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Trail Wise
For the first time in 66 years I am stimulated to write to praise an author of a magazine article [The Greatest Mountain, Alumni Magazine, Fall 1997]. My wife and I have hiked about 1,800 miles of the Appalachian Trail over the past 12 years.

We have read many entertaining articles about or by people who have duplicated what Neal Binder and Rob Cleveland accomplished. The author, Michael Terrazas, captured the ambiance of the experience incredibly well. The whole magazine is first-rate.

Robert B. Clark III
Chattanooga, Tenn.

Co-op Seniority
I enjoyed reading about Warren Batts [Alumni Magazine, Summer 1997]. However, the statement was inaccurate that said when he graduated from Georgia Tech in 1961 at age 29, he was the oldest student to have graduated from the co-op program at the time.

I entered the co-op program as a sophomore in 1948 at the age of 27. I was a co-op student in the maintenance machine shop of Republic Steel Co. in Gadsden, Ala., until 1952, when I graduated at the age of 31 with a bachelor of mechanical engineering degree. I went to work with the Engineering Experiment Station [now Georgia Tech Research Institute], and going to school part-time, I received an MS in mechanical engineering in 1956.

I was also a participant in the first doctoral program in nuclear reactor engineering under Dr. William Harrison. I was in the program for three years, but had to drop out due to the increasing number of projects I had at the Experiment Station. From 1964 to 1966, I was on loan from Georgia Tech to Kabul University as a visiting professor of mechanical engineering. Upon returning to Georgia Tech in 1966, I went into the School of Textile Engineering as an associate professor. For one year, 1979-80, I was on loan to the Department of Labor in Washington as a special assistant to the Secretary of Labor to work at the Directorate of Technology for OSHA. After returning to Tech in 1980, I continued to teach and do research until my retirement as Professor Emeritus of Textile Engineering in 1985. I continue to consult in textile and mechanical engineering.

Winston C. Boteler,
ME ’52, MS ME ’56
Atlanta

Pass Along Reading
I have read every story in the last outstanding issue of the Georgia Tech Alumni Magazine. This magazine doesn’t take second place to any that I see, and I read regularly. I have always been proud of Georgia Tech, but I am even more so when I get the quarterly magazine. Because it is so well done, I make sure to pass it on to a non-Georgia Tech friend.

Keep up the great work.

S. Joseph Ward, IM ’51
Midlothian, Va.
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Electric Tech
New facilities are boon for state's high-Tech future

Industry, academic and government leaders recently gathered to dedicate three new electronics facilities at Georgia Tech.

The new facilities, housed in Tech’s Manufacturing Research Center (MARC), will allow engineers to create the next generation of semiconductor packaging and printed wiring board assembly.

"Georgia Tech is a key partner in attracting new technological industries and in retaining what is already here," said Randolph Cardoza, commissioner of the Georgia Department of Industry, Trade, and Tourism. "From 1990-95, high-tech employment in Georgia grew over 33 percent, the second-fastest growth rate in the United States, and we are now the 10th largest state for high-tech jobs, employing over 125,000 people."

In total, the three new laboratories represent a three-year, $30 million investment by the Georgia Research Alliance, Georgia Tech, the State of Georgia, the National Science Foundation and many industrial partners.

According to both Cardoza and Research Alliance head William Todd, IM '71, investment in targeted research areas can have a positive impact on Georgia’s economy, particularly as the global electronics market is projected to grow from $800 billion today to $2 trillion over the next decade.

"We must show international companies that Georgia is the place for their future," Cardoza said. "It is the place for them to be if they want to be near the most advanced technology and the brightest scholars and researchers in the United States."

Philosophical Debate
Plastered on the rear bumper of a Georgia Tech student’s car: "My karma ran over your dogma."

Buckyballs
Nobel Laureate speaks on discovery of C60 molecules

One of the scientists who added "buckyballs" to the science encyclopedias shared the story of the award-winning discovery with students and faculty at Georgia Tech this fall.

Nobel Laureate Sir Harold W. Kroto, who discovered and synthesized the C60 buckminsterfullerene molecule with Drs. Richard Smalley and Robert Curl in 1985, delivered the William Monroe Spicer Undergraduate Science Lecture and the Molecular Design Institute Fall Lecture on Nov. 17.

"It’s always an honor to host outstanding scientists for technical lectures at Georgia Tech," said Dr. William Rees Jr., director of the Molecular Design Institute (MDI).

Kroto is a Royal Society research professor at England’s University of Sussex. He also directs research on the Kuiper Flying Observatory, seeking the C60 molecules in space.

The C60 family of molecules are named for Buckminster Fuller because they resemble the geodesic dome he designed. The compositions may provide a basis for new materials, semiconductors, drug-delivery systems, affordable solar cells and superconductors.
Author, Author!


