

Electrical and Computer Engineering



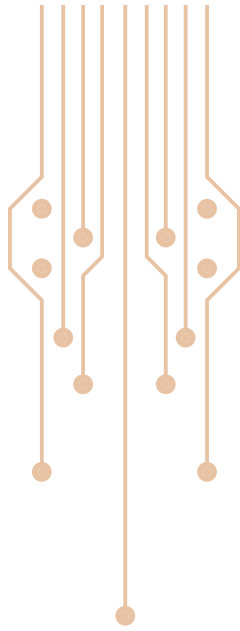
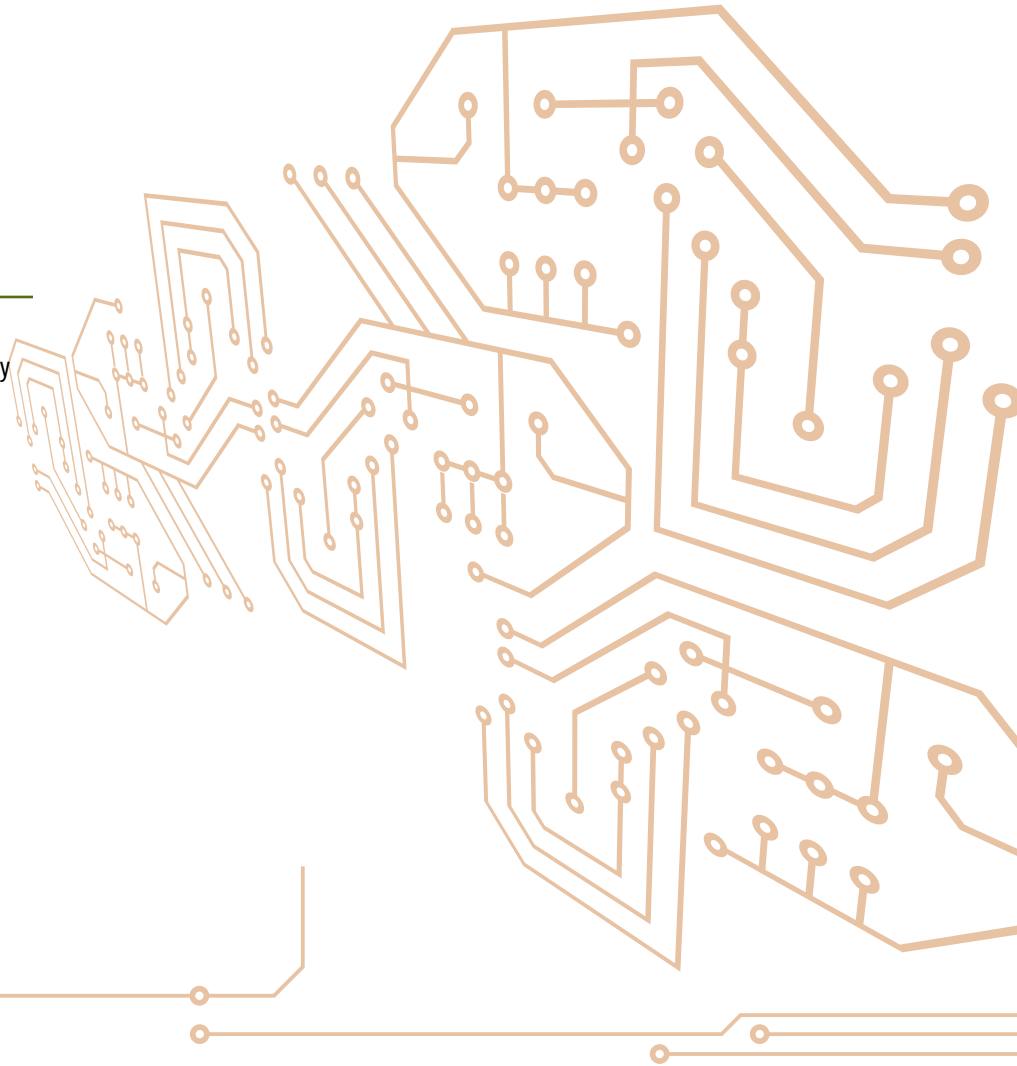


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CLEMSON
UNIVERSITY

The Holcombe Department of Electrical and Computer Engineering

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The ECE Tradition at Clemson University

Clemson University is a nationally ranked science- and technology-oriented public research university known for its emphasis on collaboration, focus and a culture that encourages faculty and students to embrace bold ideas. Its teaching, research and outreach are driving economic development and improving quality of life in South Carolina and beyond. Clemson is a high-energy, student-centered community dedicated to intellectual leadership, innovation, service and a determination to excel.

The Holcombe Department of Electrical and Computer Engineering (ECE) has been a part of Clemson University from its inception, as more than half of the first graduating class received degrees in mechanical-electrical engineering in 1896. One of the oldest engineering departments at the University, ECE was officially formed in 1933, adding a graduate degree program in electrical engineering in 1948 and awarding its first doctoral degree in 1967.

The department is now one of the largest and most active at Clemson, with more than 40 faculty members who teach and perform research in a broad range of topics in electrical engineering and computer engineering. Many members of our faculty are known nationally and internationally, and among our ranks are several IEEE Fellows, two endowed chairs and seven named professorships. In addition, several of our young faculty members have recently won prestigious national and international awards and grants.

Many of our alumni have reached the highest levels of professional achievement. Our student body currently numbers more than 400 undergraduates and 168 graduate students, of whom 87 are Ph.D. candidates. The department offers a rich curriculum, which comprises more than 60 undergraduate courses and 80 graduate courses. Our ratio of students to faculty is low, and we are proud of the Clemson tradition of close interaction among faculty and students.





Graduate Studies

Research

ECE faculty and graduate students are involved in diverse and challenging research projects, and the department has received a number of grant awards from highly prestigious and selective national research programs. Research activities are conducted in fully equipped laboratories, many of which are housed in the state-of-the-art Fluor Daniel Engineering Innovation Building. Current research encompasses a wide spectrum of activities in the general areas of communications, electronics, computer architecture and intelligent systems.

The department is equipped with an extensive computer facility consisting of a variety of state-of-the-art mainframes, workstations and personal computers located in several open laboratories and in a large number of specialized research laboratories. In addition, there are many specialized research laboratories and centers supporting activities in speech and image processing, communications systems, wireless networks, robotics, control systems, computer architecture, VLSI design and testing, semiconductor materials and devices, photonics, fiber optics, microwave circuits, power systems, power electronics, computational electromagnetics, vehicle electronics, and plasma science.

For organizational purposes, the department's research activities are clustered into four major areas.

Communications: The communications research focus area includes the wireless communications program, applied electromagnetics, computer networks and digital signal processing. Faculty include Carl W. Baum, Chalmers M. Butler, John N. Gowdy, Stephen J. Hubbard, Todd Hubing, John J. Komo, Anthony Q. Martin, Daniel L. Noneaker, L. Wilson Pearson, Michael B. Pursley, Harlan B. Russell, Kuang-Ching Wang and Xiao-Bang Xu.

Electronics: The electronics group has active research projects in the areas of nanoelectronic materials processing, solid-state device modeling, solar cells, biochips, power electronics, plasma displays, flexible electronics, nanophotonics, integrated optics, semiconductor lasers, optical systems, microwave circuits and integrated circuit design. Faculty include John Ballato, Michael A. Bridgwood, E.R. "Randy" Collins, Liang Dong, W. Rod Harrell, James E. Harriss, Todd Hubing, Anthony Guiseppi-Elie, Eric G. Johnson, Sung-O Kim, Kelvin F. Poole, Rajendra Singh, Pingshan Wang and Lin Zhu.

Computer Systems: The computer systems focus area includes computer architecture, high-performance computing, computer security, penetration testing, system audit and monitoring, reconfigurable computing, embedded systems and software engineering. Faculty include Jim Bottum, Richard R. Brooks, Jill Gemmill, Adam W. Hoover, Walter B. Ligon III, William J. Reid III, Robert J. Schalkoff, Haiying (Helen) Shen, Melissa C. Smith, Barr von Oehsen and David White.

Intelligent Systems: The intelligent systems group has active research projects in the areas of computer vision; sensor fusion; sensor networks; robotics; image processing; nonlinear estimation and control; biological modeling; bioprinting; autonomous air, ground and water vehicles; situation and threat assessment; and power systems. Faculty include Stanley T. Birchfield, Richard R. Brooks, Karen Burg, Timothy C. Burg, Darren M. Dawson, Keith Green, Richard E. Groff, Adam W. Hoover, Elham B. Makram, Robert J. Schalkoff, Joachim Taiber, Ian D. Walker and Guigen Zhang.

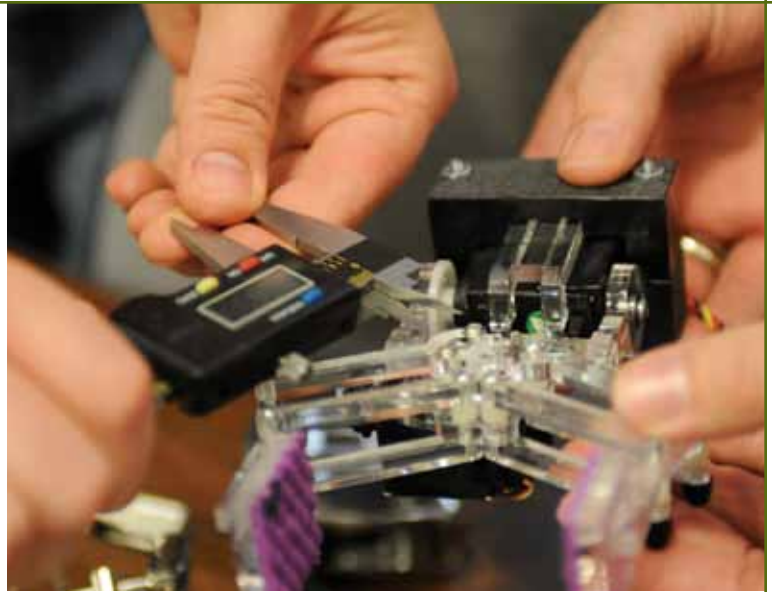
Joint programs are maintained with other units within the College of Engineering and Science, as well as with the Center for Optical Materials Science and Engineering Technologies; Clemson Computing and Information Technology; Clemson University International Center for Automotive Research; Center for Bioelectronics, Biosensors and Biochips; Institute for Biological Interfaces of Engineering; and Institute for Intelligent Materials and Systems for Architecture.

Research Resources

Many state-of-the-art research facilities are available to students in the ECE department.

- Center for Research in Wireless Communications
- Clemson University Electrical Power Research Association
- Center for Optical Materials Science and Engineering Technologies
- Clemson Computing and Information Technology
- Clemson University International Center for Automotive Research
- Center for Bioelectronics, Biosensors and Biochips
- Institute for Biological Interfaces of Engineering
- Electron Microscope Facility
- Wireless Communications and Networks Facilities
- Image Processing and Artificial Intelligence Research Laboratory
- Computational Electromagnetics Laboratory
- Microelectronics Research Laboratory
- Parallel Architecture Research Laboratory
- Power Quality and Industrial Applications Laboratory
- Robotics and Mechatronics Laboratory
- Speech Processing Laboratory
- Vehicular Electronics Laboratory
- Microstructures Laboratory (Clean Room)

For more information on research facilities and centers in electrical and computer engineering, please visit clemson.edu/ces/ece/research.



Degree Programs

Master of Science Degrees

The ECE department offers M.S. degrees in both electrical engineering and computer engineering. Students who enroll in the M.S. program may choose an all-course-work option or a thesis option. Each M.S. student must take a final examination (oral and/or written) administered by his or her advisory committee.

Each M.S. student must satisfy course requirements for one of seven technical focus areas and may also include a minor area in the degree program. The addition of a minor requires two courses (six hours) in an area outside of the major, such as math, physics, computer science or industrial engineering, as approved by the department's advisory committee.

All-Course-Work Option: Students choosing an all-course-work plan of study must include a minimum of 33 credit hours with at least 18 being at the 800 level. Nonthesis students receive a final examination consisting of an oral review. The candidate must also submit a written summary of a published paper that has been approved by the student's advisory committee.

Thesis Option: The thesis-option student must write a thesis that is approved by the advisory committee and the Graduate School. The thesis-option student must take a minimum of 30 credit hours, including 12 credit hours at the 800 level and an additional six hours of ECE 891 (Master's Thesis Research). *Advisers frequently require that students who are supported as research assistants choose the thesis option. Students anticipating continued studies toward the Ph.D. should also strongly consider the thesis option.* Thesis students must pass a final examination consisting of an oral defense of the thesis or report.



Graduate Level Certificates and Interdisciplinary Programs

Engineering Education Certificate: The Department of Engineering and Science Education offers ECE graduate students the opportunity to earn a Certificate in Engineering Education. This educational experience is designed for graduate students who seek experience in preparation for an academic career and wish to further their understanding of the education process in engineering. This certificate program includes a range of courses that may be chosen to address specific research questions or interests.

Technology Entrepreneurship Certificate: The Technology Entrepreneurship Certificate is available to graduate students in engineering and science disciplines across campus. The certificate is intended to serve those students who envision an entrepreneurial career as their long-range career goal, want to be involved in new product and new business activities within a corporate setting, or seek a better understanding of the process of commercializing inventions.

Advanced Power Systems Engineering Certificate: Recent blackouts around the world led the power engineering community to develop new, innovative methods for wide area monitoring, protection and control, wireless communication and smart grid systems. Discussions with leaders in the power industry and academia indicate that many power engineers do not have the necessary background to tackle these challenging problems related to modern power systems. To address this need, the Advanced Power Systems Engineering Certificate Program provides power engineers with an opportunity to attack more sophisticated problems associated with power systems protection, dynamics/stability, transients and distribution.

Graduate Degree Programs in Photonics: The Photonics Graduate Degree Program is an interdisciplinary degree program designed to expand a student's knowledge beyond the boundaries of traditional departmental-based graduate programs. Specifically, graduate students at the M.S. and Ph.D. levels participate in cross-departmental research, take application-related classes from multiple engineering and science departments, and develop workplace-related skills in a modern laboratory environment.

Master of Engineering Degree

The department also offers a Master of Engineering (M.Engr.) program in electrical engineering to off-campus students who take courses through Clemson's Distance Education Program (DE). DE does not require students to satisfy a focus area requirement, and the student submits an engineering report in lieu of a conventional master's thesis. The engineering report is fundamentally the same as a thesis but is required to conform to the formatting standards of the College of Engineering and Science (CES), as opposed to University thesis standards.

Doctor of Philosophy Degrees

The Ph.D. programs in electrical engineering and computer engineering each require 24 hours of graduate course work and 18 hours of research beyond the master's degree. Direct entry into the Ph.D. program is available for highly qualified students with baccalaureate degrees. Additional graduate course work is required of direct-entry students.

Each student in the program must pass qualifying and comprehensive exams, complete a written dissertation and pass an oral defense of the dissertation. Each Ph.D. candidate selects a major adviser who, in consultation with the student, chooses additional advisory committee members. The student's advisory committee must include at least four tenure-track faculty members, with three being from within the ECE department and one from outside the department.

