

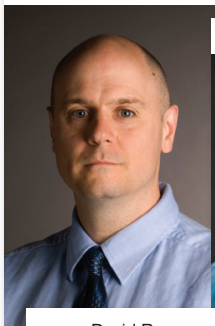
RIT RESEARCH PROGRAMS 2007 ANNUAL REPORT

ROCHESTER INSTITUTE OF TECHNOLOGY

RIT RESEARCH PROGRAMS

SCHOLARSHIP

Bernard Brooks



Stephanie Ludi



Chris Homan



David Borkholder



David Ross



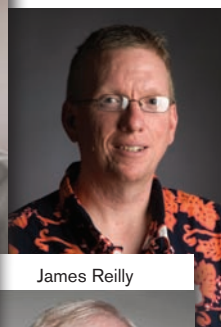
Carl Salvaggio



Eli Saber



Mark Fairchild



John Klofas



James Reilly



Don Figer



Jim DeCaro



John Kerekes



Scott Hawker



Harvey Rhody



James Winebrake



Sandra Rothenberg



Tom Reichlmayr



Mike Haselkorn



Nicholas Difonzo

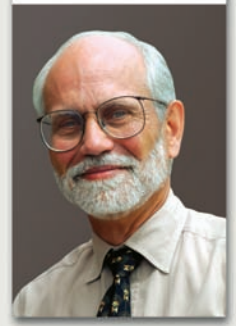


VICE PRESIDENT FOR RESEARCH REVIEW

Multidisciplinary Research at RIT

Let me begin this year's research review with a little history. RIT was founded in 1829 as an Athenaeum by community leaders who wished to engage in intellectual activity through reading and discussion groups. This offset some of the more boisterous activities of the Erie Canal construction crew in Rochester at that time. Through the next 126 years this Athenaeum evolved to be an industrial institute aimed at meeting the work force needs of the local Rochester community. RIT became a fully accredited undergraduate university, granting its first bachelor's degrees in 1955. Although it was now an academic degree granting institute, research had yet to be a focus. Another 34 years passed and the first Ph.D. degree in imaging science was granted in 1989. Research at RIT was now initiated. Just three years later, Dr. Albert J. Simone became the eighth RIT President and introduced the First in Class program to stimulate the growth of scholarship and research. First in Class focused on six strategic research areas and was used to build corporate and government partnerships by providing new technologies and solutions to meet their technical challenges. The research built on RIT's "hands on" tradition and concentrated on multidisciplinary technology themes and included both graduate and undergraduate students to expand their experiential learning at RIT. Now, after 15 years of Dr. Simone's leadership, a solid foundation for scholarship and research has been established throughout the university, is growing, and is moving RIT forward toward a "category of one" university. Thank you, Al, and enjoy your retirement!

Donald Boyd



← from inside cover

The research stories highlighted in this 2007 annual report illustrate these unique characteristics; multidisciplinary research teams, undergraduate and graduate participants, and successful outcomes for the sponsors. A great example can be seen in our spotlight story: the RIT Thermal Analysis and Microfluidics Laboratory under the leadership of Dr. Satish Kandlikar, a 17-year mechanical engineering faculty member at RIT. Dr. Kandlikar is leading multidisciplinary teams of students, faculty and engineers from sponsoring corporations to develop technology for managing heat and fluidics in applications ranging from fuel-cell-powered automobiles to next-generation microelectronics. Also featured in this issue are 12 short stories that involve multidisciplinary teams achieving significant results in their work in RIT's strategic research areas of imaging science, microsystems engineering, computing and information sciences, astrophysics, deaf education and sustainable design. We are honored to highlight the work of the 20 researchers pictured to the left. Please consider that these stories are only a sample of RIT's scholarship and research programs and the multidisciplinary teams of students, faculty and partners who are finding solutions to real world challenges.

