

Research Resources and Centers

Research plays an integral role in Rensselaer's vision of the technological university. The discovery and application of new scientific concepts and technologies, especially in emerging interdisciplinary fields, are core goals for faculty, staff, and students. Our research programs reach across the campus, linking together departments, schools, and interdisciplinary centers, and creating opportunities for integration of research and education. Undergraduates work one-on-one with faculty members in real-world, hands-on research as part of Rensselaer's Undergraduate Research Program (URP). In addition, research drives technological entrepreneurship and commercialization, interfacing closely with the Rensselaer Technology Park and Incubator Center.



The Office of the Vice President for Research provides infrastructure and resource support for the development of research programs and projects. Support services are offered for faculty seeking research opportunities, research proposal and budget preparation, and guidance on research management and intellectual property policies. The Office coordinates major research themes and programs through interdisciplinary research centers. Links from this Web site offer overviews of these centers, reviews of major research projects and recent accomplishments, as well as information on research policies, guidelines, and infrastructure.

NY State Center for Advanced Technologies on Future Energy Systems (Energy CAT)

Director: Omkaram (Om) Nalamasu

Future Energy Systems is a newly designated Center for Advanced Technologies by NYSTAR (New York State Office of Science, Technology and Academic Research) with Rensselaer as the lead university, Cornell and Brookhaven National Laboratories as partnering institutions. Future Energy Systems CAT brings together Rensselaer and Cornell's world-class scientists, programs, infrastructure, and Energy research under a CAT umbrella to focus on energy conservation and renewable energy systems through the design, development, and implementation of advanced materials, devices and systems, and the transfer of the associated technologies to New York (NY) state-based industries. The vision of "Future Energy Systems" is to make New York state a world leader in energy research, and an industrial power house in the energy business, by focusing on the core research strengths of Rensselaer and Cornell in materials, devices, systems, nanotechnology, light emitting diodes (LEDs), organic light emitting diodes (OLEDs), fuel cells and photovoltaics, and by further nurturing a tradition of industrial collaboration and technology transfer. The Center's key initial thrust areas are: Smart Lighting, Fuel Cells, and Renewable Energy Sources.

Center for Automation Technologies

Acting Director: Raymond H. Puffer, Jr.

CAT Home Page: <http://www.cat.rpi.edu/>

The CAT has been designated since 1988 as a Center for Advanced Technology by the New York State Office for Science, Technology and Academic Research (NYSTAR).

Interdisciplinary teams of faculty, staff, and students work closely with the Center's industrial partners to

conduct basic and applied research aimed at radical industrial innovations.

Research programs in the CAT are focused on automation and systems technology and include topics such as precision motion control, distributed microrobotic systems, and their applications to microphotonic and microfluidic systems. The CAT also specializes in outreach and applied research in technologies associated with industrial automation, focused on enhancing the competitiveness of industrial partners. Areas of expertise include: manufacturing process development; automaton systems design and development; precision mechanical assembly; and material handling.

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Center for Integrated Electronics

Director: Omkaram (Om) Nalamasu

Associate Director: Toh-Ming Lu

Associate Director: Morris Washington

CIE Home Page: <http://www.rpi.edu/dept/cie/>

The Center for Integrated Electronics (CIE) was created to carry out fundamental research that is industry-oriented in electronics design and manufacturing including Semiconductor interconnect technology. The center's mission is to build integrated top-down and bottom-up nanostructures, devices, and systems for information, biological, and broadband communication applications. Major activities at the CIE include pioneering research into gigascale interconnects, 3-D interconnect structures, materials properties and process modeling, wideband gap semiconductors and devices, terahertz devices and imaging systems, power electronic devices and systems, and biochips.

The Center's activities range from basic and applied research and education to commercialization through partnerships with industry. A complement of about 50 faculty, 100 students, and 15 full-time research post doctoral fellows, staff, and conduct research activities incorporating projects for specific companies, as well as longer-range programmatic efforts in fundamental areas of materials processes, design, fabrication, and characterization related to integrated electronics, electronics manufacturing, and microelectro-mechanical systems(MEM).

State-of-the-art facilities enhance research opportunities and include a Class 100 nanofabrication clean room with processing capabilities both for Si and III-V base devices/circuits, and microsystems, extensive computer resources from such companies as Apple, AT&T, DIGITAL, Hewlett Packard, IBM, and Sun, and numerous state-of-the-art processing design, testing, and characterization facilities in individual laboratories. Located on the Rensselaer campus, the CIE has immediate access to expertise in a broad range of disciplines. Participants include nationally recognized faculty from Rensselaer's Schools of Engineering, Management, Science, and Humanities and Social Sciences. In addition, over 100 undergraduate and graduate students, post doctoral fellows, and visiting scholars are supported annually through the CIE's programs.

