ANNUAL REPORT

ROCHESTER INSTITUTE OF TECHNOLOGY

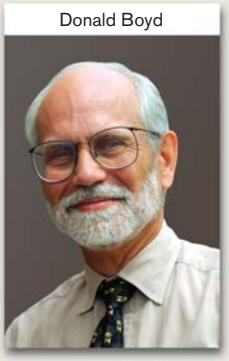
RIT RESEARCH PROGRAMS

SCHOLARSHIP



VICE PRESIDENT FOR RESEARCH REVIEW

Research Results at RIT



The obvious reason for any individual or team to engage in research is to achieve results that push the boundaries of knowledge and understanding in the subject area under investigation. However, in the university setting, achieving scientific results is only one reason for conducting research. At RIT, we expect the results of our research to benefit the university, its students and faculty, the public, and our sponsors. Dr. Arden L. Bement, Jr., Director of the National Science Foundation, said, in a recent testimony at a Senate Committee hearing on the Importance of Basic Research to U.S. Competitiveness*, "To realize our [NSF] mission, we see to it that each of our investments builds intellectual capital, integrates research and education, and promotes partnerships."

Similarly, at RIT, we expect our research to push the frontiers of knowledge, to enrich the student learning experience, to enhance the curriculum, build faculty scholarship and provide a return to our partners. When students are engaged in hands-on research, they get "hooked on research," which in turn enhances their curiosity and motivates their continued learning. Dr. Bement goes on in his Congressional testimony to say, "By providing students with significant research experiences throughout their schooling, the

continued →

←*from inside cover*

world-class scientists, technologists, engineers, and mathematicians trained in this way can transfer new scientific and engineering concepts from universities to the entrepreneurial sector as they enter the workforce."

Research leadership and reputation are key factors in attracting and retaining the best students and faculty, and in turn, provide the basis for increased partnership with industry, government, and other universities. Such partnerships become the fuel for growth in further research, infrastructure development, and in career opportunities for our graduates. To help achieve these partnerships, RIT created the First in Class program in 1999 with the mission to be first in the class of universities that achieves real, effective, and meaningful partnerships with industry and government. This means providing a positive return to our partners as well as to ourselves. Those returns are measured in technology, innovations, solutions, and most importantly, graduates ready to contribute.

The accompanying charts depict the past five years (2002-2006) of research expenditures at RIT and represent more than $147 million of externally sponsored scholarship and research. This year's totals reflect a continuing trend in the growth of federal funding for sponsored projects measured both in dollars and percentage of the total. While RIT's support from private sources (corporations and foundations) remains constant, funding from state sources has declined. Funding by discipline remains constant with Engineering and the Physical Sciences (including Imaging Science) continuing as RIT's leading research areas.

Looking at the mix of spending by purpose demonstrates the growing focus at RIT on research and student support with those categories growing, offsetting decreases in instruction (including training) and outreach.

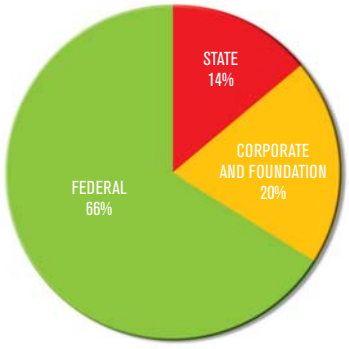
In the spotlight for the 2006 Annual Report is an RIT research pioneer, Dr. John Schott, who has been conducting leading research in Remote Sensing for more than 20 years. Also featured this year are research briefs from 17 of our leading faculty researchers in Microsystems, Imaging Science, Astrophysics, Computing & Information Sciences, Access & Learning Technology, Biosciences, Packaging, and Sustainable Systems. You can see their portraits on the facing page and their stories inside. They tell how their research results are providing positive returns for our research sponsors, enhanced learning for our students, and advancement of the state of the art in their fields.

I encourage you to review these stories and contact us to become your research partner.