In closing, we are thrilled to welcome the ninth President of RIT, Dr. William W. Destler, joining us from a leading research institution, the University of Maryland at College Park. Under his leadership we can expect more collaborations with industry on research and development and additional strategic global partnerships. I encourage you to review the stories in this year's report and contact us to become your research partner.

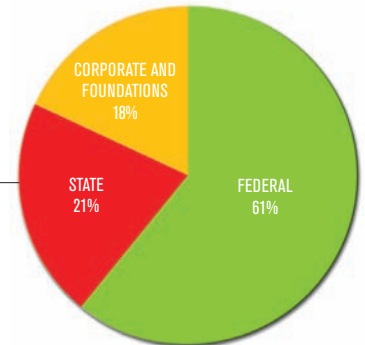
Best regards,
Donald L. Boyd, Ph.D.
Vice President for Research

Research Financial Summary

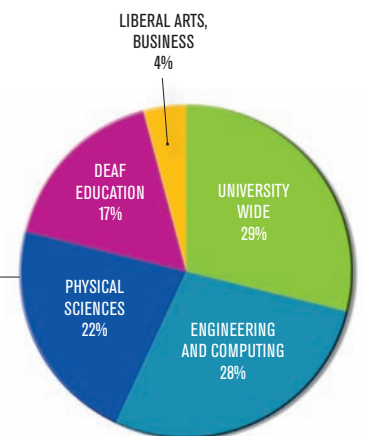
These charts depict the past five years (2003-2007) of research and scholarship expenditures at RIT and represent more than \$183 million of externally sponsored activity. The RIT Research Source continues to be led by federal funding with a strong contribution from New York state, primarily on capital construction projects, and the continued support of our applied research work by corporations. RIT receives proportionally twice as much funding from corporations as our peer private technology universities indicating our interest and responsiveness to their technology needs.

From the Discipline perspective, engineering, computing and the physical sciences (including imaging science) are our leading research areas. Interestingly, many of our multidisciplinary projects cross over these three nationally tracked disciplines. For these financial results we show our projects under the discipline of the project lead.

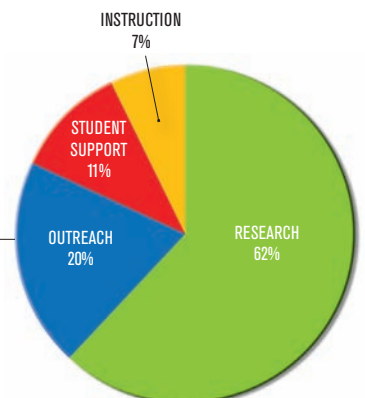
From the Purpose view, spending for research continues to increase and is the dominant activity each year. Additionally, we see growth in many outreach activities including the critical K-12 science and technology programs aimed at increasing the level of success for the next generation of college students.