Graduate Application Procedure

Admission is based on the applicant's record of academic performance, standardized test scores and letters of reference. Applicants to the M.Engr. program are not required to submit standardized test scores. Each applicant should highlight relevant work experience and detail academic goals and research interests in a written statement of purpose. Interested students may apply online at www.grad.clemson.edu/Admission.php.

Students who seek admission are encouraged to apply by the following deadlines:

Fall semester	March 1
Spring semester	August 1
First summer session	December 1

Financial Aid

ECE funds graduate students in two ways: departmental assistantships and research assistantships. Departmental assistantships are offered to select students at the beginning of their enrollment at Clemson. The ECE department chair offers departmental assistantships, which typically cover four semesters for M.S. students and six semesters for Ph.D. students, contingent upon satisfactory performance and progress toward the degree. Research assistantships are offered directly by departmental faculty. Some students have joint assistantships consisting of both a part-time teaching assistant position and a part-time research assistant appointment.

Various fellowships are available from the ECE department, CES, the University, industry, philanthropic organizations and federal agencies. Many of these fellowships are restricted to citizens of the United States.

Students submitting completed applications for admission are automatically considered for departmental and University assistantships and fellowships. A student may be admitted to the program without receiving an offer of financial support.

For Further Information

For more information on graduate studies in electrical and computer engineering, please visit clemson.edu/ces/ece/grad.



Undergraduate Studies

Electrical and computer engineers have been uniquely responsible for developing many of the innovations that have brought us modern life, and they are urgently needed today to help solve a variety of global problems, including challenges related to energy, communications, health care, global warming and national security. Specifically, electrical and computer engineers create innovative technology solutions in a wide range of areas, from handheld communications to solar panels; from cardiac pacemakers to autonomous robots; from wireless networks to bioengineered sensors that detect dangerous pathogens; and intelligent surveillance systems that perform face and motion recognition.

Electrical engineering underpins many other engineering disciplines, encompassing biomedical devices technology, microelectronics, information systems, wireless communications and signal processing, power systems, lasers and optics, electronic devices, computer software-hardware integration and control systems.

Computer engineering involves the fusion of electrical engineering, computer science and mathematical analysis for the design, development, testing and evaluation of computer-vision systems, robots, microprocessors, supercomputers, MP3 players, security/cryptographic systems and network protocols.

Undergraduate Curriculum

To address the many aspects of electrical and computer engineering, the undergraduate curriculum builds on the foundation of mathematical and physical sciences in a systematic manner to allow students to progress into the application areas of circuits, electronics, communications, controls, power, computer architecture, software-enabled systems and electromagnetics.

In addition to these technical skills, students learn to communicate effectively, both orally and with the written word. Because engineers work for the benefit of society, the curriculum includes a strong component of humanities and social science courses. Many project design assignments enable the development of interpersonal, teamwork and management skills, which are necessary for success in a professional engineering career.

Taking all these aspects into account, the ECE undergraduate curriculum has been designed to produce graduates who will

- demonstrate peer-recognized expertise in selected core areas of electrical and computer engineering;
- manifest the desire and capability to grow continuously in professional ability with lifelong learning through graduate study or professional improvement opportunities and through self-study;
- exhibit leadership and initiative to advance professional and organizational goals and facilitate the achievement of others in existing as well as new enterprises;
- communicate effectively, both orally and in writing; and
- function well on multidisciplinary teams to solve distributed tasks that may span enterprises, geographies and cultures.

Program Highlights

Honors Program and Research Opportunities: The ECE department has one of the most extensive honors programs in the college, consisting of four honors-only courses taken during the sophomore and junior years and a senior honors thesis research project. In addition, students can gain valuable research-related experience by working under the supervision of an ECE faculty member on a summer or academic-year research project.

Two-Semester Capstone Design Experience: The capstone design experience is a team-based competition where small groups of students in the course compete against each other using state-of-the-art equipment to program mechatronic systems for a given task. For example, students in a recent capstone design course programmed a miniature helicopter to automatically take off and fly to a designated landing area.

IEEE Student Competition Project Course: In this student-led course, ECE undergraduates work together to plan, build and program a robot to meet a challenge set forth each year for the IEEE Southeastcon Robotics Competition where they compete against teams from universities across the Southeast. Students are able to participate in this project course multiple times, gaining hands-on experience and leadership skill.

Summer Online Courses: All required courses in the undergraduate electrical engineering program and several required courses in the undergraduate computer engineering program are now offered online during summer sessions. These online courses allow students to stay on track during

Co-op experiences, get ahead in the curriculum track or retake a course while off-campus during the summer. The online lectures are also available as an additional resource for students taking the courses during the fall and spring semesters.

iLab Course and Lab: In the ECE 272/ECE 273 course and lab sequence, students receive instruction on programming and laboratory experience developing applications for the iPhone, iTouch and iPad. These applications and devices are used in future labs.

Biomedical Elective Technical Track: The focus on health-related issues is increasing the demand for better medical devices and equipment; hence, electrical and computer engineers are increasingly selecting job opportunities at hospitals, medical research corporations, equipment manufacturing firms and government regulatory agencies. To address this need, the ECE department offers a biomedical elective technical track that focuses in the areas of organ replacement, bioinstrumentation and bioimaging.

Renewable Energy Elective Technical Track: As the nation works to break its dependence on carbon-based fuel and increase the use of renewable energy sources, the potential widespread use of renewable resources represents a major paradigm shift for the electric power industry. To address this need, the ECE department offers a renewable energy elective technical track that focuses in the areas of solar power, wind power and grid penetration.

Electric Vehicle Elective Technical Track: As vehicle electrification expands, the automotive industry's need for electric-vehicle-savvy engineers is growing, thus creating increased demand for the associated electronic and software engineering education. To address these issues, the ECE department has created a new undergraduate-level elective track focused on key engineering skills for the development of electrified vehicles.

Entrepreneurship Programs: An entrepreneurship minor is available to undergraduate students in engineering and science disciplines across campus. This set of courses is intended to serve students who desire to supplement their undergraduate engineering degree with expertise related to accounting, finance, management, new product development and commercialization of inventions. In addition to the entrepreneurship minor, ECE students can also substitute an executive leadership and entrepreneurship course for one of the required humanities electives.



ECE Plugged In: The Electrical and Computer Engineering Plugged In Program is aimed at connecting current ECE students with ECE alumni or strong ECE advocates who serve as mentors. The mentors contact their mentee students throughout the academic year to help keep them motivated and excited about electrical and computer engineering.

Newly Renovated Laboratories and Classrooms: All classrooms and labs in the ECE department's main building, Riggs Hall, have been recently renovated. All undergraduate laboratories are also furnished with modern National Instruments equipment and new computer systems.

B.S. Degree Accreditation

Undergraduate students at Clemson can earn B.S. degrees in either electrical or computer engineering. Both programs are accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET), the recognized national accrediting agency for professional curricula in engineering.

ABET has defined the curricular objectives of an engineering education. Accordingly, we prepare our undergraduates to demonstrate

- a capability to delineate and solve, in a practical way, the problems of society that are susceptible to engineering treatment;
- a sensitivity to the socially related technical problems that confront the profession;

- an awareness of the ethical characteristics of the engineering profession and practice;
- knowledge of the engineer's responsibility to protect safety and occupational and public health; and
- an ability to maintain professional competence through lifelong learning.

Undergraduate Admission

Applicants in all fields of engineering are admitted into the University's general engineering program. Admission is competitive and based on the following factors:

- Class standing
- Standardized test scores (SAT or ACT)
- High school curriculum
- Grades

Transfer applications are reviewed on a rolling basis. Admission is based on both high school performance and the quality and amount of previous undergraduate study. Transfer applicants are also admitted into general engineering and must complete the common freshman curriculum before full admission into an engineering baccalaureate program.

For an online application and admissions information, visit clemson.edu/admission.

For Further Information

For more information on undergraduate studies in electrical and computer engineering, visit clemson.edu/ces/ece/undergrad.



John Ballato

Professor of Materials Science and Engineering

Professor of Electrical and Computer Engineering

B.S. Ceramic Science and Engineering, Rutgers, the State University of New Jersey, 1993

Ph.D. Ceramic and Materials Engineering, Rutgers, the State University of New Jersey, 1997

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Academics and Experience

John Ballato is the associate vice president for research and economic development at Clemson University where he champions the University's research and economic development in all areas of advanced materials. He is also director of the Center for Optical Materials Science and Engineering Technologies (COMSET), which is a South Carolina Research Center of Economic Excellence. He has published more than 160 archival scientific papers, holds 25 U.S. and foreign patents, has given in excess of 125 invited lectures/colloquia, and has co-organized 25 national and international conferences and symposia.

Ballato has been a PI on more than \$35 million worth of sponsored programs, gifts and contracts, including a \$10 million Endowed Chair in Optical Fiber from the state of South Carolina. He is an associate editor of the *Journal of the American Ceramic Society* and is an active participant on the Optoelectronic Glasses technical committee for the International Commission on Glass and the Ferroelectrics Standards Committee of the IEEE Ultrasonics, Ferroelectrics and Frequency Control Society.

Research

Ballato's research interests include the optical properties of materials; optical fiber fabrication; photonic bandgap materials and structures; and rare-earth doping for active and passive applications including lasers, optical amplifiers and isolators. His research focuses on new optical materials and structures for high-value photonic and optoelectronic applications. This includes light-emitting nanoparticles for transparent ceramics, lighting and sensing applications. Additionally, Ballato's group develops specialty optical fibers for high-energy laser, biomedical and industrial uses. His innovations have led to a number of important advances including

- the powder-in-tube method for directly fabricating optical fibers from unstable or unusual compositions;
- record Faraday rotation in a fiberizable aluminosilicate glass;
- hole-blocking in carbon nanotubes nanocomposite organic light-emitting diodes;
- high efficiency and high gain rare-earth doped polymer nanocomposites;
- first ultra-large mode area optical fibers utilizing the index antiguiding gain-guiding phenomenon;
- first core/multi-shell doped nanoparticles that can control the energy transfer between dopants;
- simple formalism to make slow light structure from a wider variety of commodity materials;
- first fabrication of sub-wavelength grain-sized highly transparent sesquioxide ceramics;
- first use of scalable manufacturing processes to fabricate highly crystalline semiconductor (Si and Ge) core optical fibers.

Ballato's research interests include the optical properties of materials; optical fiber fabrication; photonic bandgap materials and structures; and rare-earth doping for active and passive applications including lasers, optical amplifiers and isolators.

Academics

Carl Baum received his B.S. degree with highest distinction from the University of California at Los Angeles in 1987. While attending the University of Illinois for his M.S. and Ph.D. degrees in electrical engineering, he received the Robert Chien Memorial Award for excellence in research in the field of electrical and computer engineering. Baum joined Clemson University in 1992 and received the 1996 IEEE Browder J. Thompson Award and the 1998 McQueen Quattlebaum Faculty Achievement Award.

Research

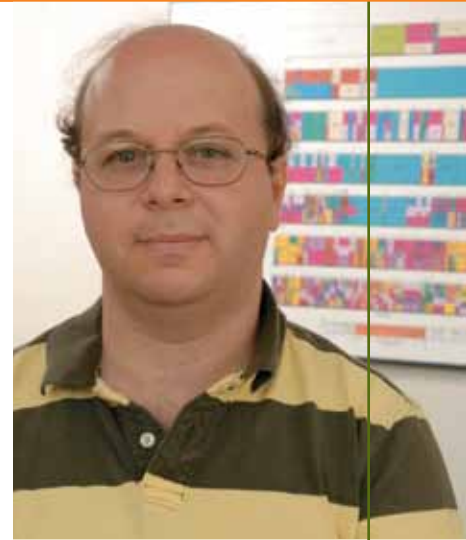
Baum's research interests fall in the general areas of communications theory, coding theory, and detection and estimation theory. One focus of his research has been in the design and performance analysis of receivers for coded wireless spread-spectrum communication in both military and commercial systems. He has also developed algorithms for coordinated and uncoordinated channel sharing for wireless ad hoc and sensor networks. In addition, his research has made contributions to

the fundamental understanding of the design of sequential multihypothesis tests, a form of decision theory in which the goal is to make a decision classification from noisy data in such a way that a metric incorporating both the speed and the accuracy of the decision is optimized.

One current area of research involves the analysis and design of computer simulations that model the traffic of mobile nodes in a communication network. Of particular interest is the effect of mobility models on the predicted performance of both ad hoc networks and networks with centralized control.

Baum's research interests fall in the general areas of communications theory, coding theory, and detection and estimation theory.

Baum is also investigating the design of protocols for spectrum sharing involving multiple wireless communication networks that share the same region of space. Receiver design continues to be a research interest, with particular focus on hardware/software interface issues in software radio systems. In addition, Baum is always interested in novel applications of detection and estimation theory, from the detection of nuclear radiation via anti-terrorism monitoring networks to modeling the effects of human and organizational decision making.



Carl W. Baum

Associate Professor of Electrical and Computer Engineering

B.S. Electrical Engineering, University of California at Los Angeles, 1987

M.S. Electrical Engineering, University of Illinois at Urbana-Champaign, 1990

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Stan Birchfield

Associate Professor of Electrical and Computer Engineering

B.S. (Honors) Electrical Engineering, Clemson University, 1993

M.S. Electrical Engineering, Stanford University, 1996

Ph.D. Electrical Engineering, Stanford University, 1999

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Academics and Experience

Stan Birchfield began his research at Stanford, where he was part of the team that won first place at the AAAI Mobile Robotics Competition of 1994, and where he was supported by an NSF Graduate Research Fellowship. From 1999 to 2003, he was a research engineer with Quindi Corp., where he developed algorithms for intelligent audio and video and was the lead engineer and principal architect of the Meeting Companion product. His experience in software engineering has led him to develop and maintain open-source computer vision software, such as the Kanade-Lucas-Tomasi feature tracker. Over the years he has worked with or consulted for various companies, including Sun Microsystems, SRI International, Canon Research Center and Autodesk.

Research

With research interests in computer vision, stereo correspondence, visual tracking, microphone array calibration, acoustic localization and mobile robot navigation, Birchfield has specialized into three main branches.

Vehicle Segmentation, Tracking and Classification

State departments of transportation around the country have installed thousands of cameras along the highway, primarily in urban areas. Because of the copious amount of data, there is a need to automatically process live video from these cameras to quickly determine vehicle counts, speeds and classes (e.g., cars, trucks or motorcycles). This can be applied to traffic planning, incident detection and roadway safety. Birchfield and his students are developing computer-vision software for this automatic video processing in real time as well as methods for automatically calibrating cameras so the software will work with pan-tilt-zoom cameras.

Interactive Perception

Humans routinely shuffle through papers on a desk or sift through objects in a drawer to quickly identify items of interest. In such cases, it is a person's interaction with the environment that improves his or her understanding of the surroundings. So, theoretically, deliberate actions can change the state of the world in a way that simplifies perception and, consequently, future interactions. Birchfield's group is researching interactive perception in which a robot retrieves and manipulates objects in a cluttered environment. The group pays particular attention to 3D reconstruction, articulated objects and non-rigid objects with infinite degrees of freedom — such as clothes for household laundry applications.

