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APPRECIATION

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INTRODUCTORY MESSAGE



This brochure will introduce you to the research activities in the Woodruff School of Mechanical Engineering. Research programs are defined by people. We have excellent academic and research faculty as well as outstanding graduate and undergraduate students and support staff. In our ranks, there are three members of the National Academy of Engineering, more than 40 fellows in national professional societies, 55 National Science Foundation doctoral fellows, and numerous faculty who have received significant professional recognition. As a group, the faculty holds more than 195 patents and is responsible for more than \$30 million a year in externally funded grants and contracts.

Our faculty are divided into self-selected research area groups, which are the bases for presentation in this brochure. In addition, our faculty participate in more than a dozen interdisciplinary centers on campus, many of which are led by Woodruff School faculty. The size of our research program allows us to provide challenging research experiences for our students in areas beyond the typical core of mechanical engineering programs.

Research in Mechanical Engineering

At its core, Mechanical Engineering is about thermal systems and mechanical systems, and the design, manufacture, and operation of these systems. Georgia Tech has a strong program in manufacturing. Mechanical Engineering's contribution to this activity is major, including design, controls, precision manufacturing, rapid prototyping, polymer processing, and electronic packaging. Environmentally conscious design and "green engineering" is also addressed.

Another important area is the behavior and utilization of structural materials, including the study of crack formation and fatigue life as they relate to the processing and micro-structure of engineering materials. Mechanical systems research includes controls, robotics, mechatronics, fluid power and motion control as well as the dynamics and kinematics of machinery. In the thermal systems field, the thermal management of electrical and electronic systems as well as building energy management studies are addressed. Other activities in thermal systems include fuel cell development, thermocapillary flows and flow instabilities, thermohydraulic performance in conventional and nuclear power plant applications as well as micro and nano applications in thermosystems.

In addition to these traditional mechanical engineering fields, the Woodruff School has strong, internationally recognized research activities in acoustics, micro-electromechanical systems (MEMS), bioengineering, and tribology. Acoustics research includes underwater acoustic-structure interaction, aero-acoustics and noise control as well as the impact of acoustics on biological systems. In the MEMS area, our faculty are concerned with the design and production of microsensors, and actuators for the mechanical, chemical, and biological fields. Our bioengineering faculty have activities that range from the mechanics of biomaterials and the mechanical behavior of biological cells, to tissue engineering and medical devices. The tribology group is well known for its studies of controllable seals and dampers, the dynamics of rotating machinery, the rheological behavior of lubricants under extreme conditions, and the diagnostic methods for health monitoring in machinery.

Research in Nuclear and Radiological Engineering and Medical Physics

The Woodruff School also includes nuclear and radiological engineering and medical physics programs. This area includes research in thermal hydraulics of nuclear power systems, criticality studies for handling nuclear materials including the storage and disposal of spent nuclear fuels, and research in medical physics that focuses on both the nuclear industry and the use of radioactive materials in the medical industry. In addition, within our nuclear engineering program, we have activity in the development of fusion power.

Interdisciplinary Research

Interdisciplinary programs are strongly encouraged in the Woodruff School. The faculty is involved in interdisciplinary research programs with faculty from the Schools of Aerospace Engineering, Biology, Chemical and Biomolecular Engineering, Electrical and Computer Engineering, Industrial and Systems Engineering, and Materials Science and Engineering. Our faculty are major participants in the Institute-wide Mechanics of Materials Research Center, the Manufacturing Research Center, the Center for Sustainable Technology, the Engineering Research Center for Low Cost Electronic Manufacturing, the Bioengineering and Biosciences Research Center, the joint Emory-Georgia Tech Biomedical Engineering Program, and the Georgia Tech Paper Science and Engineering Program.

The Woodruff School Education

We make every effort to integrate our research programs into our educational programs, for both undergraduate and graduate students. The research support obtained by our faculty is important in supporting students. The research experience of our faculty is brought to the classroom, giving students a sense of the excitement of mechanical engineering and the cutting edge nature of the discipline. We require a senior experimental design course where the students work in groups of four to six, which is directly coupled to many of our research laboratories. The objective of this course is to design, build, and conduct a mechanical engineering related project.