SPENDING BY SOURCE



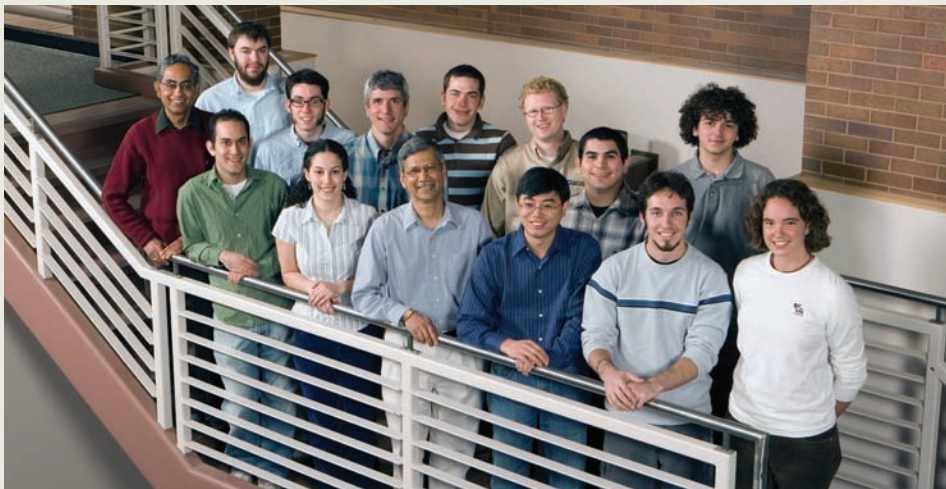
SPENDING BY DISCIPLINE



SPENDING BY PURPOSE

RIT RESEARCH PROGRAMS

FACULTY RESEARCH AND SCHOLARSHIP



IN THE SPOTLIGHT: Thermal Analysis and Microfluidics Laboratory

RIT's Thermal Analysis and Microfluidics laboratory, founded in 1991, is dedicated to fundamental research in the areas of flow boiling and single-phase liquid flow at the microscale. The laboratory is run by Dr. Satish Kandlikar, from the Kate Gleason College of Engineering's department of

Thermal Analysis and Microfluidics Laboratory Team

Row 1: (from left to right) Dr. Naval Gund Rao, Julian Peters, Jacqueline Sergi, Dr. Satish Kandlikar, Dr. Zijie Lu, Matthew Benedict, Perry Young

Row 2: (from left to right) Sean Ashman, Andrew White, Dr. Thomas Trabold (General Motors), Tim Brackbill, Jon Owejan (General Motors), Joaquin Pelaez, Charles Schillberg

Greenhouse Gas Reduction Modeling



RIT MUSES team at work: Sandy Rothenberg, Scott Hawker, master's degree student Nathan Claes, PI Jamie Winebrake, Ph.D. student Sid Pendelberry

Major industrialized countries around the world are currently designing policy mechanisms to reduce greenhouse gas (GHG) emissions. Proposed mechanisms include targets for the transportation sector, which comprise about 35 percent of total US GHG emissions. Emissions reduction would significantly affect the design and materials use of passenger cars and light trucks. However, decision makers currently lack analytical tools and models to evaluate the impact of GHG reduction policies. The goal of this five-year, \$2 million NSF project is to produce modeling tools and methods that can be used to analyze changes in emissions and materials flows resulting from policies aimed at passenger cars and light trucks. RIT is working collaboratively with researchers at the University of Michigan, UC-Berkeley and Northeastern University on this project.

Micro-pump for Gene-based Therapy

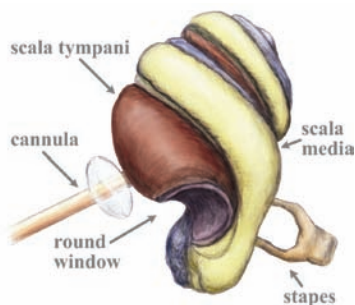


Illustration of cochlear structure and cannula insertion point for intracochlear infusions

Dr. David Borkholder, assistant professor of electrical engineering in the Kate Gleason College of Engineering, in collaboration with Dr. Robert D. Frisina of the University of Rochester Medical Center, are addressing the biological basis of deafness and auditory dysfunction. Their research is through the application of engineering approaches and technologies to gene-based deafness therapy in the mouse model system. Leveraging the capabilities of the RIT Semiconductor and Microsystems Fabrication Laboratory and the talent of undergraduate and graduate engineering students, a Micro Electro-Mechanical (MEM) implantable micropump specifically designed for intracochlear drug delivery in mice is being developed. This NIH-funded research will enable chronic, calibrated, delivery of multiple curative agents for advanced deafness therapy research.

Color Gamut Optimization



Example of enhancement in display color gamut

Dr. Mark Fairchild of the Chester F. Carlson Center for Imaging Science's Munsell Color Science Laboratory is working with graduate students to understand human perception of new technologies for image capture, processing and display. In a collaboration with Sony Corporation, experiments are aimed at determining how consumers perceive novel HDTV displays capable of producing a significantly enhanced range of colors, or color gamut. The aim is to find the optimal color gamut based on observer preference and colorfulness perception. While still in its first year, the project has already generated two conference paper submissions, each having multiple authors from RIT and Sony.