Major Programs

Center for Advanced Interconnect Systems Technologies The research plan in CIE's Center for Advanced Interconnect Systems Technologies (CAIST) focuses on finding innovative, creative, and competitive ways to maximize interconnection performance. The research involves the development of new materials, processes, simulation, modeling, and fabrication techniques for high-performance and reliable interconnections. The goal of CAIST is to investigate, test, and prototype new concepts, from the

device-to-system approach, that provide attractive options for significantly upgrading the performance of interconnections into the 21st century.

Center for Microcontamination Control The Center for Microcontamination Control is an NSF Industry/University Cooperative Research Center with Research sites at the Northeastern University, the University of Arizona, and Rensselaer. The UA site was established in 1989 and has research in high-K dielectric contamination, bacterial contamination, and ultrapure water (UPW) research. The RPI site was established in 1998 and has research in CMP and electrochemical planarization. Northeastern University established a site in 2002 with research in nano and microscale particle removal.

Center for Power Electronics Systems The Center for Power Electronics Systems (CPES), sponsored by the National Science Foundation and established in 1998, is a national Engineering Research Center (ERC), which envisions enhancing the competitiveness and growth of the power electronics industry by developing an integrated system approach with Integrated Power Electronics Modules (IPEMs). The goal of CPES is to improve the quality, reliability, and cost effectiveness of power electronics systems by tenfold at the end of the expected 10-year life span. Virginia Institute of Technology administers this Center; and the five-university consortium consists of Rensselaer, Virginia Tech, University of Wisconsin-Madison, North Carolina A & T, and University of Puerto Rico at Mayaguez.

Focus Center—New York, Rensselaer: Interconnects for Hyperintegration This program investigates radical alternatives and new concepts leading to new solutions that will enable the U.S. semiconductor industry to transcend known limits on interconnections that would otherwise decelerate or halt the historical rate of progress toward gigascale integration (GSI). This program is part of the nationally distributed Interconnect Focus Center (IFC) administered from Georgia Institute of Technology. The university consortium members are Rensselaer, SUNY-Albany, Georgia Tech, MIT, and Stanford. Rensselaer's efforts focus on multiple layers of active devices ("3-D Chips"), optical interconnects, and fundamental materials and process characterization and modeling.

Center for Broadband Data Transport and Technology IBM Corporation endows this interdisciplinary Rensselaer center, which involves faculty from the Schools of Engineering and Science, SUNY Albany, Cornell University, City College of New York, and affiliated IBM researchers. The center's primary mission is to conduct research in optical and electrical data transport, switching, and processing to enable future generations of information technology systems. The center is also involved in educating a new generation of students and postdocs for broadband data transport science and technology. The center operates the Internet Accessible Remote Laboratory (visit <http://nina.esce.rpi.edu/shur/broadband>).

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Visiting Scholar: Y. S. Kim

Rensselaer Nanotechnology Center

Director: Richard W. Siegel

Home Page: <http://www.rpi.edu/dept/nsec>

The Rensselaer Nanotechnology Center provides a major resource to advance the scientific promise represented by the nanotechnology chair and provides interdisciplinary research programs to educate new generations of students. Research areas of the Center include advanced materials and coatings, biosciences and biotechnology, nanoelectronics, and nanosystems. Nanotechnology uses clusters of molecules and atoms to make nanometer (billionth of a meter) size building blocks for new materials. These blocks have different properties than larger sizes of the same materials, such as electrical conductivity, optical properties, and mechanical strength. These materials can therefore be used for many new applications. The Center focuses on creating novel materials and devices that could create more effective drug delivery systems in the human body, result in stronger and more durable plastics, enable high capacity energy and information storage devices, and produce flame-retardant plastics for planes and automobiles, as well as other important applications.