We are proud of our research programs and hope that through this brochure you will gain respect for our faculty and their capabilities. By their very nature, printed documents are not current. Our research program is continuously evolving. This brochure was prepared to highlight the individual faculty members in the Woodruff School. A more current accounting of our research programs can be found on our website at www.me.gatech.edu.

Should you have any questions about our programs, contact me or any of the faculty listed in this book. Please stop by, write to The George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332-0405, or send an E-mail to information@me.gatech.edu.

Sincerely,

Ward O. Winer
Eugene C. Gwaltney, Jr. School Chair
2005, Atlanta, Georgia

THE GEORGIA INSTITUTE OF TECHNOLOGY

Georgia Tech's mission is "to provide the state of Georgia with the scientific and technological knowledge base, innovation, and workforce it needs to shape a prosperous and sustainable future and quality of life for its citizens." It is achieved through educational excellence, innovative research, and outreach in selected areas of endeavor.

Georgia Tech's mission in education and research will provide a setting for students to engage in multiple intellectual pursuits in an interdisciplinary fashion. Because of our distinction for providing a broad but rigorous education in the multiple aspects of technology, Georgia Tech seeks students with extraordinary motivation and ability and prepares them for lifelong learning, leadership, and service. As an institution with an exceptional faculty, an outstanding student body, a rigorous curriculum, and facilities that enable achievement, we are an intellectual community for all those seeking to become leaders in society.

Georgia Tech values its position as a leading public research university in the United States and understands full well its responsibility to advance society toward a proper, fair, and sustainable future. By seeking to develop beneficial partnerships within public and private sectors in education, research, and technology, Georgia Tech ensures relevance in all that it does and assures that the benefits of its discoveries are widely disseminated and used in society.

Research

Georgia Tech is a major center for advanced technology in Georgia and the Southeast. With academic and research faculty in excess of two thousand and graduate students in excess of five thousand, the Institute conducts research of national significance, provides research services and facilities to faculty, students, industry, and government agencies, and supports the economic and technological growth of the state. Research operations are carried out through schools, centers, and laboratories, each performing research in a particular field of interest.

Most of the research is supported by contracts with government organizations and private industry. The Georgia Tech Research Corporation, a non-profit organization incorporated under the laws of the state of Georgia, serves as the contracting agency. It also licenses intellectual property created at Georgia Tech, including patents, software, trade secrets, and other similar properties.

Georgia Tech is proud of the diversity and strength of its research programs and conducts

research in a wide range of engineering, science, computing, architecture, public policy, social sciences, management, and related areas.

Georgia Tech Research Corporation

Founded in 1937, the Georgia Tech Research Corporation (GTRC) is a state chartered not-for-profit corporation serving Georgia Tech as a University System of Georgia approved cooperative organization. By charter, GTRC "...shall be operated exclusively for scientific, literary and educational purposes ... conduct laboratories, engage in scientific research, and distribute and disseminate information resulting from research." GTRC serves as the contracting agency for all of the sponsored research activities at Georgia Tech. The Research Corporation, since its founding, has received some 39,427 contracts for a total value of over \$3.72 billion. It also licenses all intellectual property (patents, software, trade secrets, etc.) created at Georgia Tech. GTAC provides funds to Georgia Tech in the form of grants and funded support programs. Additionally, GTRC assists Georgia Tech in obtaining quality research space, enters into long-term leases for specialized research equipment, and conducts other research support programs as requested by the Institute.

Interdisciplinary Centers

To stimulate cooperation in emerging areas of education and research, Georgia Tech has established a network of more than one hundred centers that cut across traditional academic disciplines. Drawing upon human and technical resources throughout the university, the centers provide an interdisciplinary setting for addressing basic and applied problems of interest to government and private enterprise. They also provide a mechanism for interdisciplinary thrusts in graduate and undergraduate education.