Ultimately, this work with Sony will yield improved television viewing experiences in the rapidly expanding world of high definition television.

mechanical engineering. Dr. Kandlikar's efforts over the last 17 years have resulted in strong research teams with faculty and students from different disciplines, other academic institutes, and our industrial partners. The laboratory also serves as the backbone of a number of international activities, including workshops and conferences held in Mexico, Ireland, Canada and other global research centers.

A major research focus in the last 10 years has been microchannels, which are typically small diameter channels in the range of 10 to 200 micrometers (a human hair is approximately 100 micrometers in diameter). The microchannels are supplied with water or a boiling

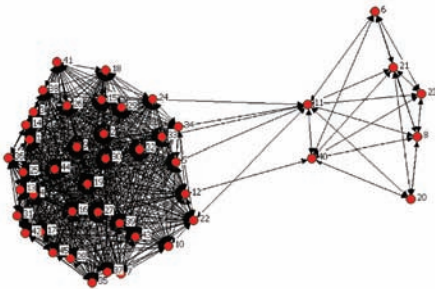
refrigerant to remove heat fluxes in excess of 1 kW/cm². Such high heat flux rates are expected to occur in computer chips and laser diode arrays within the next three to five years. IBM and the National Science Foundation have been major supporters of this work.

Water management in automotive fuel cells is another major research focus. Removal of water from the gas diffusion medium into gas flow channels is studied using advanced visualization techniques. This work has been supported by General Motors for the last seven years. Recently, the laboratory received a \$2.7 million grant from the Department of Energy to study the effect of freezing on fuel cell operation in

partnership with General Motors and Michigan Technological University.

Although the laboratory is dedicated to fundamental research needs emerging from industry, the primary focus continues to be students and their education through participation in the advanced research projects. Graduate students pursuing their Ph.D., MS and BS/MS degrees work with undergraduate co-op students. Since the lab was established, 46 students have completed their MS or Ph.D. work in the laboratory, and an equal number of undergraduate students have participated in ongoing research as co-op students working in the laboratory.

Rumor Propagation on Social Networks



The conversation network of two distinct campus groups

Rumors are a powerful, pervasive and persistent force affecting people and groups. Professor Nicholas DiFonzo of the department of psychology in the College of Liberal Arts heads an interdisciplinary team of researchers studying how social network configurations and group membership combine to affect rumor propagation. The project is funded by the National Science Foundation and includes experimentation, mathematical modeling, field, Web and archival research. RIT members of this interdisciplinary team include Dr. Bernard Brooks and Dr. David Ross, both of the School of Mathematical Sciences in the College of Science, and Dr. Christopher Homan of the department of computer science in the Golisano College of Computing and Information Sciences. Knowledge from this project will aid in the effective prevention of and response to harmful rumors.

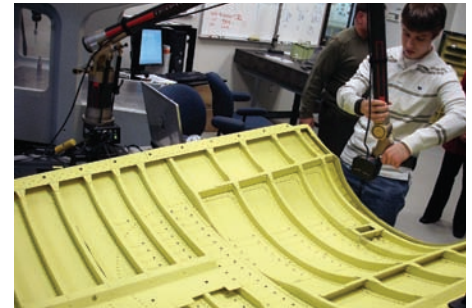
The Most Massive Stars



Hubble Space Telescope image of the Arches cluster, a cluster of massive stars

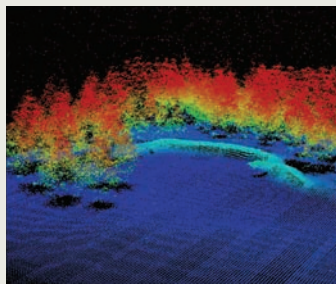
What is the most massive star in the galaxy? This question remains unanswered since first being asked over 80 years ago by Sir Arthur Eddington. Despite their heft, massive stars are difficult to find—they are hidden by the vast amounts of dust throughout the disk of the galaxy. Our five-year mission is to boldly discover the most massive stars in the galaxy. Funded by NASA, "The Most Massive Stars" is an international project, led by Donald Figer at RIT's Chester F. Carlson Center for Imaging Science, along with a host of post-doctoral researchers and data analysts. Even in its infancy, the project has discovered the richest clusters of red supergiants in the galaxy—stars on the brink of destruction in brilliant supernovae.