Mobile Robot Mapping and Navigation

The ability of a mobile robot to navigate a new environment, build a map of the environment and follow a path between two locations is important for many applications. For example, a robot may need to deliver items from one office to another; transport parts from one machine to another in an industrial setting; travel along a prespecified route to give a tour of a facility; or a team of robots may need to follow the path taken earlier by a scout robot. This research is developing software to enable automatic map-building and navigation of a mobile robot using a camera mounted on the front. Because the algorithms generally do not require calibration, they are easy to use and applicable to mass deployment. The team is also looking at ways of combining the two representations that psychologists have determined are important for humans to navigate an environment, namely route (images captured at run time) and survey (top-down) representations.

Birchfield's research interests are in computer vision, stereo correspondence, visual tracking, microphone array calibration, acoustic localization and mobile robot navigation.

Professional

Jim Bottum is the chief information officer and vice provost for computing and information technology at Clemson University. He leads efforts focusing on high-performance computing and communication as well as collaborating with state and national governmental entities. During his tenure, *ComputerWorld* named him one of the Premiere 100 IT Leaders (2007) and *Storage Magazine* featured him on the cover of its January 2008 edition. Under his leadership Clemson's Palmetto Cluster (HPC) has appeared at No. 60 in the world's Top 500 Computing Sites (top500.org) alongside Clemson's Computational Center for Mobility Systems (CU-CCMS), ranked at No. 100 (November 2008).

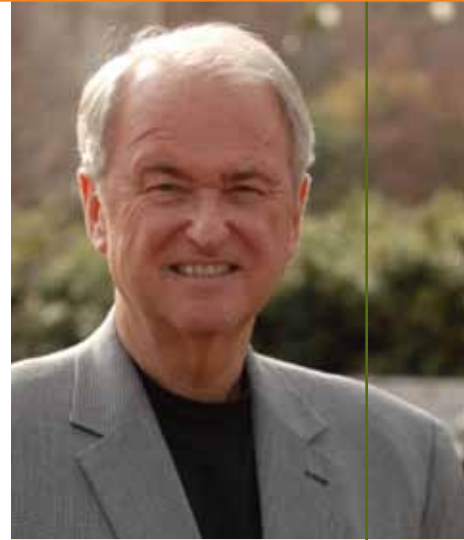
Prior to coming to Clemson, Bottum was the first CIO and VP for computing at Purdue, where he was responsible for planning and coordinating all computing and information systems across the university. He had direct oversight of the university's central IT organization, Information Technology at Purdue (ITaP). Under his leadership, ITaP was recognized nationally for innovative uses of information technology to improve teaching and learning, including classroom response systems, technology classroom sites and podcasting as a centralized service. In the fall of 2005,

Bottum leads efforts focusing on high-performance computing and communication as well as collaborating with state and national governmental entities.

laboratory boards, Educause working groups and other higher education committees and consortiums. He has provided consulting services for major universities across the U.S. and is frequently an invited keynote presenter at state, regional and national conferences regarding cyberinfrastructure and high-performance computing.

these innovative approaches were recognized by *Newsweek* and with a cover story in the *Chronicle of Higher Education*. Bottum has also had experience as executive director for the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign.

He currently serves on the NSF Advisory Committee for Cyberinfrastructure, the NSF Advisory Committee for CRPA Assessment and the Internet 2 Board of Trustees. In the past, he has served on other NSF committees as well as national



Jim Bottum

Research Professor of Electrical and Computer Engineering

B.A. Political Science, Florida State University, 1976

Professional Certification Urban and Regional Planning, Florida State University, 1976

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Michael A. Bridgwood

Associate Professor of Electrical and Computer Engineering

B.S. Electrical and Electronic Engineering, Leeds University, 1968

M.S. Control Technology, University of Portsmouth, 1975

Ph.D. Electrical Engineering, University of Portsmouth, 1979

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Academics and Experience

Michael Bridgwood works in the Center for Semiconductor Reliability Research. He has been involved in naval EMC research specifically targeted at tracing the coupling mechanisms that enable the propagation and multiplication of impulsive interference in extensive systems. Earlier in his career, he was a control and instrument engineer in the development of atmospheric control plants for the nuclear submarine program.

Bridgwood began his career as a process control and instrumentation engineer in 1968 with CJB Developments Ltd. in Leatherhead, Surrey (United Kingdom). His prime task was the development of digital and analog control schemes for atmospheric control systems installed in nuclear submarines.

Research

In 1974, Bridgwood joined the faculty of the University of Portsmouth where he investigated the generation and coupling processes associated with wide-band interference aboard naval ships. He became a member of the faculty at Clemson University in 1981 where, until 1993, his research interests were focused on the effects of electrostatic discharge on VLSI circuits for the Semiconductor Research Corp. From 1994 through 1998, he was involved in a multidisciplinary optimization design and analysis project sponsored by NASA. He began work in the area of power quality in September 1996. This work, sponsored by Duke Power, was concerned with quantifying the effects of lightning and fault-induced voltage sags on the performance of industrial process equipment. In 2001, Bridgwood began modeling the interfering effects of high-power microwave transients on CMOS logic devices sponsored by the U.S. Air Force under a multiple university research initiative. This work is ongoing.

Bridgwood is currently modeling the interfering effects of high-power microwave transients on CMOS logic devices.

Consultancies

- Spectrodyne Inc., Colmar, Pa., August 1998, redesign of optical pyrometer system in conjunction with a class of students (ECE 622)
- Tennessee State University, Nashville, Tenn., August 1997, a one-day course given as consultant on communications aspects of basic mathematical analysis
- AT&T, Liberty, S.C., March 1995, statistics of failure analysis in PC production
- Fibertech Corp., Anderson, S.C., 1983, development of software to calculate load/deflection parameters of structure for a 150-ton hydraulic press associated with antenna manufacture
- Calle Infotec Ltd., U.K., 1977, electromagnetic interference glitches on local installation of data retrieval and copying system
- CJB Developments Ltd., U.K., 1974-1981, process control and instrument calibration procedures
- McCorquedale Ltd., U.K., 1976, electromagnetic interference problems in secure access system
- Avery Hardoll, Ltd., U.K., 1975, electromagnetic interference problems on prototype gasoline pump system

Academics and Experience

Richard Brooks is the principal investigator (PI) on research programs currently funded by the Army Research Office (ARO), the Office of Naval Research (ONR) and the BMW Corp. These research projects are in coordination with missions involving autonomous combat vehicles, situation and threat assessment for combat command and control, and security analysis of cellular networks used for vehicle remote diagnostics. Brooks' current research interests include game theory, strategic reasoning, information assurance, use of statistical physics insights for distributed systems design and fusion of heterogeneous real-time sensor feeds.

Research

Brooks' research concentrates on distributed systems that interact with the real world and adapt to disturbances. Many of these systems are networks of embedded systems. He is currently concentrating on the application areas of self-organization, sensor networks and information assurance.

In particular, Brooks is concentrating on large systems characterized by peer-to-peer coordination of a large number of resource-constrained devices. Each node's behavior contains some random component, which is regulated by positive and negative feedback. When done correctly, this allows for global autonomous adaptation. Each node can also change its local software configuration using mobile code technology. Frequently, the application areas considered contain an adversary.

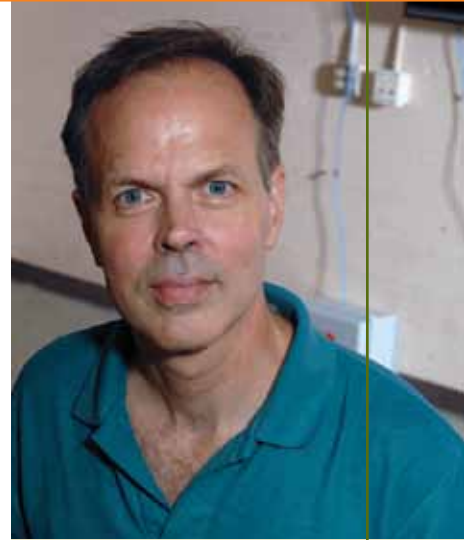
Brooks' research concentrates on distributed systems that interact with the real world and adapt to disturbances.

Highly distributed systems are difficult to design. It is especially difficult to predict the global evolution of systems with partially stochastic behavior. System design problems are approached in three steps:

- evaluation of simulations at a very abstract level,
- transition of the more promising results into a higher fidelity simulation (such as NS-2 or a number of robot simulations), and
- live testing of implementations in prototype systems.

At each level, an increasingly large number of random errors and environmental disturbances are introduced. Empirical analysis of results for the abstract problem allows for a large number of possible solutions. The implementation effort at the lower levels concentrates on potential solutions shown to have a high probability of success. The simulations contain visualization tools that help researchers understand the behavior of a global system implied by local node behaviors. There has been success with this approach in designing routing behaviors for sensor networks in urban terrains and creating distributed reconfiguration protocols as denial of service attack countermeasures.

Important tools in this work include game theory, linear algebra and probability theory. The games considered may be differential games, two-player zero sum games, games on Markov chains, combinatorial games or some grouping thereof. Typical applications include computer security, command and control, or sensor networks.



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Karen J.L. Burg

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B.S. Chemical Engineering,
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Ph.D. Bioengineering, Clemson
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Research

Development of Absorbable Systems

Absorbable materials are advantageous in that they require no surgical retrieval after implantation, and, if designed appropriately, they absorb gradually with no lingering effects. Current projects include the evaluation of absorbable bioelastic materials as well as the fabrication of absorbable materials conducive to vascular ingrowth. Additionally, the basic absorption mechanisms, such as autocatalytic effect, are investigated. This work is supported by Clemson University as well as the National Science Foundation.

Assessment of Cellular Adhesion

The cell-cell interaction and the cell-biomaterial interaction are both critical features of tissue engineering. Current research projects involve the development of customized polymeric substrates for vascular tissue engineering. This involves the design of bioreactor systems for vessel/valve development and analysis of cellular behavior in flow chambers. Related research efforts address the manipulation of stem cells for soft tissue engineering. This work is sponsored by DARPA.

Magnetic Resonance Imaging for Tissue

Engineering Application

Absorbable polymers can be very sensitive to histological processing protocol. This effect is enhanced in tissue engineering systems, which are often highly porous with relatively low amounts of tissue. Noninvasive methods of imaging are being developed to assess tissue development within porous, absorbable systems, both *in vitro* and *in vivo*. This work is sponsored by the National Science Foundation and is in conjunction with the Center for In Vivo Microscopy laboratory at Duke University.

Development of Orthopaedic and Dental Tissue Engineering Devices

Pore topography plays a critical role in the attachment of cells to a porous substrate. Changes in pore size and shape can radically affect the successful development of tissue. This work is sponsored by the AO Foundation and investigates novel methods of modulating pore structure and designing absorbable systems specifically for orthopaedic and dental applications.

Honors, Awards and Professional Activities

Invited Presenter, National Academy of Engineering Indo-America Frontiers of Engineering Symposium, 2008

Fellow, American Council on Education, 2006

Fellow, American Institute for Medical and Biological Engineering, 2006

AORF Research Prize, Arbeitsgemeinschaft für Osteosynthesefragen (AO) Foundation, Switzerland, 2006

The Governor's Young Scientist Award for Excellence in Scientific Research, 2006

Clemson University College of Engineering and Science Outstanding Young Alumnus Award, 2006

National Science Foundation Faculty Early Career (CAREER) Award recipient, 2001

Burg's work in tissue engineering, biofabrication and absorbable polymers is funded by the National Science Foundation and the Department of Defense, among others.

Academics and Experience

Tim Burg has an extensive background in nonlinear control theory, industrial control practice and sensor development. He received his doctorate from Clemson University in 1996. His dissertation, "Nonlinear Control Design for Mechatronic Systems to Reduce Sensor Count," demonstrated the design of control algorithms for nonlinear systems including electric motors and robotic systems with electric actuators. He co-authored the book *Nonlinear Control of Electric Machinery* and worked from 1996 to 2000 designing control systems for machine tools at Huffman Corp. in Clover, S.C. He then worked for Michelin Americas Research and Development Corp. from 2000 to 2005 where he developed and refined models for tire and vehicle performance and worked on the integration of electronic devices such as RFID and pressure monitoring into tires. Burg joined the Clemson faculty in the fall of 2005.

Research

Burg's research interests include application of nonlinear control design tools to robotics, unmanned aerial vehicles and haptics for surgical simulations.

Burg's research interests include application of nonlinear control design tools to robotics, unmanned aerial vehicles and haptics for surgical simulations.

Control of Aerial Vehicles

One of the fundamental (and long lasting) challenges facing UAV control development is to ensure that the craft can move to or hold a desired position and orientation. Specifically, the aircraft must be able to move from a current location to a new desired position and achieve a new orientation. It is at the low-level control that the peculiarities of the multi-bladed UAV system, such as nonlinearities and the fundamental fact that the system is under-actuated, must be addressed. An under-actuated system is especially challenging to control since it has

fewer control inputs than degrees of freedom (i.e., it has degrees of freedom that cannot be directly actuated). The control problem uses Lyapunov-based control design techniques adopted primarily from the field of robotics. A current sample project deals with the use of only output feedback and GPS position measurements to control a quadrotor helicopter.

Sample Collection with UAVs

Interaction of the aerial vehicle with a ground-based target creates the additional kinematic and dynamic complexities. Of particular significance is that in order to interact with the object, the robot must be able to apply and regulate the end-effector force, further exacerbating the under-actuated control problem.

Bio-Printing

Study focuses on developing the next generation systems that use drop-on-demand technology to print living cells into three-dimensional structures.

Haptics

Research is devoted to developing new uses for haptic feedback in applications such as laparoscopic surgery.

RFID Applications

Burg is developing applications for RFID technology such as insect tracking.



Timothy C. Burg

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Academics and Experience

Before joining Clemson University in 1985, Chalmers Butler was a member of the faculty at Louisiana State University, the University of Houston and the University of Mississippi. A member of Sigma Xi, Tau Beta Pi, Phi Kappa Phi and Eta Kappa Nu, Butler received the Western Electric Fund Award (1974) and the NCR/AT&T Excellence in Teaching Award at Clemson (1990-1991 and 1993-1994). He received the Editor's Citation for Excellence in Refereeing in *Radio Science* (1990 and 2003), the McQueen Quattlebaum Faculty Achievement Award, the Provost's Award for Scholarly Achievement (1994-1995), the Class of 1939 Faculty Achievement Award and the Alumni Award for Excellence in Research at Clemson University (2000). He received the Centennial Medal for Contributions to Electrical and Computer Engineering while at the University of Wisconsin, and he is a recipient of the IEEE Millennium Medal and the IEEE APS Chen-To Tai Distinguished Educator Award (2003).

Butler is a Life Fellow of the IEEE, and he has served as associate editor of the *IEEE Transactions on Antennas and Propagation* and *IEEE Transactions on Education*. A member of the IEEE Antennas and Propagation Society Administrative Committee (1976-1978 and 1988-1990), he also served as National Distinguished Lecturer (1977-1979).

Butler is a member of Commissions B and F of the International Union of Radio Science (URSI), and he served as chairman of U.S. Commission B and as International Commission B editor of the *Review of Radio Science*. Butler has also served as guest editor of two special issues of *Radio Science*. He served as secretary, vice chairman and chairman of the U.S. National Committee for URSI. He has been vice chairman and chairman of International Commission B of URSI. Presently, he is a vice president of URSI.

Butler's research has focused primarily upon Green's functions and integral equation techniques in electromagnetics.

Research

Butler's research has focused primarily upon Green's functions and integral equation techniques in electromagnetics. It has also included numerical methods for solving integral equations. His principal applications interests are antenna and aperture penetration. He has authored and co-authored more than 100 refereed journal papers and numerous book chapters in these research areas.