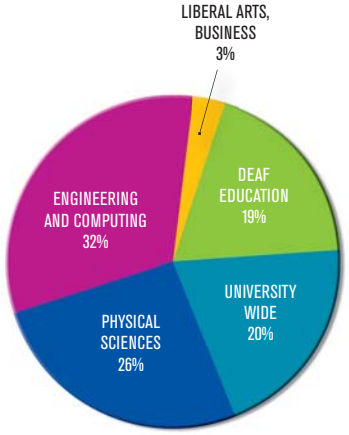
Best regards,

Donald L. Boyd, Ph.D.
Vice President for Research

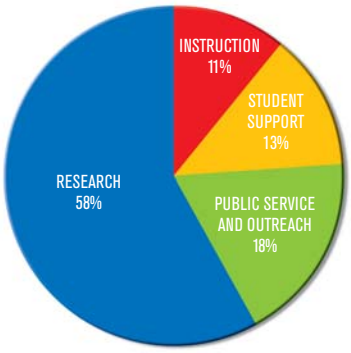
**March 29, 2006 testimony to the Senate Commerce, Science & Transportation Subcommittee on Technology, Innovation, and Competitiveness.*



SPENDING BY SOURCE



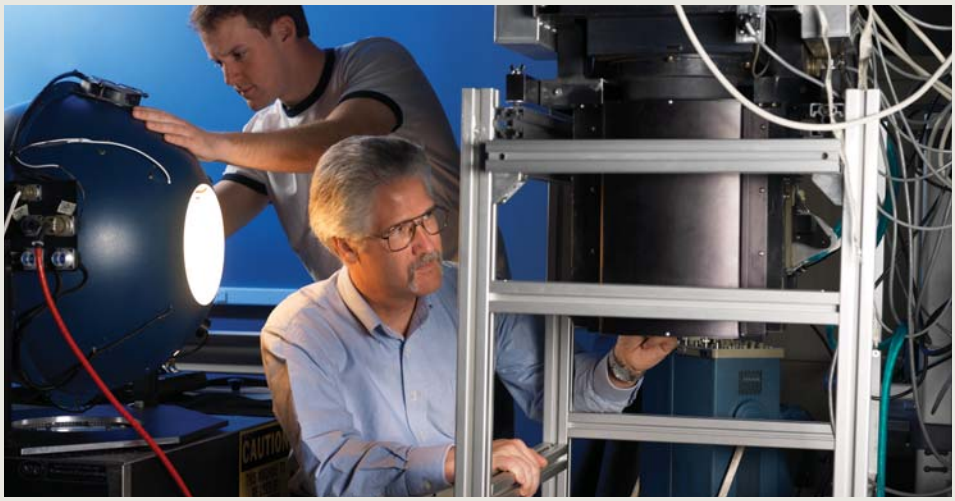
SPENDING BY DISCIPLINE



SPENDING BY PURPOSE

RIT RESEARCH PROGRAMS

FACULTY RESEARCH AND SCHOLARSHIP

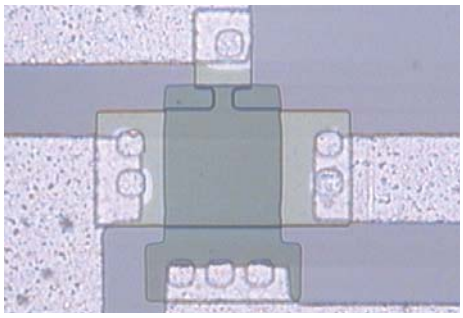


Dr. John Schott with Ph.D. student Brian Daniel in the Digital Imaging and Remote Sensing Laboratory

IN THE SPOTLIGHT:
Digital Imaging & Remote Sensing Laboratory

Dr. John Schott, Professor of Imaging Science and Director of the Digital Imaging & Remote Sensing (DIRS) Laboratory at RIT is one of the pioneers of space-based digital imaging and has played a leading role in establishing RIT as a premier research center for remote sensing applications. For this year's spotlight story on RIT research we asked John to describe the creation and evolution of the DIRS laboratory and the evolving nature of space-based imaging:

