

# 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.

## Center for Automation Technologies and Systems (CATS)

**Director:** John T. Wen, Professor of ECSE and MANE

**CAT Home Page:** [www.cats.rpi.edu](http://www.cats.rpi.edu)

The Center for Automation Technologies and Systems (CATS) at Rensselaer Polytechnic Institute serves as a focal point for a broad range of industrially relevant research and development in both practical and theoretical aspects of automation. More than 30 faculty members in 10 departments at Rensselaer participate in the research and educational programs of the Center. With annual funding from the State of New York as a NYSTAR-designated Center for Advanced Technology, the CATS pursues a mission of both research excellence and service to industry, with a focus on applying the core technologies to a broad range of applications. The CATS works with industrial partners to pursue an integrated systems approach, advancing model-based methods and applying them to design, optimization, control, and monitoring for challenging and high impact real-world problems. Current focus areas include optomechatronic systems, fuel cell manufacturing, distributed systems, biomedical systems, micro- and nanosystems, and industrial automation.

**Affiliated faculty:** Srinivas Akella, Kurt Anderson, Miki Amitay, Murat Arcak, Wayne Bequette, Theodorian Borca-Tasciuc, Selmer Bringsjord, Joe Chow, Kevin Craig, Suvranu De, Steve Derby, Alan Desrochers, Martin Hardwick, Wes Huang, Volkan Isler, Michael Jensen, Qiang Ji, Shivkumar Kalyanaraman, Junichi Kanai, Ananth Krishnamurthy, Eric Ledet, James Lu, Antoinette Maniatty, George Nagy, Jong-shi Pang, Yoav Peles, Richard Radke, Shep Salon, Arthur Sanderson, Linda Schadler, Mark Shephard, Mark Steiner, Julie Stenken, Jian Sun, Jeff Trinkle, Dan Walczyk, Michael Wozny, George Xu

**Staff:** Heidi Merrill, Ben Potsaid, Ray Puffer, Steve Rock, Glenn Saunders, Mike Shimazu, Jeanette Young

## Center for Biotechnology and Interdisciplinary Studies

**Director:** Robert E. Palazzo

**Web site:** [www.rpi.edu/research/biotech/index.html](http://www.rpi.edu/research/biotech/index.html)

The Center for Biotechnology and Interdisciplinary Studies is a 218,000-square-foot, \$100 million facility on the Rensselaer campus. With its high-tech laboratories and expansive atrium, it provides a platform for collaboration among many diverse academic and research disciplines to enhance discovery and encourage innovation.

The Center for Biotechnology and Interdisciplinary Studies faculty and researchers are engaged in interdisciplinary research, focused on the application of engineering and the physical and information sciences to the life sciences.

The Center is home to a new \$22.5 million Gen\*NY\*sis Center for Bioengineering and Medicine funded by New York State. In addition, Rensselaer has received \$750,000 in federal funding to support the creation of a new Center for Quantitative and Computational Bioscience to be housed in this facility.

Rensselaer is rapidly recruiting world-class faculty to lead research in the focal areas. Each focal area will be supported by a constellation of "star" faculty, junior faculty, and others who are experts in their fields. These constellation groupings provide for communities of distinguished researchers and the programmatic resources to ensure their success.

The core research facilities within the Center contain laboratories for molecular biology, analytical biochemistry, microbiology, imaging, histology, tissue and cell culture, proteomics, and scientific computing and visualization. The Center contains both a 600 and an 800 MHz Nuclear Magnetic Resonance (NMR) spectrometer and the computing and visualization infrastructure needed to model molecular structure at the atomic level.

Research and office space is available for approximately 400 faculty, staff, and students, and the Bruggeman Conference Center and auditorium host world-class programs and symposia.

## Center for Future Energy Systems

**Director:** Omkaram (Om) Nalamasu

The Center for Future Energy Systems (CFES) is one of 15 New York State Office of Science, Technology, and Academic Research (NYSTAR) funded Centers for Advanced Technology (CATs) in New York State. In collaboration with Cornell University and Brookhaven National Laboratory, the CFES focuses on research in the areas of energy conservation and, new and renewable sources of energy. Within these broad areas, researchers are working on technologies which include: fuel cells, smart lighting, smart displays, hydrogen generation and storage, and renewable energy systems.

The Center's mission is to connect energy research, knowledge, and technology in academia to the needs of industry through technology transfer and/or collaborations to foster economic development. It will play a pivotal role in helping New York State meet its goal of generating more than 25 percent of the state's energy needs through renewable energy sources by 2013. The Center will nurture and translate New York State's technical leadership in energy to jobs through technology commercialization in partnership with New York State industry. The CFES will help industry meet the energy challenges of the 21st century and help make New York State a world leader in the new industrial revolution based on renewable energy and energy conservation systems.