Academics and Experience

Randy Collins joined the ECE department at Clemson University in 1989 and presently serves as the associate dean of undergraduate and international studies in the College of Engineering and Science. He initiated the ECE department's online course development and delivery efforts and is a member of several IEEE societies, serving in various leadership capacities in the local IEEE Piedmont section. He is a senior member of the IEEE, a registered professional engineer in South Carolina, and is an airline transport-rated pilot and FAA-certified flight instructor. He is an active member of several committees writing international standards for power quality and presently serves as the chair of IEEE Standard 1159.

Research

Collins directs the research activities in the Power Quality and Industrial Applications (PQIA) Laboratory. He centers his work around voltage sags (short-term depressions in voltage) that are a common occurrence on power systems and cause file loss. Other disturbances happen as well and are part of normal power system operation and protection schemes. Unfortunately, the increase of sophisticated electronic equipment in industrial plants has rendered many industrial processes extremely vulnerable to these disturbances. In fact, it is estimated that more than a billion dollars of lost production occurs annually in the United States just due to voltage sags.

Collins directs the research activities in the Power Quality and Industrial Applications (PQIA) Laboratory.

Research in the PQIA lab focuses on the impacts power quality events have on end-use equipment. Recent investigations have identified and quantified power quality phenomena, utility-side mitigation of power

quality variations and load-side solutions for industrial and commercial applications. Additionally, PQIA is involved in research related to power electronics and power supplies.

Collins and the researchers in the PQIA lab are also partnering with researchers at the Clemson University International Center for Automotive Research – particularly, the Clemson Vehicular Electronics Laboratory – on research related to vehicular power systems, power electronics and energy management in hybrid and plug-in hybrid electric vehicles.



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McQueen Quattlebaum
Professor

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B.S. Electrical Engineering,
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Academics and Experience

After receiving his B.S. degree, Darren Dawson worked for Westinghouse as a control engineer from 1985 to 1987. In 1987, he returned to the Georgia Institute of Technology to work on his Ph.D. In July 1990, he joined the ECE department at Clemson University where he has held the endowed position of McQueen Quattlebaum Professor since 2001. From 2005 to 2007, he served as the ECE department graduate coordinator, and as of August 2007, he has been ECE department chair. Since June 2004, he has served on the Methode Board of Directors in which he currently serves on the technical and compensation committees. He is a senior member of the Institute of Electrical and Electronic Engineers and Sigma Xi.

Research

Over the last 20 years, Dawson has investigated the design and the experimental validation of advanced model-based controllers for mechatronic systems (e.g., electric motors, robot manipulators, overhead cranes, active magnetic bearings, flexible cables/beams, vision-based systems, automotive systems, unmanned vehicles, etc.). In these areas, his research group has attacked and solved several of the open problems associated with important and benchmark nonlinear control applications. Specifically, his work in generalized mechanical systems is often cited by other researchers as the first solution to the global adaptive output feedback tracking control problems for a general class of Lagrange Euler systems. He was also the first scholar to design, analyze and implement rigorously developed nonlinear algorithms for the important application area of sensorless control of induction motors. His work stands out from the typical control research in that the performance gains associated with his control theoretic work have been verified experimentally by his research group.

Dawson has authored and co-authored a graduate textbook, five research monographs, four book chapters, more than 165 journal papers and more than 300 conference papers. His research group has presented more than 300 talks at national/international conferences, universities and workshops. He has directed 32 completed Ph.D. dissertations and 51 completed master's theses. Dawson has served the control and robotics community in the following capacities: past associate editor of *IEEE Transactions on Control System Technology*, past associate editor of *Automatica* and numerous other conference program committees.

Dawson has investigated the design and the experimental validation of advanced model-based controllers for mechatronic systems.

Academics and Experience

Prior to joining Clemson University, Liang Dong served as senior technical manager at IMRA America Inc., R&D director at Lightwaves2020 Inc. and R&D manager at Corvis Inc. He also worked as senior scientist at Corning Inc. and managed optical fiber fabrication activities at Southampton University. Dong has more than 20 years of experience in research and development in photonics and optical fibers, covering a wide range of topics in materials, designs, simulations, photosensitive processes, nonlinear processes, optical amplifiers, lasers, active/passive optical devices and system integrations for wide-range applications such as telecommunications, industrial machining, medical and sensing.

He is the author of several invited articles and book chapters and has given numerous invited talks at international conferences. He has published more than 200 papers and has in excess of 20 granted patents. He has also served as a referee for many journals in optics and telecommunications, a member of conference committees, associate editor for *IEEE Photonics Technology Letters* and guest editor for *Optical Fiber Technology*. He currently serves as associated editor for *IEEE Quantum*

Electronics, as program chair for OSA topical meeting on Specialty Optical Fibers, and on program committees of Optical Fiber Communications Conference and Advanced Solid State Photonics.

Dong's current research focus is on the development of specialty optical fibers for high-power fiber lasers as well as design and construction of robust practical high-power fiber laser systems.

Research

In addition to Dong's ongoing interests in optical communications, his current research focus is on the development of specialty optical fibers for high-power fiber lasers as well as design and construction of robust practical high-power fiber laser systems for industrial, medical and defense applications.



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B.Sc. Electronics, Harbin
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Jill Gemmill

Research Professor

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Academics and Experience

Prior to coming to Clemson in 2007, Jill Gemmill spent more than 25 years in scientific computation and visualization, real-time programming, Internet network technology, middleware and e-security. As executive director reporting to Clemson's CIO and vice provost for information technology, Gemmill leads initiatives that enable new discoveries in research, teaching and service through integration of domain expertise with cyberinfrastructure.

Gemmill led an NSF-funded project establishing the industry standard (ITU H.350/IETF RFC 3944) by specifying integration of directory services with multiple video conferencing protocols. Subsequently, Gemmill led pioneer work demonstrating how managed university IT services, such as authentication and access control, could be leveraged for use in grids, partnering with the National Center for Supercomputer Applications to demonstrate the first use of Shibboleth for grid authentication. She is co-developer of the myVocs collaboration environment for virtual organizations.

Gemmill is a successful research scientist who has been PI or co-PI on nine federally funded grants totaling more than \$5 million. Her research has been funded by the NSF, National Institutes of Health, National Library of Medicine, Southeastern Universities' Research Association, South Carolina Research Authority and the UAB Health Services Foundation.

Research

- Community-specific (virtual organization), secure collaborative environments (experience to date with social science, health sciences, computational science, bioinformatics and ecology)
- Federated identity; authentication and authorization in distributed environments
- Network performance impact on applications
- Integration of visualization, computation and networks, and re-usable data in research domains

Gemmill's research is in collaborative environments, the impact of network performance on applications and integration of visualization, computation and networks.

Academics and Experience

John Gowdy was ECE department chair (1996 to 2007), and he previously served more than 10 years as the graduate program coordinator for the department. He is currently the ECE undergraduate program coordinator and assessment coordinator.

He is a recipient of the McQueen Quattlebaum Award (1976), the NCR Outstanding Teaching Award (1991), the AT&T Outstanding Teaching Award (1994) and the IEEE Millennium Medal (2000).

Research

Gowdy is founder and director of the Speech and Audio Processing Laboratory at Clemson. He and his students have worked on numerous projects in the area of speech processing – including speech recognition, audio-visual speech recognition, speaker recognition, speech coding, speech synthesis and analysis of foreign language sounds. The CUAVE audio-visual speech recognition database developed in Gowdy’s laboratory is used worldwide by researchers in this field.

Other research includes detecting artifacts in rotating objects, real-time quality analysis of yarn evenness and textile dyeing.

Gowdy is founder and director of the Speech and Audio Processing Laboratory at Clemson and has worked on numerous projects in the area of speech processing.

Component Analysis for Automatic Speech Recognition.” *Proceedings of the European Signal Processing Conference (EUSIPCO)*, Antalya, Turkey, Sept. 2005.

Narayanan, K., Gowdy, J. N. and Kumaran, R. “Myoelectric Signals for Multimodal Speech Recognition.” *Proceedings of INTERSPEECH 2005*, Lisbon, Portugal, Sept. 2005.

Recent Publications

Tufekci, Z., Gowdy, J., Gurbuz, S. and Patterson, E. “Applied Mel-Frequency Discrete Wavelet Coefficients and Parallel Model Compensation for Noise-Robust Speech Recognition.” *Speech Communication*; vol. 48, issue 10, pp. 1294-1307, 2006.

Kumaran, R., Gowdy, J. N. and Narayanan, K. “Language Modeling Using Independent



John N. Gowdy

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Keith Green

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Professional

Keith Green's research focus on interactive and adaptive buildings began with his master's thesis, the results of which won the Schiff Prize in Architecture of the Art Institute of Chicago. Following several years in professional architectural practice, he focused his doctoral research on how architecture might behave more like living things in response to human needs and opportunities. Before arriving at Clemson in 1999, Green was a tenured faculty member at the University of Auckland, New Zealand. At Clemson, he has been engaged in collaborative, cross-college research and teaching that is well-published, awarded national and international prizes, and supported by major federal grants. Green serves as founding director of Intelligent Materials and Systems for Architecture, a Clemson research unit partnering the School Architecture, the Holcombe Department of Electrical and Computing Engineering, and the School of Materials Science and Engineering. In addition to graduate teaching and thesis supervision, he delivers, with Ian Walker, the novel, cross-listed course ECE/ARCH 868 "Architectural Robotics: Intelligent and Adaptable Built Environments."

Green is a regular peer-reviewer and program committee member for ACM/IEEE conferences (including HRI, ACM Creativity & Cognition, and Design of Interactive Systems), and he co-hosts, with Mark Gross of Carnegie Mellon University, ARCHIBOTS, a workshop on "Architectural Robotics" last offered at Ubicomp. He is also a practicing, award-winning architect.

Green's research explores how the built environment — from small domestic objects to buildings to urban infrastructure — might behave more like living things in response to human needs

Research

Green's research explores how the built environment, at scales ranging from small domestic objects to buildings to urban infrastructure, might behave more like living things in response to human needs and opportunities in an increasingly digital society.

Supported by NSF, his research pursuits are, more specifically, aimed at designing, prototyping and evaluating "intelligent environments" with embedded robotics. The contexts for these projects include computer-supported collaborative work, aging in place and learning environments cultivating STEM interest and creativity in children.

The Animated Work Environment (AWE)

AWE is a user-programmable, robotic environment that dynamically shapes and supports the working life of collaborators using digital and analog materials and tools. AWE is composed of eight hinged panels and three mobile, horizontal work surfaces that change the spatial characteristics of the work environment, affording work and play activities such as collaborating, composing, presenting, viewing, lounging and gaming.

Intelligent, Robot-Embedded Domestic Environments for Aging in Place

The comforTABLE is a living environment that "ages in-place" with its inhabitants, adapting to their changing needs and capabilities. The project is developed and tested in the home+ lab specifically created for this research within the Greenville Hospital System.

Intelligent Learning Environments

Learning environments, like our Robot-Room, consist of architectural-robotic installations situated outside the formal classroom, and manipulated digitally and physically by teams of children and adults to cultivate creativity and interest in STEM (Science, Technology, Engineering and Math).

Academics and Experience

Prior to joining Clemson University in 2006, Richard Groff worked as an IC postdoctoral research fellow in the Department of Electrical Engineering and Computer Science at the University of California-Berkeley. His work in gecko-inspired adhesives demonstrated that a normally low-friction material such as polypropylene can be micro- and nano-structured to behave like a high-friction or adhesive material at the macro-scale. Groff incorporated gecko-inspired adhesives into small, insect-like crawling robots made with carbon fiber composites, flexure joints and piezoelectric actuators.

Groff is a member of IEEE and ASME.

Research

Groff is broadly interested in the application of systems theory to the design, analysis and fabrication of physical systems — especially biological systems and systems at small-length scales. Current research themes include bio-inspired design and control, use of novel materials in sensors and actuators, and fabrication and rapid prototyping of electromechanical systems at small length scales.

Groff is broadly interested in the application of systems theory to the design, analysis and fabrication of physical systems — especially biological systems and systems at small-length scales.

will serve as a platform for studying systems biology and tissue engineering, which offer exciting new frontiers for systems theory.

Magnetic Microfibers

Magnetic microfibers are polymer fibers embedded with paramagnetic nanoparticles (fabricated by Clemson's materials science and engineering department) that align with magnetic field lines. Using video feedback from a microscope, the position of a magnetic microfiber can be controlled with an array of electromagnets. These fibers will be used in microfluidics for moving drops of liquid and as actuators for small swimming robots.

Bio-Printing

In collaboration with Clemson's bioengineering department, a "bio-printer" is being developed to accurately place multiple types of living biological cells in 3-D patterns. The bio-printer



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Anthony Guiseppi-Elie

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Professor of Bioengineering

B.Sc. (First Class) Applied Chemistry, University of the West Indies, 1979

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Sc.D. Materials Science and Engineering, Massachusetts Institute of Technology, 1983

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Academics and Experience

Anthony Guiseppi-Elie was named the Dow Chemical Professor in the chemical and biomolecular engineering department at Clemson in 2006. He holds joint appointments at Clemson as a professor of bioengineering and a professor of electrical and computer engineering. He also serves as director of the Center for Bioelectronics, Biosensors and Biochips, a multidisciplinary faculty cluster represented by bioengineering, chemical and biomolecular engineering, chemistry, ECE and materials science in the College of Engineering and Science. Guiseppi-Elie has spent 15 years in entrepreneurial industrial research, product development and executive leadership at such companies as W.R. Grace and Co., Molecular Electronics Corp., Ohmicron Corp. and ABTECH Scientific Inc. He holds distinguished professorships at the University of the West Indies and the University of Western Cape. He has published approximately 200 technical papers and abstracts and 31 book or proceedings chapters. A holder of eight patents, he is a Fellow of the American Institute for Medical and Biological Engineering, a Senior Member of IEEE and a Life Member of AIChE. He teaches courses in engineering materials, biomolecular engineering, biosensors and bioelectronics, and nanobiotechnology.

Research

Guiseppi-Elie's research interests are in engineered bioanalytical systems in the service of human health and medicine.

Bioelectronics and Organic Electronics

- The synthesis and characterization of chemically and biologically responsive materials such as CNT-Enzyme supramolecular conjugates, CNT-conductive electroactive polymer (CEP) composites and their integration with CMOS technology such as in Enzyme-FETS and chemoresistors.
- The clinically relevant applications of arrays of FETs and chemoresistors for electronic noses and electronic tongues used in "sniffing" and "tasting."
- Signal processing and data fusion of plura-sensory data to aid decision making under uncertainty.
- The application of bioimpedance to the understanding of tissue perfusion and its relation to wound healing and the development and clinical deployment of devices and systems for studying the etiology of chronic wounds and wound healing.

Biochips and Biofuel Cells

Guiseppi-Elie's research in this area focuses on development of implantable biochips for physiologic status monitoring. Research aims to integrate enzyme-based biotransducers, mixed-signal electronics, low-power devices and wireless communications into clinically relevant systems for monitoring during trauma and surgery and for monitoring in the intensive care unit. Enzyme biofuel cells are being developed as an *in vivo* energy source for powering implantable electronic devices. Biofuel cells use CNT-Enzyme supramolecular conjugates and exploit direct electronic transfer between enzymes and nanotemplated electrodes.