Affiliated Faculty: P. M. Ajayan, Y. Akpalu, B. Benicewicz, R. Bizios, T. Borca-Tasciuc, W. Colon, J. Crivello, J. Dordick, R. Doremus, D. Duquette, G. Dvorak, J. Fish, D. Gall, S. Garde, L. Interrante, R. Kane, P. Keblinski, S. Kumar, N. Koratkar, R. Linhardt, T-M. Lu, C. McDermott, J. Moore, O. Nalamasu, S. K. Nayak, R. Ozisik, R. E. Palazzo, P. Persans, L. Peters, C. Picu, G. Ramanath, C. Ryu, L. Schadler, M. Shephard, E. F. Schubert, M. Shima, M. Shur, R. W. Siegel, J. Stegemann, M. Washington, R. Wright, X. C. Zhang

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Scientific Computation Research Center

Director: Mark S. Shephard

Associate Director: Kenneth E. Jansen

Home Page: <http://www.scorec.rpi.edu>

The Scientific Computation Research Center (SCOREC) is focused on the development of reliable simulation technologies for engineers, scientists, medical professionals, and other practitioners. These advancements enable experts in their fields to employ, appraise, and evaluate the behavior of physical, chemical, and biological systems of interest.

SCOREC research is focused on the development of the technologies necessary to enable multiscale systems engineering. Multiscale systems engineering will introduce a new paradigm in which all interacting scales important to the behavior of materials, devices, and systems will be accurately modeled and accounted for in the design of optimized products and processes. To enable the implementation of this new paradigm, advanced modeling, simulation, optimization, and control technologies must be developed to provide the basis for design environments in which systematic exploration of alternative designs is supported by (1) a hierarchy of models that provides a consistent description of multiscale

phenomena, (2) adaptive simulation methods that account for the scale interactions, (3) efficient computational analysis, optimization and control methods, and (4) the representation of uncertainty and its propagation.

The interdisciplinary team of faculty, research staff, and students working with SCOREC are involved in funded research to address key research areas that must be addressed in terms of the overall methods involved as well as their application to specific critical application areas such as nano-composites design and vascular disease modeling. SCOREC research programs include the active transition of the methods and simulation technologies developed to industrial practice and commercialization by software companies.

Affiliated Faculty: K. Anderson, T. Cale, C.D. Carothers, S. De, J. Fish, J.E. Flaherty, S. Garde, K. Jansen, P. Keblinski, S. Kumar, A. Maniatty, D.R. Musser, S. Nayak, R. Ozisik, C. Picu, L. Schadler, M.S. Shephard, R.L. Spilker, S. Sternstein, B.K. Szymanski, M. Zeghal

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Administrative Staff: M. Verville

The Academy of Electronic Media

Home Page: <http://www.academy.rpi.edu>

Electronic media is an integral part of all aspects of society, yet with all the potential offered by today's electronics and computing we have only begun to scratch the surface of how we may use technology to improve our lives. The Academy's vision is to produce and facilitate the use of interactive environments that explore a creative application of electronic media and computing. We strive to empower individuals by developing innovative electronic media and technologies that engage users and remove the restrictions imposed by static toolsets, passive entertainment, conventional media, structure boundaries, or physical proximity. The web has provided a means for access to information at anytime, from anywhere. Today's limit to what knowledge can be learned and applied by an individual is a shortage of time.

The mission of the Academy is to fundamentally challenge and expand the way electronic media impacts people, and the way people relate to electronic media and technology. The Academy combines multiple award-winning (2003 PREMIER AWARD for Excellence in Engineering Education Courseware) artistic and technological expertise to investigate basic IT research in the areas of dynamic data access/utilization (e.g. animation, video, multimedia, etc.), collaborative computing environments, 2-D/3-D visualization & modeling, user I/O interactivity programming, and electronic media scalability/ platform adaptation. At the Academy, developing interactive electronic media that stimulates multiple senses to better understand, visualize, and express ideas is part of the daily work.

New interactive user interfaces and visualization technologies hold the promise for many to now grasp and utilize information and concepts that once was the domain of a select few. The Academy offers those competing in increasingly technical and global markets a greater potential for achieving new success in shorter periods - through the use of innovative technologies, multi-user web-based environments, and interactivity. The Academy is a magnet for scholarly students, faculty/staff, and corporate partners to work together on projects in education and arts & entertainment. Some of the Academy's recent projects involve the development of a multimedia tool to teach Greek as a second language (in collaboration with the

Hellenic American Union), educational materials to support engineering and computer science (through a number of NSF supported efforts), a visual language that explores an evolutionary writing system (the Glide project), nanotube-based sensor R&D modeling (an NUE project), and interactive musical visualizations. The Academy offers a home where community members can exercise both the technical and artistic sides of their creativity, while serving as a Rensselaer resource to facilitate the utilization of electronic media and offer the guidance necessary to allow content providers to produce innovative material and technology.

Academy Staff: D. Millard, Director; W. Brubaker, Programming Director; K. Carlson, Production Coordinator; D. Slattery, Associate Director; A. Yu, Systems Administrator