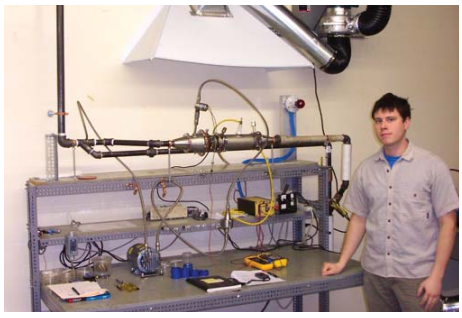
Transistors on Glass



A thin-film transistor (TFT), made on Corning's new substrate material

Dr. Karl D. Hirschman, Associate Professor in Microelectronic Engineering in the Kate Gleason College of Engineering and his students, are engaged in a project sponsored by Corning, Inc., exploring the fabrication of thin-film transistors (TFTs) on a new glass substrate material. The goal of the project is to develop a low temperature process that can realize high-performance TFTs on glass, and to establish the performance potential of the new material. This material and process are projected to have a major impact on the flat panel display industry allowing the integration of electronic circuitry on display glass substrates. The project utilizes RIT's unique microfabrication capabilities at the Semiconductor and Microsystems Fabrication Laboratory (SMFL) which has a complete toolset for transistor fabrication and can accommodate non-traditional substrate materials.

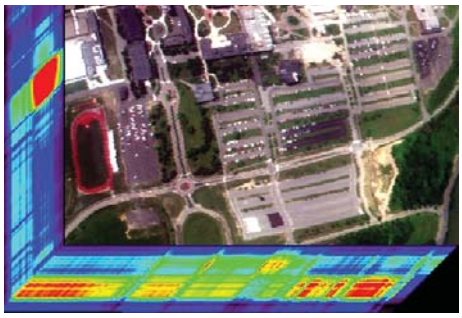
Diesel Emissions Particulate Trap



Mechanical Engineering student Joseph Pawelski with the self-regulating particle trap test bench

Dr. Ali Ogut, Professor in the Mechanical Engineering Department of the Kate Gleason College of Engineering, has developed a self-regenerating particulate trap for diesel emissions under a grant from New York State Energy Research and Development Authority (NYSERDA). The particulate trap relies on high voltage ionization (oxidation) of soot to create treatable exhaust gases, thereby reducing particulate emissions while not creating exhaust back-pressure as filter-based technologies would. RIT's Technology Licensing Office has signed an agreement with Environmental Energy Technologies (EET), Inc., an RIT spin-off company, to deploy this technology as retro-fits on vehicles such as school buses and heavy-duty utility trucks to meet new Environmental Protection Agency (EPA) diesel emission regulations taking effect in 2007.

Imaging for Automatic Target Recognition

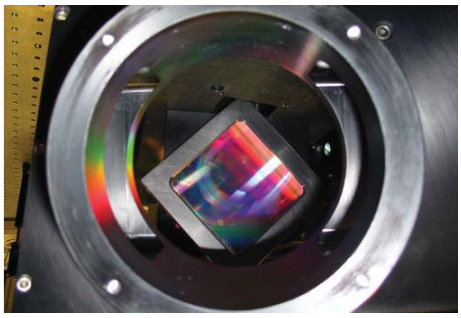


A "hypercube" image of the RIT campus used in vehicle tracking experiments

Dr. John Kerekes in the Chester F. Carlson Center for Imaging Science studies hyperspectral imaging systems and how they can be used for environmental, defense, and homeland security applications. These airborne or space borne cameras collect images in hundreds or thousands of spectral bands, creating a "hypercube" of image data extending from the visible through the thermal infrared. Currently, Dr. Kerekes is working with the Air Force Research Laboratory's Sensor Directorate under a Revolutionary Automatic Target Recognition and Sensor Research (RASER) grant. The goal of this project is to investigate if hyperspectral imagery can be used to track ordinary vehicles in a cluttered urban environment. Using imagery collected by RIT's Modular Imaging Spectrometer Instrument (MISI), the project has demonstrated the feasibility of autonomously tracking a specific vehicle from image to image.