Nano and Microfabrication and BioMEMS

Guiseppi-Elie and his research group design and fabricate interdigitated arrays, microdisc arrays and arrays of arrays for biological detection.

- Integration of arrays into biomedical diagnostic devices
- The use of under potential electrodeposition to control the nanotopology, catalytic properties and interfacial impedance of metal/tissue interfaces.

Guiseppi-Elie's research

in electrical and computer engineering focuses on bioelectronics and organic electronics, biochips, biofuel cells, nano- and microfabrication, and bioMEMS.

Research

Organic Electronics: Polymer-Based Devices

Polymers are materials consisting of long chains of repeating structure connected by covalent bonds. Most polymers are plastics and poor conductors of electricity, but a new class of polymer has been developed that can conduct electrical current. Members of this class are usually referred to as inherently conducting polymers (ICPs). When an ICP is mixed with a solvent and doped with a protonic acid, the solution can be spun or printed onto a substrate and dried. Layers of ICPs can be deposited with conductivities ranging from insulating to semiconducting to metallic. These materials can be prepared at relatively low cost with a wide range of electronic, optical and mechanical properties; therefore, they have numerous applications in micro- and nanoelectronics. Rod Harrell's research group is investigating the properties of various ICPs and performing research on electronic device applications using ICPs. Devices such as capacitors, diodes and transistors made with ICPs are a major focus. These devices have applications in sensors, photonics, flexible microelectronic chips and solar cells – just to name a few.

Harrell primarily studies organic electronics, polymer/carbon nanotube composites and bioelectronics.

Polymer/Carbon Nanotube Composites

Carbon nanotubes (CNT) have generated significant interest in recent years for nanostructure and materials technology. CNTs are known to possess exceptional electronic, mechanical and thermal properties. Although both CNTs and ICPs have promising physical properties, there are significant challenges in bringing them to their full potential in practical applications. Combining these two materials to form composites can potentially exploit the strengths of each while overcoming some of the challenges involved in utilizing the individual materials. CNTs have been shown to

improve the thermal stability, mechanical strength and electrical conductivity of ICPs. Combining the unique properties of conducting polymers and CNTs into functional nanocomposites offers many opportunities for research into basic materials science as well as technological applications. The group is not only studying the electronic, thermal and mechanical properties of these nanocomposite materials, but also investigating electronic device applications such as supercapacitors, sensors, diodes and transistors.

Bioelectronics

Harrell's lab has recently become involved with Clemson's Center for Bioelectronics, Biosensors and Biochips. This area of research applies many of the ideas and techniques used with organic and inorganic nanoelectronics to understand the interface between biological materials and solid state materials such as metals, insulators and semiconductors. This research has applications in implantable biological sensors and diagnostic biochips for future clinical use.



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Research

Adam Hoover's research focuses on tracking systems. Tracking can refer to physical problems, such as locating where things are in the world, and also signal problems, such as identifying the relative health of an individual's blood pressure over time. Image and signal processing, state-space modeling, filtering and embedded computing form the background of his work. His group works with many types of sensors and often builds embedded systems that prototype novel tracking ideas.

Ultra-wideband Position Tracking

In the past 30 years, GPS tracking accuracy has improved on the order of 20 times, while receivers have shrunk to the size of a watch. Currently, ultra-wideband (UWB) position tracking within a building is as crude as the GPS was in the 1980s. Hoover's research group focuses on improving UWB tracking accuracy in indoor environments so that a "local positioning system" (LPS) becomes as ubiquitous as the GPS. The group's methods focus on modeling error sources so that they can design sophisticated filters for reducing noise. A state-of-the-art indoor tracking facility is used to evaluate methods in a building-sized area.

The Bite Counter

Obesity is a growing epidemic. In the United States, roughly one-third of the population is obese, and another one-third is overweight. Worldwide over 1 billion people are overweight. Hoover's research group is investigating techniques to help an individual monitor his or her food intake. The research involves a device worn like a watch that tracks wrist motion during eating. By detecting a characteristic pattern, it can identify when a bite of food has been taken. It can monitor intake in real-time and provide feedback to the wearer. The feedback could tell the user to slow down or to stop eating after a target intake had been reached, or it could help the user track long-term eating patterns.

Arousal Meter

Hoover's group has built a monitoring device that produces a real-time cardiac-based measure of physiological arousal based upon changes in respiratory sinus arrhythmia, an established measure of vagal activity. The monitor provides a computing system with information about the physiological state of the user. Current computer systems receive no data regarding the physiological or cognitive state of the user, but there are many situations where these data could be useful. For example, as the user becomes bored or lethargic, the system could raise the workload or audiovisual feedback to stimulate arousal. As the user becomes tense or strained, the system could lighten the workload or simplify the feedback to lessen arousal. This type of physiological-based closed-loop feedback could be applied in a number of scenarios, such as driving, training, stressful repetitive work (e.g., air-traffic control) and military operations.

Hoover's research focuses on tracking systems using image and signal processing, state-space modeling, filtering and embedded computing.

Research

Todd Hubing and his associates in the Clemson Vehicular Electronics Laboratory (CVEL) are developing electronic components, systems and design tools that will greatly improve the performance, fuel efficiency and reliability of the next generation of automobiles.

Electric Energy Conversion and Storage

Current methods for storing and converting electrical energy in automobiles are relatively inefficient. Significant improvements in performance, fuel efficiency and reliability can be realized by optimizing these methods for automotive applications. CVEL is developing new methods for storing and transforming electric energy more efficiently and quietly by recapturing energy that is currently wasted in today's electric and hybrid vehicles. They also greatly reduce the electromagnetic fields present in the passenger compartment.

Automotive Electronics Expert System

Today's automobiles are complex electronic systems containing dozens of microprocessors and a variety of RF transmitters and receivers. Keeping track of all possible interactions that might result in an interference problem is a formidable task. Hubing's expert system monitors automotive systems while they are being designed, identifies design features that are likely to cause interference problems and estimates the magnitude of these problems. Because of this, potential problems can be averted before the first prototypes are built and tested.

The Clemson Vehicular Electronics Laboratory develops electronic components, systems and design tools that will greatly improve the performance, fuel efficiency and reliability of the next generation of automobiles.

patterns that can be relatively complex. Put the same antenna/tire combination on a vehicle, and the pattern is changed again. Put the antenna in another part of the vehicle, and the result may be completely different. The dominant interactions between the antennas and other automotive structures are being studied to develop relatively simple models that will predict the performance of antennas located at various places on an automobile without requiring every possible vehicle configuration and environment to be analyzed.

Modeling Antennas in Automobiles

The radiated field pattern from a standard RFID antenna can be significantly altered when the antenna is embedded in the wall of an automobile or truck tire. Currents generated in the tire's steel belts and cords create field



Todd Hubing

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Academics and Experience

As the PalmettoNet Endowed Chair in Optoelectronics, Eric Johnson serves as the head of the S.C. SmartState Center of Economic Excellence in Optoelectronics. Before joining Clemson, Johnson held a joint appointment as a professor of physics and optical science and a professor of electrical and computer engineering at the University of North Carolina, Charlotte, where he also served as the director of the Center for Optoelectronics and Optical Communications. Johnson served a two-year appointment as the program director of the Electronics, Photonics and Cyber Systems program in the National Science Foundation's (NSF) Division of Electrical, Communications and Cyber Systems. His responsibilities included the management and oversight of the photonics area. Johnson was also an associate professor at the College of Optics and Photonics at the University of Central Florida, and prior to that, he was the vice president of research and development at Digital Optics Corp. He has also held various other positions in industry for research, engineering and management.

Johnson has served on the board of directors for the International Society for Optics and Photonics (SPIE) and on committees for scholarship, conferences and technical programs within the organization. He has also been an ex-officio member on IEEE's EDS Optoelectronic Devices Committee. The past chair for the Optics in Information Science division of the Optical Society of America (OSA), he also chaired the organization's former Holography and Diffractive Optics technical group. Johnson has been the topical editor for OSA's *Applied Optics* journal and an associate editor for SPIE's *Journal of MEMS*. He is a Fellow of OSA and SPIE as well as a senior member of the IEEE.

Johnson's research spans the areas of micro-optics and nanophotonics, with particular emphasis on active and passive photonic devices.

Research

Johnson's research spans the areas of micro-optics and nanophotonics, with particular emphasis on active and passive photonic devices. Some of his major innovations include the development of methods for fabricating 3-D micro- and nano-optics (metaoptics), high-power lasers, novel integrated fiber-beam shaping devices utilizing multimode interference, sensors, fiber lasers, data communications and passive optics for spectral and polarization filtering. He has more than 150 publications in the field and 13 issued patents, and he has earned more than \$15 million in external funds for university and small-business research. He was a recipient of the NSF CAREER Award and has received funding from the Defense Advanced Research Projects Agency, the Air Force Office of Scientific Research, the Office of Naval Research and numerous industrial organizations.

Johnson has also supervised numerous optics and electrical engineering students as they pursued their doctoral degrees.

Academics and Experience

Before his arrival at Clemson University in 2008, Sung-O Kim was a member of the faculty at National Chiao Tung University (NCTU) in Taiwan, serving in the Department of Photonics and the Display Institute. Prior to joining NCTU, he was a postdoctoral research fellow at the University of Illinois at Urbana-Champaign where he worked on the development of micro-plasma and plasma display panels. Kim has also worked as a technical manager and a R&D engineer for Samsung SDI where he studied plasma and thin films in plasma display panels. He is a member of IEEE, Society of Information Display, American Vacuum Society and American Physical Society.

Research

Kim has expertise in plasma medicine, flat panel displays, nanomaterials, nano- and microplasma devices, and various thin films.

Plasma Medicine: Kim's research focuses on the biomedical applications using various atmospheric pressure plasma devices.

Kim has expertise in plasma medicine, flat panel displays, nanomaterials, nano- and microplasma devices, and various thin films.

Flat Panel Displays: Kim's research group is working toward development and applications of electronic displays such as liquid crystal displays, plasma display panels, OLED and flexible displays.

Nanomaterials: This group is working toward various low-temperature synthesized nanomaterials such as graphenes, nanowires, nanosheets, etc.

Plasma Thin Films: These plasma-polymerized thin films can be used for many applications, including use in semiconductor, electrical, optical and magnetic devices, as well as in flat panel displays and environmental applications.

Recent Publications

Furmanski, John, Jae-Young Kim, and Sung-O Kim. "Triple-Coupled Intense Atmospheric Pressure Plasma Jet from Honeycomb Structural Plasma Device," accepted to *IEEE Transactions on Plasma Science*, 2011.

Shim, Jang Bo, Jesse W. Grant, William R. Harrell, Hyuk Chang, and Sung-O Kim. "Electrical Properties of Rapid Hydrothermal Synthesized Al-doped Zinc Oxide Nanowires in Flexible Electronics," *Micro & Nano Letters*, 6(3), 147-149, 2011.

Kim, Jae-Young and Sung-O Kim. "15 μm -Sized Single-Cellular-Level and Cell-Manipulatable Microplasma Jet in Cancer Therapies," *Biosensors and Bioelectronics*, 26, 555-559, 2010.

Kim, Jae-Young, John Ballato, Paul Foy, Thomas Hawkins, Yanzhang Wei, Jinhua Li, and Sung-O Kim. "Single Cell-Level Cancer Therapy using a Hollow Optical Fiber-Based Microplasma," *Small*, 6(14), 2010. (The cover picture)

Kim, Jae-Young, Yanzhang Wei, Jinhua Li, and Sung-O Kim. "A Flexible Cold Microplasma Jet Using Biocompatible Dielectric Tubes for Cancer Therapy," *Applied Physics Letters*, 96, 203701, 2010.



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Research

Parallel I/O systems

In recent years, the disparity between input/output (I/O) performance and processor performance has led to I/O bottlenecks in many applications, especially those using large data sets. A popular approach for alleviating this kind of bottleneck is the use of parallel file systems. Parallel file systems are software that distribute file data among multiple storage nodes in a parallel computer and coordinate concurrent access to files by multiple tasks of a parallel application. The goal of the parallel virtual file system (PVFS) project is to explore the design, implementation and uses of parallel file systems. The PVFS project is conducted jointly between the Parallel Architecture Research Laboratory (PARL) at Clemson University and the Mathematics and Computer Science Division at Argonne National Laboratory along with several additional partner institutions. Current research focuses on very large, high-end computing systems with hundreds of thousands of compute processors and tens of thousands of I/O nodes. Current efforts focus on small, unaligned accesses and metadata operations. As part of this research, Walter Ligon's group is developing detailed simulation models of parallel file system protocols and experimenting with a number of features including caches, distributed directories and intelligent servers. Promising results are implemented for production use in PVFS by the Clemson PVFS development team, which is a joint effort with Clemson Computing and Information Technology.

Parallel computing environments

Many problems in developing efficient parallel codes can be traced to the computational model. The traditional "von Neumann" model, unfortunately, does not capture much information that can be used to affect important optimizations. The most popular approach to developing parallel systems is to keep the programming model as close as possible to the traditional model, thus allowing codes to be readily ported. An alternative approach involves using newer models that give system software more flexibility in achieving the desired computation. Unfortunately, this approach may make it difficult for some programmers to migrate their applications. The PARL conducts research into the development of tools and techniques to simplify the development of parallel codes that utilize slightly different models of computation. These tools enable the use of various modes of optimization to increase the performance and functionality of the system without requiring applications programmers to develop these techniques. Current efforts center on the river model, which focuses on scheduling the data that flows through a computation in order to allow I/O and message passing to be optimized.

Other research topics

Ligon also has interests in fields related to high-performance computing, including reconfigurable architectures, grid scheduling and co-allocation, compilers, operating systems and high performance network protocols.

Ligon studies parallel I/O systems and computing environments in addition to high-performance computing.

Academics and Experience

Prior to joining Clemson in 1985, Elham Makram was an assistant professor at North Carolina A&T University. She has worked for Siemens-Allis as a project engineer and also as an engineer in power system planning in Assiut, Egypt. Makram is an IEEE Fellow and a member of ASEE, Sigma Xi, NSPE and CIGRE. She is a registered professional engineer, and her present research interests include computer simulation of power systems, wind energy, power system harmonics and smart grid applications.

Research

Makram has specialized her research to study transient-constrained optimal power flow, computer simulation of power systems, hybrid energy sources and smart grid applications.

Coastal Clean Energy Impact on South Carolina Power Transmission System

Makram's group is studying the power transmission system of the state of South Carolina to analyze the effect of the wind energy penetration on the power grid. The investigation is done in three steps of incremental wind energy production using power flow solutions. During the initial phase of the project, the wind farm will deliver roughly 80 MW of power. In the second phase, an extra 1 GW of wind energy will be added at two different locations near the S.C. shore, followed by an additional 2 GW of wind energy added during the third phase. The project is estimated to deliver a total of 3.08 GW by the year 2030. The study may be extended to include switching transients and its impact on the existing S.C. transmission system.

Makram's research is specialized in the areas of transient-constrained optimal power flow, computer simulation of power systems, hybrid energy sources and smart grid applications

Wide Area Power System Transient Stability Assessment Using Synchrophasors

This project employs a technique to monitor the real-time wide area power system transient stability assessment using sudden changes of the power system operation to study the stability margin of the system. This is an improvement on conventional approaches aimed at determining numerous thresholds for different operating condition parameters. This research is based on the stability between generator clusters, making it ideal for the distributed generation control in smart grid implementation.