Centers are established and terminated as needs and opportunities change. Tech's centers involve faculty from academic colleges and from the Georgia Tech Research Institute (GTRI). GTRI provides additional flexibility to research at Georgia Tech and complements academic programs. All of Tech's interdisciplinary centers perform sponsored research on a contractual basis. Industry affiliate memberships are also available through several of the centers. Membership benefits include special access to Tech's broad technical resources, cooperative research programs, and timely technical reports and reprints. A brief description of the majority of Georgia Tech's centers can be found at www.gatech.edu/colleges-schools/centers-institutes.html.



THE WOODRUFF SCHOOL

In October 1888 the Georgia School of Technology opened its doors and admitted its first engineering class: 129 mechanical engineering students enrolled in Tech's first degree program. As part of their education these early students worked at trades such as forging, woodworking, machining, and mechanical drawing. The products of these shop exercises were then sold to the public to produce income for the School.

The first Head (starting in 1888) and Professor of Mechanical Engineering was John Saylor Coon, a graduate of Cornell University and a charter member of the American Society of Mechanical Engineers. He held this position for 35 years until his retirement in 1923. For eight years mechanical engineering was the only degree offered at Tech, and Dr. Coon saw to it that classes were challenging—so challenging that only 28 of the original students earned degrees. Uncle Si, as Professor Coon was known, set high standards, which became a precedent at Tech.

Over the years, the mechanical engineering program expanded and changed. By 1896, the contract system of shops had been abandoned. Free from the need to render a profit on instructional time, Dr. Coon implemented an educational format which, while it retained elements of hands-on shop training, placed more stress on the emerging tenets of quantification and analysis. Dr. Coon revised the curriculum, describing a mechanical engineering program that emphasized design, mathematics, and problem solving. Increasing emphasis was given to higher mathematics, theoretical science, and original research.

The notion that an engineer was a technical master first and a businessman second permeated the curriculum of Georgia Tech at the turn of the century. Mechanical engineering students conducted efficiency tests for businesses in Atlanta and experiments using campus facilities. Practical projects at local businesses became a significant part of the educational process at Georgia Tech, especially after the Cooperative Program officially began in 1912.

Tech graduated its first two students, with bachelor's degrees in mechanical engineering, in 1890. The first MSME was authorized in 1922, and a doctoral program was added in 1946. The first MS degrees were awarded in 1925, and the first Ph.D.'s were granted in 1950. Georgia Tech was renamed the Georgia Institute of Technology in 1948. Women were admitted in 1952, and the campus was voluntarily integrated in 1962. In 1949, the Department of Mechanical Engineering officially became the School of Mechanical Engineering with its own director and administrative staff. In 1985 the School was named for its benefactor, distinguished Atlanta business and civic leader, the late George W. Woodruff (class of 1917).

Today, the Woodruff School of Mechanical Engineering is the oldest and second largest of the ten divisions in the College of Engineering at Georgia Tech. We have programs in mechanical engineering, nuclear and radiological engineering, medical physics, paper science and engineering, and bioengineering. We offer nine degrees: two in undergraduate studies (BSME and BSNRE) and seven in graduate studies (MS, MSME, MSNE, MSMP, MSPS, MSBIOE, and the Ph.D.). Research and teaching in the Woodruff School is directed by a distinguished group of academic faculty, full-time



J. Erskine Love Jr. Manufacturing Building

research engineers and scientists, and academic professionals. Also, many of our graduate students are employed as research assistants and are an integral part of this technical community.

In 2000, the American Society of Mechanical Engineers recognized the Woodruff School as a Mechanical Engineering Heritage Site. Of the 225 landmarks, sites, and collections, we are the only educational institution with this honor, which was granted for the impact that mechanical engineering education at Georgia Tech had on the South and the nation.

Graduates from Georgia Tech have always had a hand in helping build industry in the South. This is as true today as it was more than a century ago when Georgia Tech began to educate engineers and revitalize the economy of the South, devastated after the Civil War. Today's rigorous engineering curriculum allows our students to continue to have a lasting impact on the global society.



Manufacturing Related Disciplines Complex