Addressing Design Obsolescence



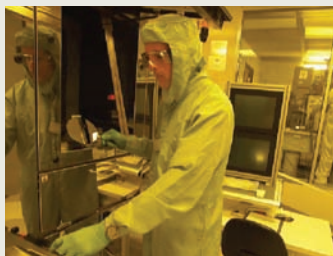
3D Laser Scanning and analysis utilized to update on obsolete part design

Dr. Michael Haselkorn of the Center for Integrated Manufacturing Studies (CIMS) is the team leader for the materials and structures technologies. His team, funded by Naval Air Systems Command (NAVAIR), first reverse engineered and then updated the design of the EA-6B mid-turtleback by capturing the original part geometry using 3-D laser scanning techniques, and then using this data to generate a CAD geometry. The design was updated to eliminate tack welds in the aluminum and reduce the manufacturing costs by eliminating a number of the complex metal forming operations. The tack welds were a major problem because over time they corroded and failed in the salt water environment. The new design reduced the cost to fabricate each mid-turtleback from \$80,000 to \$15,000. Working with Acro Industries, two flight-ready prototype EA-6B mid-turtlebacks were fabricated and sent to NAVAIR for testing.



Imaging Science

- Algorithms, Data Fusion, Data Mining, and Visualization
- Biomedical Imaging
- Color Science
- Nanoimaging and Materials
- Printing Materials and Processes
- Remote Sensing
- Sensors and Imaging Systems
- Vision



Microsystems

- Bio MEMS Devices
- Microchannels and Microfluidics
- Microelectronic Devices
- Microelectronic Fabrication
- Micro-optical Systems
- Microphotonic Devices
- Mixed Signal Microelectronics
- Nanolithography
- Nanomaterials
- NanoPower Applications



Center for Integrated Manufacturing Studies

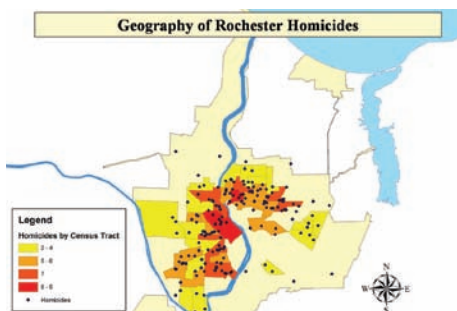
- Asset Health Management
- Asset Recycle Management
- Clean Technologies
- Design for Remanufacture/Design for the Life Cycle
- Green Product Assessment
- Intelligent Testing and Diagnostics
- Life-cycle Engineering
- Material Aging
- Modernization through Remanufacturing and Conversion
- Reliability Engineering
- Reverse Logistics
- Value Engineering



Computing and Information Sciences

- Computational Biology and Bioinformatics
- Computer Security and Information Assurance
- Cyberinfrastructure and Grid Computing
- Gaming and Simulation
- Immersive Environments
- Intelligent Systems and Computer Vision
- Medical Informatics and Medical Imaging
- Networking and Systems Administration
- Software Engineering
- Visualization and Usability Engineering

Public Safety Initiative



The "Crime Crescent" In the City of Rochester

Computing for Visually Impaired Students



Programming robots engages middle and high school students.