One of the first research contracts the remote sensing group at RIT took on was to fly an aerial infrared line scanner underneath NASA's Landsat 4 spacecraft and check out the calibration of a new satellite imaging system called the Thematic Mapper (TM). This was in the early 1980s and the RIT airborne sensor was a Vietnam War era single channel line scanner that came to RIT as surplus from an industrial lab. Much has changed over the 20 years since then. The Digital Imaging and Remote Sensing (DIRS) Laboratory's research activities have grown from one or two contracts to tens of programs at any given time. These programs support a range of sponsors encompassing defense, intelligence, civilian space, and commercial remote sensing. The research group has grown from a handful to nearly 50 faculty, staff, and students. As much as the lab changed, some things haven't changed: NASA still takes delicate electro-optical instruments and subjects them to a rocket launch and then must see that they continue operating properly, gathering critical environmental data from space. The RIT team continues to support NASA by validating and updating the calibration of these instruments. Today the RIT team is using the Modular Imaging Spectrometer Instrument (MISI, shown on the cover and in the picture of this story) they designed and built to perform these tasks. It is flown in an airplane at 10,000 feet under the Landsat 7 satellite to calibrate NASA's most advanced sensor system. This calibration research also is attempting to establish a 20-plus-year record for the Landsat 5 TM sensor. The Landsat 5, which had a 5-year design life, has been operating successfully since 1985. The growth of the remote sensing activities at RIT has made Landsat calibration a much smaller portion of the DIRS research portfolio, at the same time maintaining the integrity of the data from these space instruments is increasingly important as investigators all over the globe turn to the 20-year history of Landsat image records to study global climate processes.

Multi-Object Spectrometer



View of the Digital Micromirror in the Multi-Object Spectrometer

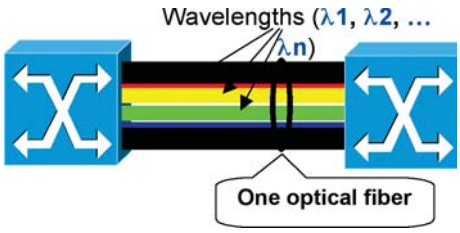
Dr. Zoran Ninkov of the Center for Imaging Science in the College of Science carries out research in the development of new spectroscopic and astronomical imaging sensor systems. In a recent project sponsored by the New York State Office of Science, Technology and Academic Research (NYSTAR) and ITT Industries, Dr. Ninkov's research has led to the design and commercialization of a flexible multi-object spectrometer (MOS). This instrument uses an off-the-shelf Digital Micromirror Device (DMD) as the heart of the imaging system. Dr. Ninkov's team discovered that replacing the fiber-bundles and positioning systems found in conventional MOS designs with a DMD provides for a lower parts-count, less complex, lower power, lighter weight, and more adaptable system. The device will see use in remote sensing, microscopy, and astronomy instruments.

Astrophysical Imaging

Spitzer infrared image showing the bright nucleus in the center of an active galaxy

