David Frost wants to change the perception that Georgia Tech only means Atlanta. He believes Georgia Tech’s Savannah campus, located on a 46-acre tract of land off Interstate-95, is uniquely positioned to act as a catalyst for changing education, research and service in coastal Georgia and the southeastern United States.

“Georgia Tech Savannah students go through the same degree program as the Atlanta students, but they get a little something extra,” says Frost, a professor of civil and environmental engineering, director of Georgia Tech Savannah and a Georgia Tech vice provost. “With the distributed environment utilized for part of their academic engineering program, students are not bound by classroom walls or campus fences, but are very comfortable using technology to connect and interact. A large number of employers have commented that they like this in our graduates.”

Beyond their teaching responsibilities, each of Georgia Tech Savannah’s 25 faculty members is conducting several research projects, ranging from hurricanes, tsunamis and beach erosion to development of technologies and logistics for port operations and distance learning. Frost notes that a growing number of research projects are being facilitated by Savannah-based industries such as Gulfstream and JCB, another benefit of being a coastal Georgia campus.

“We have ties back to the main campus in Atlanta and are able to easily access resources, but our geographic location is a unique asset that allows our students and faculty to complement the programs and activities in Atlanta,” he says. “By working together, we can move the Institute forward and make a greater impact in this state and beyond.”

What follows is a small sampling of the research being conducted at Georgia Tech Savannah.

**Developing Educational Technologies that Enhance Student Experiences**

Monson Hayes, professor and associate chair for electrical and computer engineering programs at Georgia Tech Savannah, says it was the inherent challenges of the Georgia Tech Regional Engineering Program (see sidebar) that led him and his colleagues to explore how to enhance students’ distance learning classroom experiences.

“Oftentimes, faculty here will be teaching students that are distributed on other campuses. Delivering audio and video of lectures over the Internet can sometimes lead to lower quality, and traditional distance learning students can feel a bit detached,” he notes. “That’s what we want to change at Georgia Tech Savannah.”

When Hewlett-Packard (HP) issued a call for proposals to explore how tablet PCs might be used in the classroom, Hayes and Elliot Moore, an assistant professor in the School of Electrical and Computer Engineering, proposed using the PCs to get high-quality video of distance learning lectures to the students. They were awarded funding to jump-start their research project and HP also donated 22 tablet PCs. Due to the success of the program and the novelty of their idea, Microsoft provided additional funding the following year.

Tablet PCs allow users to incorporate aspects of pen and
“With the distributed environment utilized for part of their academic engineering program, students are not bound by classroom walls or campus fences, but are very comfortable using technology to connect and interact.”

- David Frost, director of Georgia Tech Savannah
paper into computing via a stylus pen or wireless keyboard. Information such as handwritten class notes or annotated electronic documents can be stored digitally and accessed wirelessly. The portability of the tablet PCs also allows professors to lead classroom discussions even if they are away from campus.

Hayes and Moore began using software called DyKnow, which uses intuitive tools to enhance teaching strategies and engage students. The software allows instructors to turn over control of the classroom to any student, broadcasting material from the students’ tablet PC to everyone else. Students can be engaged – from a distance – to solve problems, take quizzes and answer questions or polls.

“Tablet PCs could probably be used in just about any STEM discipline – science, technology, engineering, mathematics,” Hayes says. “They definitely involve a different teaching style and philosophy.”

Ghassan AlRegib, an assistant professor in electrical and computer engineering, is also researching educational technologies that project distant classrooms into a “cyber classroom” that is accessible by instructors and students. Examining multimedia and immersive communications, he is collaborating with colleagues at several institutes and corporations to develop networking and streaming algorithms for sending multimedia objects over the Internet, in particular video and 3-D environments that require large bandwidth.

“I come from a multimedia processing and communications background, and there’s something called immersive communication where you can immerse people – students, teachers, business people, CEOs – in this virtual world,” AlRegib says. “I want to know how we can use multi-camera arrays to capture the real environment.”