Physical Characteristics of Prints



Cross-sectional Structure of a Photographic Print

Dr. John Klofas, professor of criminal justice and department chair at RIT, is an "action researcher." He wades into the world of practical problems in criminal justice and brings his students with him to help address the challenges and provide experiential learning. In partnership with the City of Rochester and funded by the U.S. Department of Justice, he heads the Center for Public Safety Initiative and spends most of his time studying and working to solve the problem of violence and homicide in Rochester. Without compromising the quality of the research, Dr. Klofas seeks to engage practitioner-experts from the law enforcement community in a data-based problem-solving process. Dr. Klofas has been recognized locally and nationally for his research results and his students have found success as researchers in the field as well as admission to graduate programs in criminal justice, law and public policy.

Increased diversity in computing requires broadening participation to groups of students who may otherwise not consider a career in computing. With funding from the National Science Foundation, middle and high school students who are visually impaired participate in a summer workshop at RIT that allows them to explore robotics, programming and computer hardware. Using technology such as Lego Mindstorms, the students work in small teams to solve design problems through theme-based, hands-on activities. The principal investigators, Dr. Stephanie Ludi and professor Tom Reichlmayr from the department of software engineering, in the B. Thomas Golisano College of Computing and Information Sciences, are using the workshop and their inclusive instructional materials to make computing interesting and engaging.

James M. Reilly, IPI director, and Ryan Boatright, staff scientist at the Image Permanence Institute in RIT's College of Imaging Arts and Sciences, have developed a suite of imaging and cross-sectioning techniques that reveal the inner structure and surface character of photographic prints in astonishing new ways. Employing advanced digital imaging and optical microscopy methods, the project has advanced the understanding of the physical character of both traditional and digital print papers. The techniques are being used to create a standard body of images that visually convey the relationship between the physical nature of a print (layers, additives, image structure) and its appearance (sheen, texture, contrast). Funded by the Mellon Foundation, the research has attracted the attention of curators, collectors and practicing photographers.



Astrophysics Science and Technology

- Active Galactic Nuclei
- Astroinformatics
- Computational Astrophysics
- Optical, X-Ray, IR, and Radio Astronomy
- Solid State Image Sensors
- Stellar and Galaxy Formation and Evolution



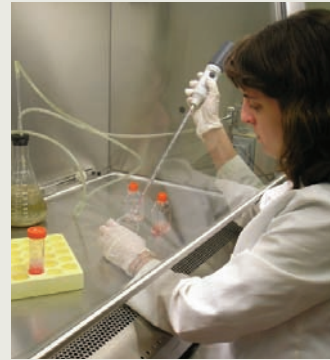
National Technical Institute for the Deaf

- Faculty and Staff Communication Skill Development
- Job Success and Mobility
- Teaching and Learning
- Technology, Access and Support Services



Printing and Graphic Media

- Printing Industry Environment and Evolution
- Printing, Paper and Material Evaluation
- Workforce Training in the Graphic Arts



Biomedical and Life Sciences

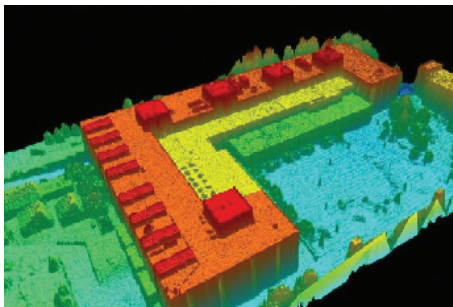
- Basic and Applied Hearing Loss Research
- Biomedical and Biotechnology Professional Training
- Biomedical Engineering
- Biomedical Visualization



Arts and Design

- American Crafts
- Design
- Digital Publishing
- Fine Art
- Motion Media
- Photographic Arts and Sciences