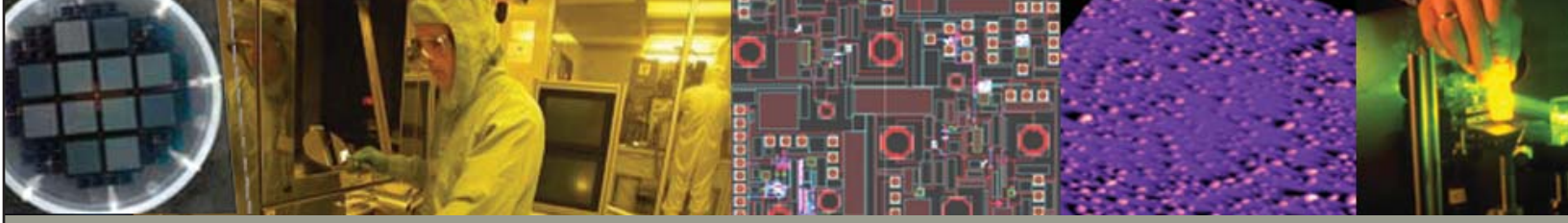
Dr. Christopher O'Dea of the Physics Department in the College of Science is studying "active" galaxies in the local universe. Galaxies become active when gas in the galaxy is attracted by the massive black hole in the center and forms a hot and very bright disk around the black hole. The view of these central regions is often blocked at visible wavelengths by cosmic dust in the galaxy. Dr. O'Dea is using infrared imaging and spectroscopic observations from NASA's Spitzer Space Telescope to see through the dust and probe the structure of the regions around the black hole. Using this data, Dr. O'Dea has proposed a new classification scheme for the infrared spectra of these galaxies and ruled out one class of models for the structure of the inner galaxy. This research is funded by the NASA Jet Propulsion Laboratory.

Switching Framework for Optical Networks



Wavelength-Division Multiplexing Architecture

Dr. Xiaojun (Matt) Cao from the Golisano College of Computing and Information Sciences has won a prestigious National Science Foundation Career Award for his research focusing on the design of multi-granular switching frameworks for optical networks. This technique is being developed to meet the huge bandwidth demand generated by the explosion of network traffic and uses wavelength-division multiplexing (WDM) technology to divide fiber bandwidth into a large number of wavelengths which use an individual wave of light to transmit data. By comparison, current optical networks are costly to install, maintain and interconnect, and do not use optical technology to its fullest potential. Dr. Cao's research investigates the development of a new switching framework to offer higher margin services while reducing the complexity, cost, and size of both electronic and optical switches.



LABORATORIES AND RESEARCH CENTERS AT RIT

RIT performs applied research in partnership with industry and

Chester F. Carlson Center for Imaging Science

- Digital Imaging & Remote Sensing Laboratory
- Integrated Sensing Systems Laboratory
- Munsell Color Science Laboratory
- Rochester Imaging Detector Laboratory
- Biomedical Imaging Laboratory
- Visual Perception Laboratory
- Laboratory for Printing Materials and Process
- Laboratory for Document Reconstruction
- Astrophysics Science & Technology

Microsystems

- NanoPower Research Laboratory
- Semiconductor & Microsystems Fabrication Laboratory
- Center for Electronic Manufacturing & Assembly
- Center for Nanolithography Research
- RF/Analog Mixed Signal Laboratory
- Thermal Analysis & Microfluidics Laboratory
- Analog Devices Integrated Microsystems Laboratory
- Microphotonics Laboratory

Printing & Graphic Media

- Sloan Printing Industry Center
- Printing Applications Laboratory
- Image Permanence Institute
- Printing Industry Education Program

National Technical Institute for the Deaf

- International Center for Hearing & Speech Research
- Research & Teaching Education Center
- Center for Education Research Partnerships
- Center on Access Technology in Deaf Education

The Impact of Viral-Host Interactions

Dr. Ferran and student Warren Hammond investigating the effects of VSV infection on the host cell

Dr. Maureen Ferran and a team of undergraduate researchers in the Department of Biological Sciences in the College of Science are investigating the mechanisms used by vesicular stomatitis virus (VSV) to evade the interferon system, a primary component of the host cell's antiviral response. In addition to contributing to our basic understanding of virus-host interactions, this research is central to a potential novel type of cancer therapy. Many tumor cells lack a functional interferon response; therefore, cancer cells display increased sensitivity to VSV infection when compared to non-cancer cells. A better understanding of how this virus affects the host cell and how it regulates the interferon system is crucial if VSV is to be used as a cancer therapy. This research is funded by the National Institutes of Health.