The multi-camera array, provided by HP, consists of 24 small cameras aimed at a wall that is 32 feet long and eight feet high. The software developed by HP stitches all of the images together, allowing for high resolution in real time. For example, students in a remote classroom are able to zoom in and out to focus on writing on a whiteboard, and professors...
Approximately 160 students are enrolled at Georgia Tech Savannah – 132 undergraduates and 32 master’s and doctoral students. Degrees are available in civil, computer, electrical, environmental and mechanical engineering. The first undergraduate degrees were awarded in fall 2001, and since then, nearly 275 students have graduated from the Savannah campus.

There is also a strong transfer program as part of the Georgia Tech Regional Engineering Program (GTREP), a formal academic collaboration between Georgia Tech and three partner institutions: Armstrong Atlantic State University and Savannah State University in Savannah, and Georgia Southern University in Statesboro, Ga. Students are taught by Savannah-based faculty complemented by distance instruction from other Georgia Tech campuses.

In addition, students have access to world-renowned researchers in a wide variety of disciplines and expertise. There are 16 instructional labs in areas such as automation and robotics, digital education, electronic circuits and instrumentation, hydromechanics and systems and controls, and 18 research centers and laboratories.

Academics are not the only focus of Georgia Tech Savannah; outreach is also an integral part of the campus. The Savannah office of the Advanced Technology Development Center (ATDC) – Georgia Tech’s nationally recognized science and technology incubator – assists new ventures arising from Savannah’s diverse technology community that includes educational institutions such as the Savannah College of Art and Design, established companies and a growing community of startups. Currently, there are six ATDC member companies in Savannah.

The Savannah campus is also home to a regional office of Georgia Tech’s Enterprise Innovation Institute, an organization that helps companies, entrepreneurs, economic developers and communities improve their competitiveness through the application of science, technology and innovation. It is one of the most comprehensive university-based programs of business and industry assistance, technology commercialization and economic development in the nation.

By Nancy R. Fullbright
can see the facial expressions of students, making the experience as close to the traditional classroom as possible. The camera is currently operational in an experimental classroom at Georgia Tech Savannah where AlRegib’s research group is conducting research and developing educational tools that utilize the camera.

“The high resolution of the camera and the scenes being stitched together at the pixel level in real time are unique to this camera and make it cutting edge,” AlRegib notes. “My prediction is that this will be the future of imaging in educational environments.”

AlRegib is also conducting research in collaborative virtual environments, a technology he and his colleagues developed for use in science teaching and 3-D manuals, among others. The transmission algorithms – which allow for a networking of multiple virtual environments – dictate when and in what state information is to be transmitted across the network. When multiple virtual environments are networked, users have the opportunity to cooperate or compete with other users. Interacting with humans more realistically models the actual world on which the virtual environment is based.

“All of this fits into communication – the camera captures the visual and the collaborative system captures the motion,” he says. “Both capture the real environment and map it into a virtual environment so people can meet, interact and work together in a natural way. The applications are really endless.”

**Applying Sensing Technologies to Real-World Problems**

James Tsai, an associate professor of civil and environmental engineering at Georgia Tech Savannah, probably knows more about Georgia’s 18,000 miles of highways than just about anybody else. For more than 10 years, he has been working with the Georgia Department of Transportation (DOT) to implement a pavement preservation and management system – Georgia Pavement Management System – based on information technology and geographic information systems (GIS).

“The focus of my research is pavement distress, preservation and management,” he says. “Departments of transportation typically spend more than half of their total annual budgets on infrastructure, especially pavements. Applying the right pavement treatment method in the right location at the right time means saving money, so the economic impact of my research is potentially large.”

- James Tsai, associate professor in the School of Civil and Environmental Engineering
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Tsai works with a 10-member, multi-disciplinary Georgia Tech research team on pavement condition assessment, pavement rehabilitation technology, deterioration and forecasting models, long-term system performance simulation, and resource optimization. For local transportation agencies, Tsai and his team have developed and implemented an integrated asset-management system that uses global positioning system technology. They are extending their research to manage other assets, including traffic signs, bridges and railroads.