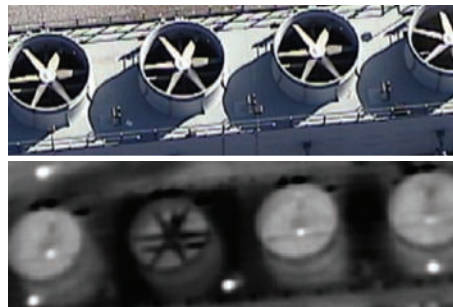
Automated Scene Modeling



Semi-Automated DIRSIG Scene Modeling from 3D LIDAR
Photo: Stephen Lach

Funded by a grant from the National Geospatial Intelligence Agency, Dr. Harvey Rhody and Dr. John Kerekes from the Chester F. Carlson Center for Imaging Science, Dr. Eli Saber from the electrical engineering department and several graduate students are developing world-class multimodal image registration, three-dimensional scene reconstruction and material analysis and characterization algorithms. The underlying goal is to reduce the time required to construct physically accurate models for complex scenes, such as a campus or a section of a city, from many months to a few days. This is accomplished by acquiring multimodal imagery using visible, infrared, hyperspectral and LIDAR sensors on airborne or satellite platforms and then utilizing newly developed techniques for image registration, material analysis and scene reconstruction.

Tracing Radiant Energy



Visible and thermal infrared images of Mechanical Draft Cooling Towers at Savannah River National Laboratory

Dr. Carl Salvaggio of the Center for Imaging Science in the College of Science studies the fundamental physical phenomenology that produce detected signals in image data. In a project being carried out for the Department of Energy's Savannah River National Laboratory (SRNL), Dr. Salvaggio and other researchers in the Digital Imaging and Remote Sensing Laboratory at RIT are addressing the difficult problem of tracing the radiant energy through mechanical draft cooling towers. It was discovered by this research team that modeling the full bidirectional reflectance distribution function was a necessary task to predict the total energy being released by these towers. Knowing this energy dissipation rate will help analysts utilize thermal infrared imagery to predict the operational state of power plants and other facilities.

Postsecondary Education Network



PEN-International Classroom/Lab at Bauman Moscow State Technical University

The Postsecondary Education Network-International (PEN-International), a worldwide partnership of colleges and universities, has been funded with more than \$8 million in grants from The Nippon Foundation of Japan to the National Technical Institute for the Deaf at RIT. Directed by Dr. James J. DeCaro, the program works to improve postsecondary education for deaf and hard-of-hearing students in the developing world by promoting cutting-edge instructional and educational technology, and conducting faculty development and training. PEN has built high-technology multimedia and video conferencing labs in Russia, China, Japan and the Philippines and trained faculty in their use. PEN recently completed a three-year research study of postsecondary deaf education in China and presented its findings and recommendations to the China Disabled Persons' Federation in 2006.

2007 Annual Research Symposium



President Albert Simone addresses participants at the IT Collaboratory 2007 Annual Research Symposium
Photo: A. Sue Weisler/RIT

RIT hosted the Annual IT Collaboratory Research Symposium in April 2007 to highlight our accomplishments in the remote sensing field. Over 120 scientists and researchers attended, including representatives from industry, government and our partner universities. Key topics in the technical breakout sessions included remote sensor design, system integration, algorithm development and information exploitation. This annual event provides an opportunity to demonstrate our progress and formulate new projects with our partners in support of the RIT research enterprise. The keynote speaker this year was Daniel Gundersen, the new upstate co-chairman for the Empire State Development Corporation. His opening session emphasized the importance of university research and collaboration in generating economic growth in our region. Other key technical speakers from ITT Space Systems, Pictometry International and the National Geospatial-Intelligence Agency helped kick off the event.



Opening Session speaker Daniel Gundersen, co-chairman, Empire State Development Corporation
Photo: A. Sue Weisler/RIT

Contact Us

RIT conducts focused research to advance the body of knowledge, enhance student learning experiences and build its reputation in the scientific and technical communities, while providing positive returns on sponsoring partners' investments. Please contact us directly or through the RIT research website www.rit.edu/research if you would like us to help your organization achieve its goals.

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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 1,300 acres in suburban Rochester, New York.
- The RIT student body consists of approximately 11,650 full-time and 1,500 part-time undergraduate students, as well as 2,450 graduate students.
- Enrolled students represent all 50 states and more than 95 countries.
- RIT alumni number more than 100,000 worldwide.
- Cooperative education provides career-related work experience in many degree programs, annually placing more than 3,500 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