Regulation of Invasive Species

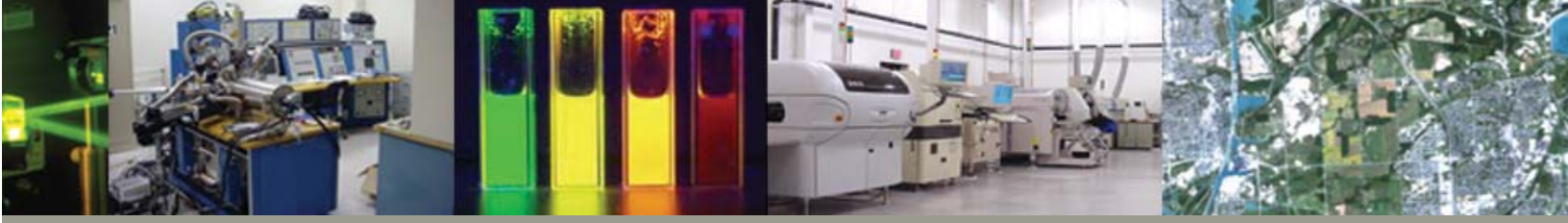
Zebra Mussels, an invasive species impacting fresh water lakes across the U.S. Photo-Randy Westbrooks, US Geological Survey

Dr. Amit Batabyal, the Arthur J. Gosnell Professor of Economics in the College of Liberal Arts, is studying the impacts of alternate invasive species exclusionary regulations on consumers and producers in the U.S. This project is funded by the U.S. Department of Agriculture's Program of Research on the Economics of Invasive Species Management. Invasive species can and have caused major economic and ecological losses in the U.S., hence it is important to understand the ways in which their spread might be best regulated. Project results have helped policy makers understand the pros and cons of alternate inspection policies, the tradeoff between economic cost reduction and biological invasion damage control, and the scenarios in which trade policy is a useful regulatory tool.

Eliminating Communication Barriers

Portable eye-tracking equipment reveals how deaf and hearing students allocate visual attention

Professor Marc Marschark of the Center for Education Research Partnerships in RIT's National Technical Institute for the Deaf conducts research aimed at improving success in learning for deaf and hard-of-hearing students. A recent National Science Foundation project examines how students cope with the visual demands of multi-media classrooms. Wearing a portable eye-tracker developed by co-investigator Jeff Pelz of the Center for Imaging Science in the College of Science, deaf and hearing students view lectures given by RIT faculty. Understanding how students allocate visual attention among instructors, sign language interpreters, computers, and LCD projectors is leading to methods to enhance teaching and learning for all students in today's high-tech classrooms and laboratories.



government sponsors in a number of fields through its laboratories and centers:

Center for Integrated Manufacturing Studies

- National Center for Remanufacturing & Resource Recovery
- Systems Modernization and Sustainment Center
- Sustainable Systems Research Center
- Center for Alternative Energy
- Center for Excellence in Lean Enterprise
- Manufacturing Technologies Program
- Imaging Products Laboratory
- Occupational Safety & Ergonomics Laboratory
- CIMS Training Programs

Center for Advancing the Study of Cyberinfrastructure

- Laboratory for Intelligent Systems
- Laboratory for Computer-Human Interaction
- Laboratory for Astrophysical Dynamics
- Laboratory for Graphical Simulation, Visualization and Virtual Worlds
- Laboratory for Wireless Networks & Security
- Laboratory for Advanced Communications Technology
- Laboratory for Social Computing

Multidisciplinary Research & Training Centers

- The IT Collaboratory
- Center for Quality and Applied Statistics
- Center for Biosciences Education & Technology
- Packaging Science Laboratory
- American College Testing (ACT) Center
- Venture Creations: RIT High Technology Incubator
- Center for Innovation and Entrepreneurship