Sensitivity-Constrained PMU Placement Utilizing Integer Programming

Phasor Measurement Unit (PMU), which is based on GPS technique, is able to provide power engineers with immediate and precise measurements. By utilizing PMUs, the reliability and stability in power systems are expected to improve. Traditionally, an optimal PMU placement is considered to use the least number of units to make the entire system completely observable. It is recommended not only to optimize the number of PMUs but also to install the majority of PMUs on the most sensitive buses in a power system. A sensitivity-constrained Integer Linear Programming (ILP) method is used to solve for the optimal PMU placement.



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Professional

Prior to 1991 when he joined the Clemson University faculty, Anthony Martin worked for the Electromagnetic Application Center within the TRW Space and Technology Group as a project engineer and lead analyst. Presently, he is an associate professor within the Holcombe Department of Electrical and Computer Engineering at Clemson University.

Martin has served on numerous technical program committees for the IEEE Antennas and Propagation Society International Symposia. He has also served as a technical session chair at several meetings and as a reviewer for the *IEEE Transactions on Antennas and Propagation*. A member of the steering committee for the 1998 Electromagnetic Theory Symposium, Martin also served on the steering committee as technical program co-chair for the 1998 IEEE APS International Symposium. In 1999, he served as a co-convenor for the 1999 URSI General Assembly of Commission B. From 1998 to 2001, he was an associate editor of the *IEEE Transactions on Antennas and Propagation*. He has also served as an associate editor of the *IEEE Transactions on Antennas and Propagation Letters* since its inception and is the editor-in-chief for the *IEEE APS Digital Archive*. Martin was a member of APS Ad-Com from 2000 to 2003 and now serves as a member of the APS Education Committee. He was also general chair for the 2009 IEEE Antennas and Propagation Society International Symposium and USNC/URSI National Radio Science Meeting.

Research

Martin's research interests are in wideband and switched antennas, electromagnetic penetration into electronic devices and efficient electromagnetic computational methods. He has been working on the development of numerical techniques for the analysis of electrically large objects and on problems involving signal coupling and penetration.

Other major components of his research include the development of broadband antennas for wireless communications and finite element modeling of microwave absorber. Martin's research is sponsored by the U.S. Army Research Office, the U.S. Air Force Phillips Labs and Voss Scientific (Edwards AFB).

Martin's research interests are in wideband and switched antennas, electromagnetic penetration into electronic devices and efficient electromagnetic computational methods.

Academics and Experience

Dan Noneaker received his B.S. degree (with high honors) from Auburn University in 1977 and his M.S. degree from Emory University in 1979, both in mathematics. He received his M.S. degree in electrical engineering from the Georgia Institute of Technology in 1984, and he was awarded his Ph.D. degree in electrical engineering from the University of Illinois at Urbana-Champaign in 1993.

Noneaker has industrial experience in both hardware and software design for communication systems. From 1979 to 1982, he was with Sperry-Univac in Salt Lake City, Utah, and from 1984 to 1988, he worked with the Motorola Government Electronics Group in Scottsdale, Ariz. He was a research assistant in the Coordinated Science Laboratory at the University of Illinois from 1988 to 1993. Since then, he has been with Clemson's ECE department, where he currently holds the positions of professor, associate department chair and departmental graduate program coordinator.

Research

Noneaker is engaged in research on wireless communication for both military and commercial applications with emphases on spread-spectrum communications, error-control coding for fading channels and protocols for mobile radio networks. He has published numerous papers on the design and analysis of multiple-access systems for cellular communication and ad hoc packet radio networks. He continues to contribute to the engineering profession through service as a conference technical program chair and through his conference board activities.

Noneaker has industrial experience in hardware and software design. He currently studies wireless communication for both military and commercial applications.



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Academics and Experience

L. Wilson Pearson is the Samuel R. Rhodes Professor of Electrical and Computer Engineering. His background includes experience at the University of Kentucky, the University of Mississippi, the Naval Surface Weapons Center and McDonnell Douglas Research Laboratories. During his tenure at McDonnell Douglas, he was an affiliate professor of electrical engineering at Washington University. Pearson has been professionally active in the Antenna and Propagation Society (APS) of the IEEE and a member of the IEEE Microwave Theory and Techniques Society. He has served on the administrative committee of APS as an associate editor and editor of *IEEE Transactions on Antennas and Propagation* and on the editorial board of *IEEE Proceedings*. Pearson is a member of Commissions B and D of the U.S. National Committee of the International Radio Science Union and has served as the chair of Commission D. He has been recognized with several honors because of his professional activities, including Fellow membership in the IEEE.

Research

Pearson has published more than 50 reviewed papers, including work in computation electromagnetics, electromagnetic transients, asymptotic methods in electromagnetics, as well as radio frequency (RF) and millimeter wave systems. He has directed a five-university team on a \$5 million research program in spatial power combination under the aegis of the Department of Defense's Multidisciplinary University Research Initiative. His work has been funded by the Office of Naval Research, the Air Force Office of Scientific Research, the Army Research Office and several other research laboratories. His current research activities involve RF front ends for software-defined radio operating over extreme bandwidths. This work includes digital preconditioning to augment RF performance.

Pearson's current research activities involve RF front ends for software-defined radio operating over extreme bandwidths.

Academics and Experience

Before joining Clemson University as an associate professor in 1985, Kelvin Poole was a member of the Department of Electrical Engineering at Natal University for 13 years, serving as a professor of microelectronics and electrical engineering. In 1982, he was acting head of the department, and from 1981 to 1989, he was the Post Office Chair of Microelectronics.

Over the past 20 years, Poole has been responsible for developing and teaching courses in materials, physical electronics and integrated circuit design at Clemson.

Poole holds funding from NASA for his research of dosimetry intercomparison and miniaturization.

Poole is a member of the IEEE and currently holds funding from NASA for his research of dosimetry intercomparison and miniaturization.

He also holds patents for his system of methods and computer program products for prediction of defect-related failures in integrated circuits and his process for forming layers on substrates. He has published more than 85 publications in research journals

and conference presentations. His prior work has included semiconductor service and circuit reliability, IC design, ultra-high-vacuum deposition of thin film metals and dielectrics, and other metal/semiconductor contracts. Much of his work has been funded by SRC, Schlumberger and Itron.



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Academics and Experience

Michael Pursley has held the Holcombe Endowed Chair in Electrical and Computer Engineering at Clemson since 1992, and he held visiting faculty positions at UCLA and Caltech in 1985. He is the author of two textbooks: *Random Processes in Linear Systems* (2002) and *Introduction to Digital Communications* (2005).

Pursley was elected Fellow of the IEEE in 1982 and president of the IEEE Information Theory Society in 1983. He was a member of the editorial board of the *Proceedings of the IEEE* from 1984 through 1991, and he is currently a member of the editorial advisory board for the *International Journal of Wireless Information Networks*, a senior editor of the *IEEE Journal of Selected Areas in Communications* and a distinguished lecturer for the IEEE Communications Society. He was awarded an IEEE Centennial Medal in 1984, the Ellersick Best Paper Award in 1996, the IEEE Military Communications Conference Award for Technical Achievement in 1999 and an IEEE Millennium Medal in 2000. He received the IEEE Communications Society Edwin Howard Armstrong Achievement Award in 2002. In 2005, he received a distinguished alumnus award from the University of Southern California, and in 2008, he was named Outstanding Electrical and Computer Engineer by Purdue University.

Research

Adaptive Protocols for Cognitive Radios

As the spectrum policy for wireless communications evolves from fixed spectrum allocations to spectrum sharing and dynamic spectrum access, radically different equipment and protocols will be required. Cognitive radio promises to be the enabling technology for achieving reliable, efficient, wireless communications in the dynamic spectrum-access networks of the future. Aside from their role in permitting dynamic access to spectrum, cognitive radios are aware of their environments and may provide each other with the information needed to form a robust network that can overcome the variability of the wireless communication medium.

Cognitive radios equipped with new, adaptive protocols can make intelligent use of a time-varying communication channel. Pursley's group has developed low-complexity adaptive transmission protocols that give nearly optimal performance for channels that vary from packet to packet. The group has also derived Shannon capacity limits on the achievable throughput for any protocol and has shown that the throughput performance of adaptive transmission protocols is very close to the capacity limit.

Pursley is on the editorial advisory boards for several professional journals and researches adaptive protocols for cognitive radios.

Research

Harlan Russell's research interests are in distributed protocols for wireless networks. Highly mobile communication networks are necessary for applications such as military operations, emergency search-and-rescue and data collection in inhospitable environments.

Reliable and Efficient Mobile Wireless Networks

A challenge in the design of protocols for ad hoc networks is the unreliability of the wireless links. A novel aspect of Russell's work employs information from the communication receiver to characterize the link quality. The link quality information is incorporated into the network protocols to improve forwarding, routing and transmission protocols. For example, the group has introduced least-resistance routing, a routing protocol that can quickly adapt to dynamic network topologies. Routes are selected based on criteria such as the level of interference, the ability of the links to support quality-of-service requirements and the energy required to deliver traffic.

Russell's research interests are in distributed protocols for wireless networks, including shared access to the RF spectrum and frequency-agile radios.

Shared Access to the Radio-Frequency Spectrum

The radios in an ad hoc network must share the radio-frequency spectrum fairly. Russell's group is investigating both contention-based and scheduled approaches to channel access. Contention-based channel access protocols that permit radios to begin transmissions as packets are available, but the protocols must negotiate how to recover from collisions due to conflicting demands when transmissions are permitted. The group is designing protocols that can dynamically adapt to the environment to maximize spectral efficiency. Scheduled channel-

access protocols avoid collisions and provide for the possibility of efficient access to the channel when there is a high demand for shared access to the spectrum. Russell's group is investigating protocols that jointly schedule transmissions and select routes for the relay of packets that maximize the network capacity and adapt to bottlenecks.

Protocols for Frequency-agile Radios

Emerging software-defined radios are enabling increasing flexibility to utilize multiple frequency channels with widely different characteristics. As components of the radios that have typically been implemented in hardware are replaced with software-based systems, it becomes possible to update the software quickly to change the transmission frequency and format with very little delay. These types of frequency-agile radios allow the channel parameters to be modified at the time the network is deployed or as the operating conditions change. Russell's group is investigating new protocols that permit the radios to self-configure in order to utilize these bands as they become available.



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Academics and Experience

Prior to joining Clemson University in 1985, Robert Schalkoff was an associate professor of electrical engineering at Worcester Polytechnic Institute. From 1976 to 1977, he was an engineer for Exxon Production Research Co. (Subsea Systems Section) in Houston, Texas. He is currently a senior member of IEEE, a member of Tau Beta Pi, Eta Kappa Nu and Sigma Xi, and a Fellow of the Society of Photo-Optical Instrumentation Engineers. His primary scholarly interests are in intelligent systems and computing.

Schalkoff is the author of several textbooks, including *Digital Image Processing and Computer Vision* (1989), *Artificial Intelligence: An Engineering Approach* (1990), *Pattern Recognition: Statistical, Syntactic and Neural Approaches* (1992), *Artificial Neural Networks* (1997), *Programming Languages and Methodologies* (2007) and the forthcoming *Intelligent Systems: Principles, Paradigms and Pragmatics*.

Research

Schalkoff's research focuses on digital image processing, pattern recognition and computer vision, including surface modeling and mapping, autonomous visual inspection, biometric pattern recognition, color image processing, image sequence analysis and meta-algorithms, and machine learning.

His research group also works with programming languages and paradigms, and evolutionary and soft computing in the areas of artificial intelligence, artificial neural networks and fuzzy systems.

Schalkoff's research focuses on digital image processing, pattern recognition and computer vision.

Academics and Experience

Haiying (Helen) Shen is currently the director of the Pervasive Communications Laboratory at Clemson University. Her research has been published in top journals and conferences. She is a reviewer for most major journals in these areas including *IEEE Transactions on Parallel and Distributed Systems*, *IEEE Transactions on Computers* and *Journal of Parallel and Distributed Computing*. She was the program co-chair for a number of international conferences and a member of the program committees of many leading conferences.

Research

Shen's research interests include distributed and parallel computer systems and computer networks, with an emphasis on peer-to-peer (P2P) and content delivery networks, publish/subscribe systems, wireless networks, wireless sensor networks, high performance cluster and grid computing, data mining and RFID. Her distributed computing research focuses on two goals: access to information and services anytime and anywhere around the world, and pooling of globally distributed resources for cooperative use to achieve greater supercomputing capability.

Shen's distributed computing research focuses on two goals — increased access to information and services, and pooling globally distributed resources to achieve greater supercomputing capability.



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Academics and Experience

Before joining Clemson University, Rajendra Singh was a visiting assistant professor at both the University of Waterloo, Canada, and at Colorado State University, Fort Collins. In 1980, he joined Energy Conversion Devices Inc. as senior research scientist and worked on amorphous silicon solar cells and thermoelectric devices. Part of the work done there resulted in one U.S. and four foreign patents. He served as a professor and the director of the Microelectronics Laboratory at the University of Oklahoma's School of Electrical Engineering and Computer Science for 10 years. In 1992, he joined Clemson University as the first D. Houser Banks Professor in the Holcombe Department of Electrical and Computer Engineering. From 1996 to 1999, he served as the director of the materials science and engineering program at Clemson. In 1997, he became the director of the Center for Silicon Nanoelectronics at Clemson.

Singh has published more than 300 papers in various journals and conference proceedings. He is editor or co-editor of more than 10 conference proceedings and has presented more than 50 keynote addresses and invited talks in various national and international conferences. In 2008, he delivered a keynote talk to a conference in Europe on "Global Green Energy Conversion Revolution in the 21st Century through Solid State Devices."

Research

Singh's research contributions have been primarily in the field of rapid thermal processing, ultra-thin gate dielectrics, low and high-k dielectrics, superconductivity, manufacturing of silicon-integrated circuits, solar cells, thermoelectric devices and nanotechnology. He was the first to report the fundamental differences between furnace processing and rapid thermal processing. His work on rapid thermal processing has led to various new applications, such as novel chemical vapor deposition techniques for high- and low-dielectric-constant materials and the manufacture of solar cells. His fundamental work has served as an initial incubator to rapid thermal processing (RTP) technology.

His discovery of concepts used in commercial RTP tools has been credited with the related semiconductor equipment manufacturing industry now being valued at over \$1 billion per year. The use of RTP in solar cells manufacturing is also mainly due to Singh's contributions. His work on solar cells is included in many recent textbooks on solar cells and has been cited by researchers throughout the world. His early work on ultra-thin gate oxide led to the passivation techniques used on the surface of commercial silicon solar cells. Similarly, his work on conducting oxide semiconductors led to the use of these materials in all kinds of commercial thin-film solar cells. In 2011, he was named as one of 10 global "Champions of Photovoltaic Technology" by *Photovoltaics World* magazine for his lifelong work on the science of solar cells.

Singh's research has been primarily in the field of rapid thermal processing, ultra-thin gate dielectrics, low and high-k dielectrics, superconductivity, manufacturing of silicon integrated circuits, solar cells, thermoelectric devices and nanotechnology.