The CFES leverages the core research strengths of Rensselaer and Cornell in materials, devices, systems, and nanotechnology. CFES activities include focused research, technical assistance, product evaluation and testing, and workforce education programs.

The CFES is currently concentrating on four technology areas: Fuel Cells and Hydrogen, Renewable Energy, Smart Lighting, and Smart Displays. However, the CFES is an agile organization that constantly monitors technology development and marketplace opportunities to shape its priorities and adjust its focus.

**Affiliated Faculty** P. Ajayan, B. Benicewicz, B. W. Bequette, I. Bhat, P. Chow, P. Dutta, A. Dyson, G. Eisman, M. Jensen, R. Leslie, S. Lin, T. Lu, L. Martin, N. Narendran, E. F. Schubert, M. Shur, J. Sun, C. Wetzel

**Staff** H. Merrill, R. Robertson, L. Valenti

## Center for Integrated Electronics

**Director:** Nag Patibambla

**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 CAIST program at Rensselaer is

sponsored jointly by the Semiconductor Research Corporation (SRC) and New York State, administered by the State University of New York at Albany. The technical direction of the program is shared between the Institute and SUNY-Albany. 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 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 includes Rensselaer, SUNY-Albany, Georgia Tech, MIT, and Stanford. Rensselaer's efforts focus on nanowire and molecular technologies, 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>).

**Connection One** This is a Rensselaer NSF Industry/University Cooperative Research Center involved in basic and applied interdisciplinary research in secure optical and electrical data transport switching, processing, materials, devices, systems, and information technology, enabling the massive scaling required by these systems. The research at RPI also addresses terahertz device design and characterization for VLSI testing and for wireless interconnects. This research is based on using plasma waves in semiconductors to carry information rather than relying on the electron drift, since the velocity of plasma waves is 10 to 20 times higher than the maximum electron drift velocity (visit <http://www.connectionone.org/>).

**Affiliated Faculty** P. Ajayan, R. Bizios, T. Borca-Tasciuc, T. Cale, P. Chow, N. DePaola, J. Dordick, D. Duquette, P. Dutta, J. Fish, J. Flaherty, D. Gall, B. Gill, R. Gutmann, B. Ishwara, S. Kalanaraman, R. Kane, R. Kersting, R. Kraft, G. Korniss, Y. Lecoz, L. Levinson, J. Lu, T.M. Lu, A. Maniatty, J. McDonald, D. Millard, S. Murarka, D. Nalamasu, S. Nayak, A. Ostrogorsky, R. Parsons, P. Persan, C. Picu, J. Plawsky, G. Ramanath, G. Rymaszeewski, C. Ryu, A. Sanderson, J. Senkevich, M. Shephard, L. Schowalter, E.F. Schubert, M. Shur, D. Siegel, G. Slack, R. Spilker, D. Spooner, C. Steinbruchel, J. Sun, G.C. Wang, M. Washington, T. Zhang, X.C. Zhang

**Technical Staff and Support:** J. Barthel, R. Bragaspathi, V. Chaisson, D. Chichester, L. Couvillon, D. King, R. Kraft, J. McMahan, S. Nicholas, K. Orava, G.G. Pethuraja, J. Tedesco, A. Tyson

**Postdoctoral Associates:** N. Bajwa, D. Bentz, L. Ci, S. Lee, H. Li, S. Kar, R. Pati, R. Vajtai, T. Karabacek, S. Sahoo, P-I Wang

**Visiting Scholars:** Y. S. Kim, Q. Yan

## Rensselaer Nanotechnology Center

**Director:** Richard W. Siegel

**Home Page:** <http://www.nano.rpi.edu>

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

**Visiting Scholar:** S. Sen

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**Postdoctoral Associates:** S. Brooks, L. Coulombel, S. J. Kwon, T. Liu, W. Shang, S. Shenogin, G. Zhu

**Research Staff:** R. Vajtai, H. Yang.

## 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. Koblinski, 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

**Research Associate:** A.C. Bauer

**Research Scientists/Engineers:** C. Dupre, D. Godavarty

**Post Doctoral Research Associates:** S. Amanuel, E. Bohr, M. Cloirec, D. Littlewood, X. Luo, J. Mueller, H. Waisman

**Administrative Staff:** K. Orava, 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 (e.g., 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 more recent projects involve the development of a multimedia tool to teach Greek as a second language (in collaboration with the Hellenic American Union), a simulation/training experience for intelligent transportation systems operators (at Traffic Operations Centers), educational materials to support engineering and computer science (through a number of NSF supported efforts), nanotube-based sensor R&D modeling (an NUE project), and a web-based interactive play/musical. 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; A. Yu, Systems Administrator