Biomedical Engineering Capstone Projects

Wireless seizure monitor prototype

Under a grant from the National Science Foundation, nearly 50 Kate Gleason College of Engineering seniors embarked this year on projects aimed at using engineering to improve the quality of life for people with disabilities. The projects are the first from the 5-year NSF grant awarded to Professors Elizabeth DeBartolo, Daniel Phillips, Matthew Marshall, and Maria Helguera aimed at introducing engineering students to biomedical engineering principles through the design and development of devices to address unmet needs of individuals with disabilities. Projects to date include a wrist-worn monitor that warns when the wearer has a seizure, a mechanism that lowers clients into a therapy pool, and workplace modifications that allow visually impaired employees to fill orders in a shipping department.

Life Cycle Logistics

Prognostics system field testing with the US Marines at Camp Pendleton

Dr. Michael Thurston of the Center for Integrated Manufacturing Studies (CIMS) is the team leader for the development and integration of diagnostics and prognostics technology under a project sponsored by the U.S. Marine Corps. In the latest phase of this project, RIT technology has been deployed on two Light Armored Vehicles (LAVs) for extended testing at Camp Pendleton, California. One of the innovative features of the system is prognostic algorithms that give advanced warning of failures in the reduction gears mounted in each of the eight wheels. This system has provided feedback to trainers on incorrect operation of the LAV and has identified reduction gear problems resulting in proactive repairs. This year, the team's work was recognized with the Defense Manufacturing Excellence Award.

Creating Value in Packaging

Bill Pope and Tim Richardson from PAL review printed packaging materials for color accuracy.

Consistency in graphics and color in packaging printing leads to a consistent brand image ultimately resulting in increased loyalty and higher sales. Research conducted in collaboration with Exxon Mobil Chemical Company, Specialty Films Division led by Professor Robert Chung, School of Print Media, and Bill Pope of the Printing Applications Laboratory (PAL) from the College of Imaging Arts & Sciences has developed a methodology for achieving consistent, repeatable color for packaging printing through an optimized and controlled manufacturing environment. This, in turn, enables predictable color between design and production while importantly reducing cycle time. Findings and case studies from this research will be shared with package brand owners and technical personnel from across the industry in a symposium being held at RIT in November of 2006.

Research Update

IT Collaboratory Ribbon Cutting – March 3, 2006

The IT Collaboratory Research Center, a New York State office of Science, Technology and Academic Research (NYSTAR) sponsored Strategically Targeted Academic Research (STAR) center described in the 2003 Research Programs Annual Report, has been completed and opened in March 2006. Research activities organized under the IT Collaboratory banner have ramped up considerably and include:

Total Research Grants	$28.6M
Total Research Projects	73
Invention Disclosures	30
Patents Applied for or received	19
Licensing Agreements	4
Companies Created	4

These results make the IT Collaboratory one of the most successful STAR centers in New York State. Look for an announcement soon for the second IT Collaboratory Symposium to be held in the spring of 2007.

The IT Collaboratory Research Center. Photo–Paul Stella 2006

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 graduates with tools they need for successful careers in these fields;
- supports industrial and government partners with technology, resources, and people they need to remain competitive; and
- fosters economic growth by creating the workforce of the future.

More information on the First in Class program and research at RIT can be found on our website at www.rit.edu/firstinclass or by contacting:

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Director, Research Relations Office
(585) 475-2698
medpop@rit.edu

RIT at a Glance

- Founded in 1829 and emphasizing career education, RIT is a privately endowed, coeducational university.
- The campus occupies 1,300 acres in suburban Rochester, New York.
- 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 95,000 worldwide.
- Cooperative education provides career-related work experience in many degree programs, annually placing 3,300 students in co-op positions with 1,900 employers.
- RIT is consistently ranked in the top of its categories in the annual *U.S. News & World Report* survey of universities.

RIT's eight colleges:

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

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