Professional

Before her appointment at Clemson in 2006, Melissa Smith was a research associate at the Oak Ridge National Laboratory (ORNL) for 12 years. While at ORNL, she was involved in a variety of research activities including high-energy and nuclear physics instrumentation (Spallation Neutron Source at ORNL, the PHENIX particle physics experiment at Brookhaven National Laboratory and the Nuclear Weapons Inspection System program), sub-micron CMOS circuit design (analog, digital and mixed signal), fault tolerant sensor networks, software-defined radio, and high-performance and reconfigurable computing for real-time systems and scientific computation.

In 2004, Smith began collaborations with the newly formed Future Technologies Group at ORNL and conducted research on emerging computing architectures including reconfigurable computers, multi-core and optical processors. She continues to collaborate with some of the top research scientists at ORNL and across the country in areas of heterogeneous high-performance computing, Distributed Sensor Networks, System Performance Modeling and Analysis, and High-Speed Data Acquisition Systems.

Smith's current research activities focus on the applied use of emerging computing architectures.

architectures for various application domains including scientific applications (modeling and simulation), high-performance or real-time embedded applications, and medical and image processing. Her group explores optimization techniques and performance analysis for emerging heterogeneous platforms, including many multi-core processors, Graphical Processing Units and Field-Programmable Gate Array-based reconfigurable computers. Also of interest are the tools and methodologies that are needed to efficiently and effectively program and utilize these architectures.

Research

- Reconfigurable and High-Performance Computing
- Embedded Computing
- Distributed Sensor Networks
- System Performance Modeling and Analysis
- High-Speed Data Acquisition Systems
- Software Defined Radio

Smith's current research activities focus on the applied use of emerging heterogeneous computing architectures. Her research group is interested in the performance computing



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Professional

Prior to joining Clemson in 2010, Joachim Taiber led the Information Technology Research Office in the BMW Information Technology Research Center (ITRC) at the Clemson University International Center for Automotive Research (CU-ICAR). He designed and implemented an open-innovation business model with leading information and communication technology companies such as a first-of-its-kind in the automotive industry. Since the ITRC started operation in 2005, he has completed more than 50 research projects in close cooperation with universities, especially with Clemson University faculty members from ECE, mechanical engineering and the School of Computing. He also created a 4G wireless communication infrastructure at a high-speed track, which is considered the first of its kind in the automotive industry.

Taiber served as vice-chairman of the S.C. Educational Service Broadband Commission until 2009 and as a member of the executive board of the ECE faculty of Clemson University from 2006 – when he was with BMW – until he fully joined the ECE department in 2010. He currently serves as chair of the Subcommittee on Automotive Standards of IEEE IES. He is member of ACM, IEEE, IES and VDI (Association of German Engineers).

Research

Taiber's current research interests center on clean transportation and advanced vehicle communication. Specifically, the following topics are in his research focus:

- Data connectivity between fast-moving vehicles and the IT backend infrastructure using secure wireless networks
- Power and data connectivity concepts and standards between electrical vehicles and the power and communication grid
- Simulation and verification in real testbeds of use cases and applications for connected vehicles using V2I (vehicle to infrastructure), I2V (infrastructure to vehicle) concepts
- Simulation and verification in real testbeds of clean transportation concepts considering new business models as well as new power train, energy storage and power transfer technologies

Taiber is responsible for a new infrastructure initiative between Clemson University and the S.C. Technology Aviation Center to support interdisciplinary research on clean transportation and the connected vehicle in cooperation with leading industry partners.

Taiber's current research interests center on clean transportation and advanced vehicle communication.

Professional

Prior to joining the Cyberinfrastructure Technology Integration (CITI) group at Clemson University, J. Barr von Oehsen was employed by the Center for Advanced Engineering Fibers and Films, an NSF-funded engineering research center, where he oversaw the research and development of finite element software for modeling polymer processes. He has worked as a computational scientist at Clemson for more than 10 years.

As director of computational science for CITI, von Oehsen is responsible for directing and implementing high-performance computing (cluster) and high-throughput computing (Condor) application support and research.

A TeraGrid Campus Champion, von Oehsen is the local source of knowledge about TeraGrid high-performance computing resources and the services offered. Through this, he is able to provide opportunities that will engage both faculty and staff. Academic institutions that require HPC resources for their scientific research are sometimes unaware of the “free” resources made available by NSF via the TeraGrid.

As the director of computational science for CITI, von Oehsen has interests in high-performance and high-throughput computing.

Research

In addition to his interests in high-performance computing and high-throughput computing, von Oehsen also studies mathematical modeling, parallel programming, distributed grids, hardware architecture, compilers for distributed computing on hybrid architectures and visualization.



J. Barr von Oehsen

Research Professor of Electrical and Computer Engineering

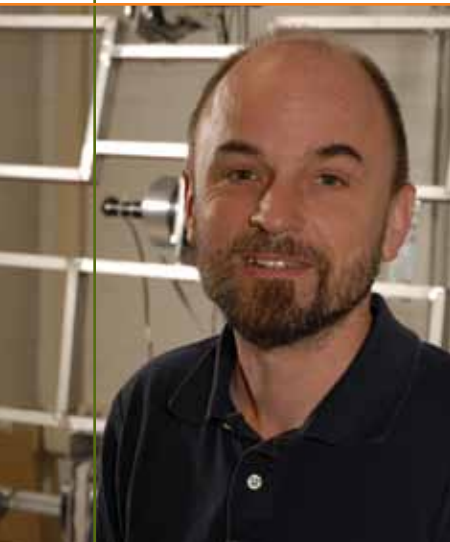
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Professional

Ian Walker is a Fellow of the IEEE and a Senior Member of the AIAA. He has served as vice president for financial activities for the IEEE Robotics and Automation Society and as chair of the AIAA Technical Committee on Space Automation and Robotics. He has also served on the editorial boards of the *IEEE Transactions on Robotics*, *IEEE Transactions on Robotics and Automation*, *International Journal of Robotics and Automation*, *IEEE Robotics and Automation Magazine* and *International Journal of Environmentally Conscious Design and Manufacturing*. His research has been funded by DARPA, the National Science Foundation (NSF), NASA, NASA/EPSCoR, NSF/EPSCoR, the Office of Naval Research, the U.S. Department of Energy, the S.C. Commission of Higher Education, Sandia National Laboratories and Westinghouse Hanford Co.

Research

Walker's research centers on robotics, particularly novel manipulators and manipulation. His group is conducting basic research in the construction, modeling and application of biologically inspired "trunk, tentacle and worm" robots.

Their work is strongly motivated by the dexterous appendages found in cephalopods, particularly the arms and suckers of octopus and the arms and tentacles of squid. The ongoing investigation of these animals reveals interesting functional aspects of their structure and behavior. The arrangement and dynamic operation of muscles and connective tissue observed in the arms of a variety of octopus species motivate the underlying design approach for our soft manipulators. These artificial manipulators feature biomimetic actuators, including artificial muscles based on pneumatic (McKibben) muscles. They feature a "clean" continuous backbone design and redundant degrees of freedom and exhibit significant compliance that provides novel operational capacities during environmental interaction and object manipulation. The unusual compliance and redundant degrees of freedom provide strong potential for application to delicate tasks in cluttered and/or unstructured environments. This work in turn leads to novel approaches to motion planning and operator interfaces for the robots. This work is currently funded by DARPA under the DSO BIODYNOTICS program, by NASA and by NASA/EPSCoR.

Walker also conducts research in the area of fault tolerance and reliability of robots. New work focuses on the creation of animated environments. This work in architectural robotics, a fast-emerging area, exploits key aspects of engineering and architecture in exploring how our environments of the future could morph in real time. Applications being investigated by Walker's group focus on assisted living and aging in place.

Walker's research centers on
robotics, particularly novel
manipulators and manipulation
through biometric actuators.

Research

Kuang-Ching Wang is currently engaged in research in wireless networks and mobile computing, ad hoc and sensor networks, distributed protocols, and pervasive applications and embedded systems.

Broadband Wireless Networking under Extreme Mobility

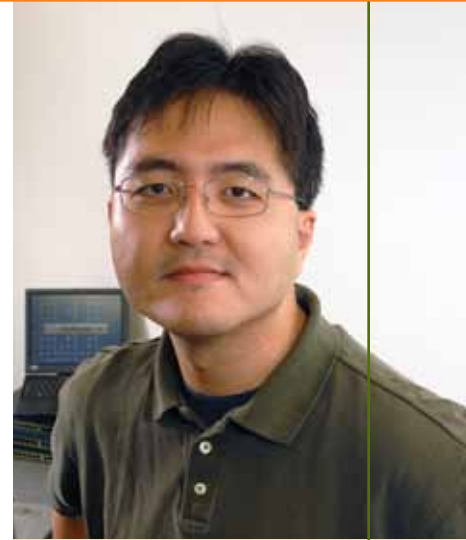
Advanced wireless technologies will soon offer connections to the global communication network from anywhere and at any time. Today's wireless networks are challenged to accommodate devices that are on the move, often delivering degraded or disconnected network service due to changes in radio coverage and propagation conditions. Network performance continues to degrade as one moves faster or into more complex environments. Wang's research group is tackling challenging issues for wireless networks that connect devices with extreme mobility, such as fast-moving vehicles and machine parts. To predict their performance and bring them constant broadband communication, Wang's group is studying adaptive transmission, scheduling and routing methods to greatly alter the way information is sent by these devices over a network infrastructure. Mobile networking solutions have been studied for decades, but to achieve true broadband under extreme mobility, new network architecture, protocols and radio designs remain to be discovered.

Wang's research group is tackling issues for wireless networks that connect devices with extreme mobility, such as fast moving vehicles and machine parts.

Wang's research group also designs untraditional wireless networks for use as traffic control devices along urban and rural roadways, to connect machine sensors in factories, for ecologists to connect sensors in the wilderness and for automobile manufacturers to connect critical components on a moving vehicle.

The group performs field measurements, theoretical analysis and software simulation methods to understand, model and design adaptive solutions to cope with a diverse range of challenging networking requirements.

Wang's research group is developing hardware testbeds and software simulations for studying wireless networks under varying conditions. The group has established testbeds for vehicle wireless networks, machine sensor networks, nature sensing networks and campus mesh networks. The testbeds allow for collection of realistic performance measurements and network characteristics.



Kuang-Ching Wang

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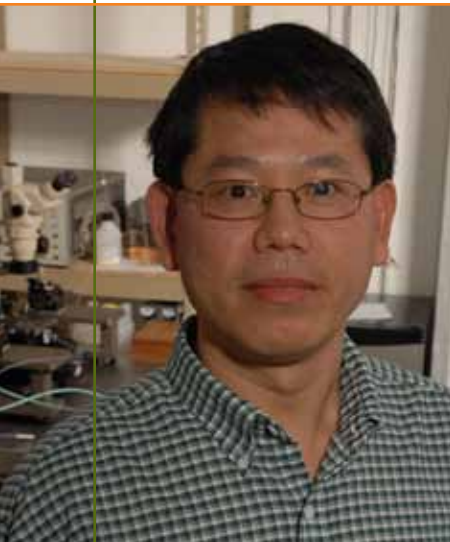
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Academics and Experience

Pingshan Wang worked for the Institute of Applied Electronics, Mianyang, China, where he was promoted to principal engineer in charge of high-power microwave research activities. After receiving his Ph.D. in 2004, he served on the faculty of Southern Illinois University, Carbondale for two years before joining Clemson University.

Research

Wang's research focuses on integrated high-frequency systems and their applications. He is currently developing network-analyzer-on-chip (NAoC), high-speed analog-to-digital converters (ADCs), high-frequency nanofluidics, and high-frequency devices incorporated with patterned ferromagnetic materials.

High-speed integrated circuits and systems: NAoC and ADC

Vector network analyzers (VNAs) are indispensable for high-frequency characterization and analysis of electronic devices, circuits and systems. They are also widely used in other areas, such as material science, biology and chemistry. Commercial VNAs are powerful, yet bulky, expensive and user-unfriendly. Based on radio-frequency CMOS technology, Wang's group is developing NAoCs for various applications, including micro-total-analysis-systems (μ TAS). ADCs are critical for many applications. Unfortunately, the speed of ADCs is limited in CMOS technologies even though terahertz (THz) devices are in sight. Based on THz pulses and on-chip spatial sampling, the group is developing CMOS ADCs that rival optical approaches in speed and resolution.

High-frequency micro- and nanofluidics

Micro- and nanofluidic devices are ideal for integration into a μ TAS or a lab-on-a-chip system for analytical separations and determinations of cells and biomolecules (e.g., DNAs and proteins). High-frequency electromagnetic waves, ranging from lower radio-frequency to THz waves, have many unique properties such as label-free, non-intrusive sensing and analysis approaches for a μ TAS. Wang's group is developing high-frequency planar micro- and nanofluidic devices for biological and chemical applications.

High-frequency passive devices incorporated with ferromagnetic materials

High-frequency passive devices, such as integrated inductors, are a bottleneck of the dominant CMOS electronics technologies. One possible approach to solve this problem is to incorporate ferromagnetic materials into the devices. Wang's group studies the high-frequency properties of patterned permalloy thin films, including noise properties and dynamics of an individual nano-ferromagnetic structure.

Wang's research focuses on integrated high-frequency systems and their applications, including high-speed integrated circuits and systems, micro- and nanofluidics, and passive devices incorporated with ferromagnetic materials.

Academics and Experience

David White's environmental research has focused on the effects of land-based activities and the relation to changes in biological communities with a focus on phytoplankton and nutrient dynamics in estuarine environments. These research efforts were integrated with the use of geographic information systems, remote sensing and geostatistics to address spatial variation and classification issues of the ecological parameters under study.

While completing his dissertation, White was hired to support the development of a real-time data collection cyberinfrastructure for coastal and ocean environments. His efforts focused on the development of Web-based data reporting and use of metadata to support data discovery and documentation. Upon completing his dissertation, he left the University of South Carolina to lead a data management program at the NOAA Hollings Marine Laboratory in Charleston, S.C. In this position, he designed data and information management systems for environmental, marine animal and genetic data. These efforts include directing the deployment of hardware and software systems for multidisciplinary research activities and the design and implementation of spatially enabled relational databases to support geospatial portals and Web services.

White is focusing on the development of advanced cyberinfrastructure to support scientific data collection and visualization.

In his current position as director of data management for CITI, White is continuing to focus on the development of advanced cyberinfrastructure to support scientific data collection and visualization. His most recent efforts are focused on the development of automated statistical-based modeling to perform quality assurance on real-time environmental data to identify sensor drift and outliers.

Other research interests include information technology, data management, coastal and estuarine ecology, hydrology, geographic information systems, geostatistics and remote sensing.

At Clemson, White has contributed to development of "Intelligent River" (intelligentriver.org) and the Open Parks Grid initiative.



David White

Research Professor

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B.S. Biology, University of
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Academics and Experience

Xiao-Bang Xu is a senior member of the Institute of Electrical and Electronics Engineers (IEEE), a member of IEEE Antennas and Propagation Society, a member of IEEE Microwave Theory and Techniques Society, a Fellow of Electromagnetics Academy and a member of Phi Kappa Phi.

Research

Xu's research interests are in applied electromagnetic theory and numerical methods. His research interests are mainly in two areas. One is in the development of surface/volume integral equation methods and application of the hybrid finite element/boundary integral equation method to study the electromagnetic scattering/radiation near a media interface, which requires an efficient evaluation of Sommerfeld-type integrals. Recently, he has been studying the electromagnetic scattering by 3D objects buried below random rough surfaces using the PSTD method and Monte Carlo simulations. The research findings in this area are expected to be useful for sensing and remote-sensing applications, including detection of buried targets, geophysical exploration and nondestructive testing of underground facilities.