It Feels So Good

Former Tech star pitcher Kevin Brown (left center) is bearhugged by catcher Charles Johnson and mobbed by other Florida teammates after Brown pitched the Marlins to a 7-4 win over Atlanta for the National League Championship. The Marlins went on to win the World Series against Cleveland.
Georgia Tech students, alumni, faculty and staff turned-out more than 1,100 strong on a cold November morning as volunteer workers for TEAM Buzz Community Service Day.

TEAM is an acronym for Tech Enhancing Atlanta Metropolitan, and volunteers tackled some 30 Atlanta community projects, including working with schools and children, the homeless, health care and the environment.

Event organizer and Tech graduate student Tony Chan, IE '94, said one of the most important goals of TEAM Buzz was emphasizing a sense of community at Georgia Tech, involving all members of the Georgia Tech family. Former President Jimmy Carter, Cls '46, served as honorary captain for the Nov. 15 project. Volunteers heard Carter's endorsement of the effort and support via videotape at a kick-off rally at the Georgia Tech Plaza. Members of the steering committee are (left to right above) Trey Childress, Jenn Stokes, Melissa Byrd, Tony Chan, Renee Contardo, Tracy Countryman and Mark Allen.

Reedy GTRI Leader
Researcher takes post after serving as interim

After serving as interim head for eight months, Dr. Edward K. Reedy has been named vice president and director of the Georgia Tech Research Institute (GTRI). Reedy replaces Adm. Richard Truly, who left in March to become director of the National Renewable Energy Laboratory in Golden, Colo. Joining Georgia Tech in 1970 as a research engineer, Reedy spent 13 years at the helm of the Radar and Instrumentation Laboratory, one of Georgia Tech's largest research labs. He was named associate director of GTRI in 1990 and three years later became director of research operations, responsible for all nine GTRI research labs. Reedy has also served as an adjunct professor in the School of Electrical and Computer Engineering, where he taught, supervised a series of special problems projects and helped develop a "Management of Technology" certificate program. Reedy received his doctorate in electrical engineering from the University of Tennessee in 1968.
New Vision for Tech?
Atlanta sculptor is Tech's artist-in-residence

Atlanta sculptor Clark Ashton is Georgia Tech's artist-in-residence for the 1997-98 academic year, filling a newly created post jointly appointed by the College of Architecture and the School of Mechanical Engineering.

A one-year appointment, the new post will bring a variety of artists and media to the Georgia Tech campus.

"I build mechanical towers," says Ashton, 39, a native of Augusta, Ga. One of his sculptures has already been installed on campus in front of the Coon Mechanical Engineering Building on Cherry Street—a 17-foot tower of iron and steel that Ashton calls a "Sky Scratcher." By cranking the handle, passersby activate a claw-like element at the top of the tower, moving it up and down.

"We believe this post will inject new energy and ideas into Georgia Tech," says Thomas D. Galloway, dean of Architecture. Adds Ward Winer, chair of the Woodruff School of Mechanical Engineering, "Art involves not only conception, but also fabrication and production. The artist-in-residence program gives us the opportunity to explore the synergism among art, design and engineering."

In some respects, the artist-in-residence program has its roots in the past. The late Julian Hoke Harris, Arch '28, was an artist and sculptor. He returned to Tech in 1936, where he taught and worked for nearly four decades. Harris created a number of works for the campus, including 10 corbelled heads in Brittain Dining Hall and bronze gates in the Naval ROTC Armory.

"We hope this program will revive and add to the legacy that Julian Harris began," Galloway says. GT

This Year at Tech

A Very Good Year Although Georgia Tech received its charter in 1885, it was 110 years ago when the Institute officially opened its doors in ceremonies on Oct. 5, 1888, at the Atlanta Opera House. Dr. Isaac Stiles Hopkins, Tech's first president, embraced a "shop culture" approach to engineering education, and 129 students signed up for class that academic year.

Ninety Years Ago Tech produced its first yearbook, a metal-bound Blue Print, in 1908. It contained the first published version of Tech's gridiron ballad, "Ramblin' Wreck." Although the words are almost identical to the current fight song, it appeared in the Blue Print under the heading, "What Makes Whitlock Blush."

First Homecoming Tech alumni officially observed their "First Annual Homecoming" 75 years ago on Nov. 28, 1923—a banquet attended by school President Marion L. Brittain, football coach W. A. "Alex" Alexander and presided over by Alumni Association President Tommy Stout. "It was unanimously decided to make the homecoming an annual event, but it was thought best to have it at some big game other than the one on Thanksgiving," said an article in the December 1923 Georgia Tech Alumnus magazine.
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Setting the Pace

Pete Silas brings leadership, experience to The Campaign for Georgia Tech

During his student days at Georgia Tech, C. J. “Pete” Silas set the pace as a basketball star—totaling 1,084 points during his career and leading the United States to gold in the Pan American Games.