Some of Tsai’s research, sponsored by the Innovation Deserving Exploratory Analysis Program of the National Cooperative Highway Research Program, has involved the development of an intelligent sensing system and vehicle to automatically collect roadway asset and pavement distress information. Tsai and his team developed innovative image-processing technology using cameras and lasers to measure pavement quality, roadway signs, number of lanes, pavement width and shoulder width.

“By using sensing technologies, including lasers and cameras mounted on a van, we can take photographs every 20 feet and obtain laser data to automatically collect information on signs and pavement distress,” Tsai says. “We have developed algorithms to analyze pavement distress and to build a forecasting and optimization model. This sensing technology provides us the most comprehensive and accurate information.”

This year will mark the tenth anniversary of the implementation of Tsai’s Computerized Pavement Condition Evaluation System (COPACES), a program used by Georgia DOT to evaluate its highway system.

Whereas Tsai is using sensing technologies to examine surfaces, David Frost, professor of civil and environmental engineering and director of Georgia Tech’s Savannah campus, is using them to go below the surface. He has improved traditional penetrometers – instrumented cylindrical devices made of hardened steel – used to record friction resistance and pore pressure in soils. They are also used to evaluate soil types and predict where soil will liquefy, to determine how foundations of buildings will behave and to study the characteristics of natural and man-made geo-materials under earthquake and other dynamic loading conditions.

“When we first began this research in 1996, we were studying how to quantify the roughness or smoothness of these man-made materials – called geo-membranes – that are often used in landfill liner systems,” he recalls. “This earlier research sparked an idea to build something that would allow us to produce a number that quantitatively relates the device texture to soil behavior. Through the insight we’ve gained, we can now tell you how much texture and what type of texture will work best for a particular application.”

The original cone penetrometer – considered the standard for more than 50 years by the American Society for Testing and Materials (ASTM) – was designed to have a smooth surface. Frost and his colleagues modified the device to include multiple sleeves of different roughness that would yield different measurements. The National Science Foundation funded work on the multi-friction penetrometer, and ASTM recognized Frost and his student with its 2003 International Hogentogler Award, an annual award given to the authors of a paper of outstanding merit on soil and rock for engineering purposes.

“This new device gave us the potential to measure multiple values of force with a single device in a single sounding,” says Frost.

Frost has since developed a multi-piezo friction penetrometer, which is able to measure not only force, but also water pressure. Each textured sleeve is associated with a piezo sensor so friction force and water pressure can be measured independently. The device is especially useful when studying earthquakes.

Frost, who most recently traveled to China as part of a U.S. delegation to meet with Chinese government officials and study the May 12 earthquake in Sichuan Province, is currently exploring how to miniaturize the technology for investigating the characteristics of soil on the moon.

“Because of plans to perhaps build permanent bases on the moon and on Mars, the National Aeronautics and Space Administration (NASA) has begun investigating soil,” he says. “Our devices, which have been patented by Georgia Tech, represent a dramatically different approach to what technology was available and used when previous lunar explorations occurred in the late ‘60s and early ‘70s.”

**Imagining Georgia Tech’s Coastal Future**

Frost is passionate about moving the Savannah campus forward by leveraging local assets and opportunities as part of a network of campuses and programs that educates the leaders of a technology-driven world. According to Frost, this will be achieved in part by continuing to develop educational programs, conducting basic and applied interdisciplinary research, stimulating regional economic development, developing an interdisciplinary academic environment, expanding access to an engineering-centered education, and growing a modern campus.

Planning metrics call for 500 students to be enrolled at the Savannah campus by 2012, with more than half participating in an out-of-classroom experience like the cooperative education program or an international program. In the same time, faculty research expenditures will increase, a graduate-student-to-faculty ratio of four to one will be achieved, and at least two dual degree programs with partner institutions will be offered.

“This all comes back to technology,” Frost says. “Technology is the enabler that allows us to achieve our vision. Innovative education has no boundaries.”