The other major component of his research is the application of electromagnetic theory and numerical techniques in the analysis of power transmission/distribution systems, which are of practical interest. Typical projects include the application of Fourier series technique and unimoment method to the investigation of extremely low-frequency magnetic fields generated by underground power transmission lines and the development of numerical techniques for computing the zero-sequence of underground pipe-type cables. Both these projects involve the modeling of energy penetration through nonlinear magnetic materials. He is also studying the development of numerical technique and software, based on electromagnetic theory and dynamics, to investigate the probability of magnetically induced subsequent fault in power line topologies. The software Xu and his graduate students developed is currently being tested and used by a major power company in the design of new power transmission/distribution lines and for the evaluation of existing lines.

Xu's research has been sponsored by the NSF, the Electric Power Research Institute, Duke Energy Co. and S.C. Electric and Gas Co.

Xu's research interests are in
applied electromagnetic theory
and numerical methods.

Academics and Experience

Guigen Zhang began his academic career at Tongji University in 1987. After his doctoral and postdoctoral training, he resumed his research career at Northwestern University. Before joining Clemson in 2008, Zhang was an associate professor at the University of Georgia where he pioneered a bio-micro/nanotechnology program.

Zhang currently serves as deputy director of the IBIOE at Clemson University – an interdisciplinary research institute focused on cellular engineering for biomedicine and the development of diagnostic tissue test systems for the improvement of health care. Zhang oversees an array of research and industrial initiatives.

Zhang currently serves as deputy director of the IBIOE at Clemson — an interdisciplinary research institute focused on cellular engineering for biomedicine and developing diagnostic tissue test systems to improve health care.

Biomechanics and biomaterials

Zhang and his group are developing new methods, tools and devices for the construction of tissue constructs and biomaterials and the evaluation of their nonlinear and viscoelastic mechanical properties.

Nanostructure-influenced tissues and cellular engineering

Use of integrated micro- and nanostructures as substrates provides a platform to interface biological cells and tissues with an engineering world.

Modeling of multidisciplinary phenomena

This research is leading to the development of finite-element-based computer models to perform multidiscipline and multi-scale simulation of the complex phenomena including electrical, mechanical, material, magnetic, thermal, electrochemical, biochemical and biological examples encountered in many biomedical devices, biosensors and other systems.

Research interests

Micro/nano structures for electron-transfer devices

Zhang's group develops novel integrated micro- and nanostructures and uses them as electrodes in electron-transfer devices such as biosensors, fuel cells and bioconversion systems.

Electrochemical processes of nanostructure electrodes

Research is conducted via experimental and computational means, investigating the electrochemical processes such as electrode reactions, corrosion, mass transport, the effect of electrical double layers of nanostructure electrodes, and single and interdigitated electrodes.



Guigen Zhang

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B.S. Engineering Mechanics, Tongji University, China, 1984

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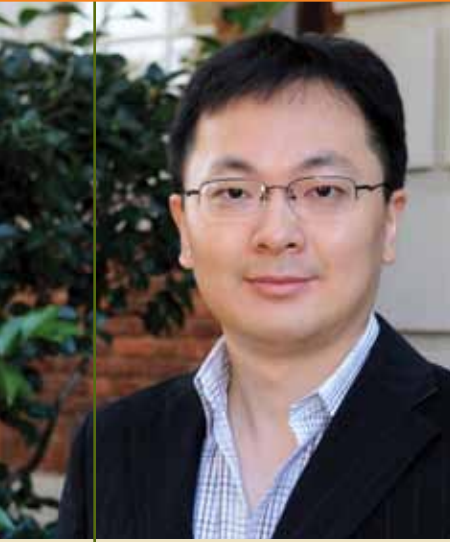
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Academics and Experience

Lin Zhu obtained his Ph.D. in electrical engineering from California Institute of Technology in 2008. While at Caltech, his work mainly focused on the modal control of high power, broad area semiconductor lasers using photonic periodic nanostructures. Zhu's current research interests include high power, high beam quality diode laser arrays, beam combining, optomechanics and plasmonic devices. His work has been funded by many federal and state agencies, including ARO, DARPA, NSF, SC Space Grant, SC EPSCoR/IDeA and ORAU. Zhu was the recipient of the 2010 DARPA Young Faculty Award and 2010 ORAU Ralph E. Powe Junior Faculty Enhancement Award.

Zhu's work has resulted in more than 40 refereed journal publications, magazine articles and invited presentations at a number of conferences and workshops. He is a reviewer for most major journals in optics, including *Applied Physics Letters*, *Nano Letters*, *Optics Letters*, *Optics Express*, *Optics Communications*, *IEEE Journal of Lightwave Technology*, *IEEE Journal of Quantum Electronics* and *IEEE Photonics Technology Letters*.

Research

Zhu's research involves investigating nanophotonics – especially studying optical microcavity and photonic crystal lasers and generating, modulating, switching and delaying light in semiconductor and polymer materials. Zhu's group also investigates plasmonics and metamaterials, examining hybrid integration of optical devices and systems, optical periodic structures and coupled resonators, high-power solid-state and fiber lasers, and THz optics.

Zhu's research involves
investigating nanophotonics,
plasmonics and meta materials.

James E. Harriss

Research Associate Professor

B.S. Physics, Georgia Institute of Technology, 1971

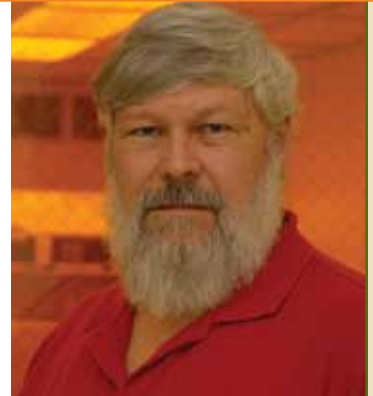
M.S. Physics, Georgia Institute of Technology, 1973

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After 10 years of industrial experience in semiconductor manufacturing, James Harriss joined Clemson University in 1989. His principal responsibility is managing and operating the Microstructures Laboratory. His teaching interests include VLSI reliability, semiconductor manufacturing, statistical process control and the design of experiments.



Stephen J. Hubbard

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Stephen Hubbard has held several engineering positions in industry, where his work included the design and development of analog and digital electronic hardware, signal processing algorithms, software and designing systems for a variety of applications – including audio signal processing, weighing and force measurement, speech processing and electronic warfare. Hubbard joined the ECE department in 1998.

Teaching is the focus of Hubbard's work at Clemson, where he has taught courses in signal processing, probability, statistics, random processes, electronics, systems, computing and circuits. He also served for two years as director of the Effective Technical Communications Program in the College of Engineering and Science.

As time permits, Hubbard enjoys research in applied signal processing. His most recent work concerns the development of statistical signal analysis techniques for the assessment of electric power quality.





John J. Komo

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John Komo served on the faculty of St. Louis University from 1965 to 1968, the faculty of the University of Missouri, Columbia from 1968 to 1973, and was a consultant to McDonnell Douglas Corp., Harris Corp. and Warner Robbins Logistic Center. He has been at Clemson University since 1973.

Komo's research interests are in sequences for error control coding, spread spectrum communications and finite field applications. He is also the author of the textbook *Random Signal Analysis in Engineering Systems*.



William J. Reid

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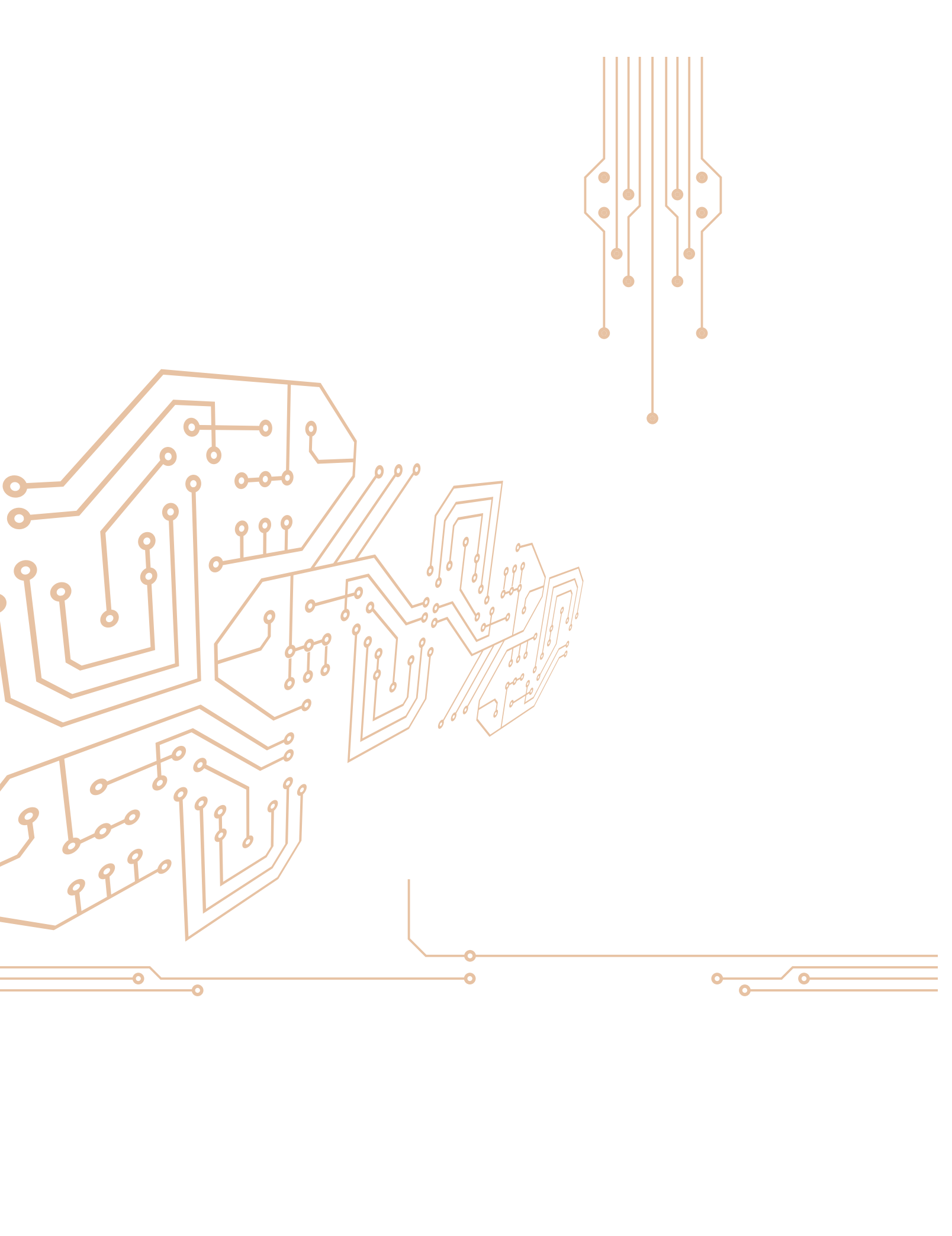
M.S. Electrical Engineering, Clemson University, 1990

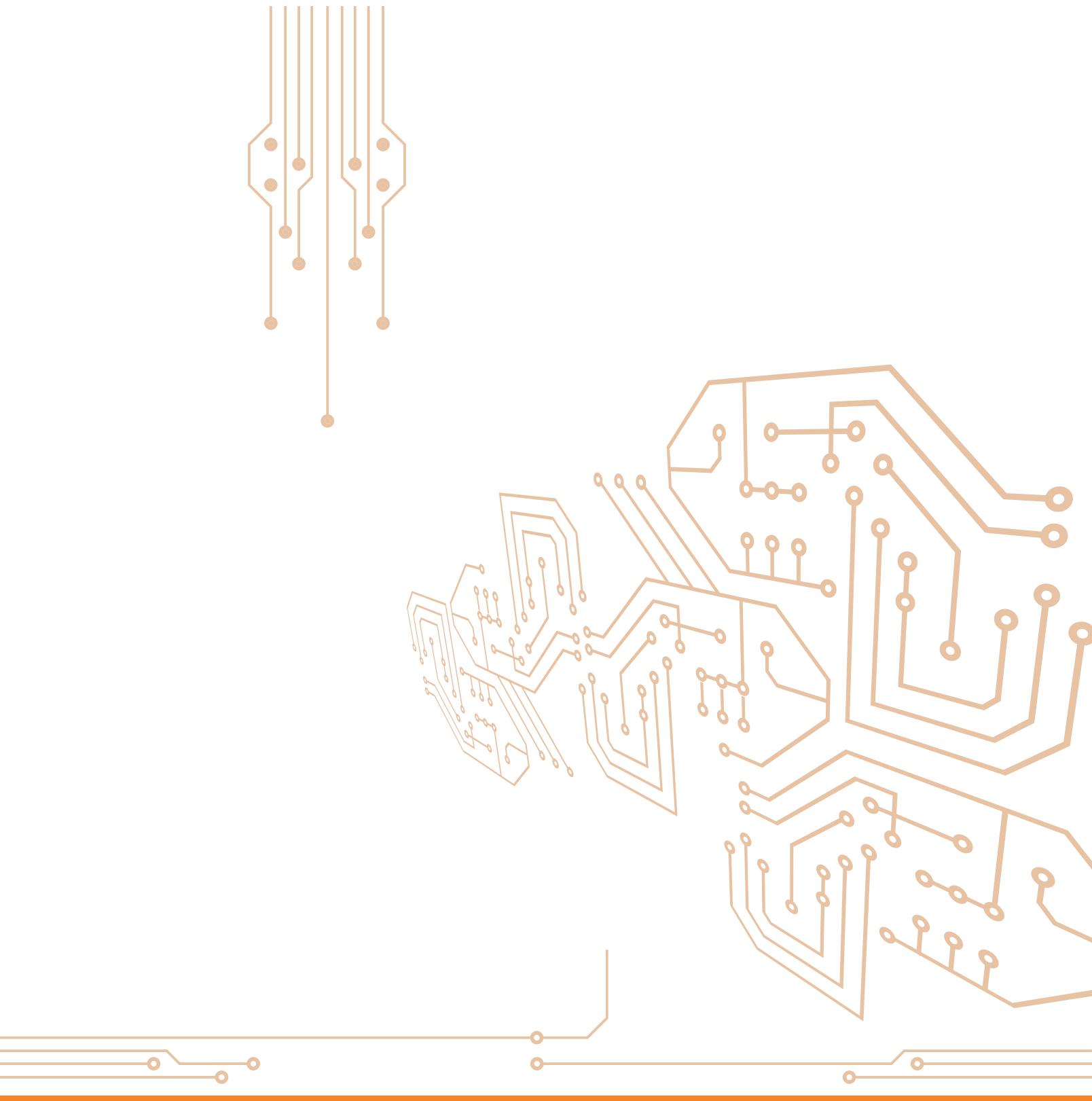
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William Reid's Ph.D. dissertation dealt with the soft-decision decoding of BCH codes. He joined the faculty of Clemson in 2000 as a visiting assistant professor. Before returning to Clemson, he worked as a test engineer for Ryobi Motor Products Inc. and as an embedded systems designer and programmer for Dixie-Narco Inc. He has taught courses in digital design, computer architecture, circuit theory and random signal analysis.





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