Silas, who retired in 1994 as chairman and chief executive officer of Phillips Petroleum Co., is again setting the pace for Georgia Tech—this time at the helm of its $400 million capital campaign.

Silas, ChE ’53, volunteer chairman of the Campaign for Georgia Tech, has been criss-crossing the country generating support to take the Institute to a level among the nation’s top universities. His recent travels have taken him to Chicago, Houston, New York, Atlanta and Washington, D.C.

“I was fortunate to get a great education at Georgia Tech,” Silas says. “It’s very important that we support education. Georgia Tech needs the funds not only to maintain its quality, but to improve its quality. Georgia Tech is a good investment.”

Silas brings leadership and experience to the campaign. His career at Phillips Petroleum spanned 41 years. His civic and business activities include service as past chairman of the National Boys and Girls Clubs of America and past chairman of the U.S. Chamber of Commerce. He received the Royal Norwegian St. Olav’s Order for his contributions to Norway’s energy and allied industries, and was named CEO of the Year by the International Television Association.

Georgia Tech has inducted Silas into both the Georgia Tech Athletics Hall of Fame and the Engineering Hall of Fame. He received the Alumni Exceptional Achievement Award and has served on the Georgia Tech Foundation and Advisory Board.

“We’re off to a good start,” says Silas, who has teamed up with Tech President Wayne Clough, CE ’64, MS CE ’65, to visit Georgia Tech Clubs in Houston, New York and Washington.

“We’ve had great turnout,” Silas says. “Wayne talks about the progress of Georgia Tech and the long-range plans, and he explains where the money is going to be spent. I encourage those who feel comfortable to do so to give to a very good cause—Georgia Tech.”

Silas says $75 million of the campaign would go toward students: $30 million to scholarships, $30 million to fellowships, $10 million to a public-service cooperative program, and $5 million to capital projects.
The Campaign for Georgia Tech

million to the cooperative education endowment.

"We have 17 chairs now," Silas says. "It takes about $1.5 million to fund a chair. In addition to bringing in the high-quality students to Georgia Tech, it is very important that we have high-quality professors."

The campaign is raising $50 million to endow chairs, $10 million to endow professorships, $12 million for young faculty endowments, $5 million for eminent-practitioners endowments and $3 million for Georgia Research Alliance eminent scholars.

"In addition to the scholarships for the students and endowed chairs for the professors, we have an obvious need for equipment and for buildings," Silas said. The campaign will raise $45 million to provide first-rate facilities for academics and research, including $15 million for the bioengineering/biosciences building.

"Now that we have some 8,000 beds on campus, we have more of a campus life than we have ever had before." The campaign will provide $35 million for student-life programs, including $8 million for the Georgia Tech Library and Information Center.

"Wayne does a good job of explaining that not only are we trying to improve the academic part of Georgia Tech, but the cultural and social experience on campus," Silas says.

Athletics will receive $35 million for the addition of men's and women's soccer and women's swimming and golf programs.

The campaign will raise $105 million for Georgia Tech's endowment, the hallmark of a maturing and prestigious institution.

The volunteers at Georgia Tech and in regions around the country who are working on the campaign are outstanding, Silas adds.

"We're getting a lot of young volunteers involved and that's important," Silas says. As veterans of the five-year centennial campaign, Silas says he and Gellerstedt know the significance of that experience. Their legacy, he says, will be to train younger volunteers to carry on future campaigns.

This campaign will carry Georgia Tech into the new millennium, he says, but 10 and 15 years from now, other alumni must become the leaders who help ensure Georgia Tech's future. — John Dunn

Architecture Competition

Southern GF Corp. renews support of annual graduate project prize

The College of Architecture has received a 10-year commitment from Atlanta-based Southern GF Corp. to sponsor its annual SGF Prize competition.

The Southern GF Corp., a major supplier of construction materials, has sponsored the prize on a year-by-year basis for the past 22 years. The Southern GF Prize is awarded to the outstanding graduate project in the College of Architecture.

"We're very, very fortunate that we've had such a good relationship with SGF through the years," says John Kelly, director of the architecture program. "The SGF competition is the big event of the year for our program. Just to have a project selected as one of the finalists is an honor in itself."

The competition, which is held in the spring, is actually part of the graduate students' curriculum as they submit their final graduate projects to a jury for review. The panel of jurors, which usually includes a nationally known chair, is made up of professionals and educators.

Of the 25 or 30 entries submitted by the students each year, between six and eight are chosen as finalists to be further critiqued and culled to determine the best three. "There are good projects, good criticism and a lot of learning going on," says Kelly.

The first-place winner receives a $6,000 traveling scholarship and a valuable wood sculpture designed by architect and Georgia Tech alumnus Ed Moulthrop. Second- and third-place finishers receive $1,000 and $500, respectively.

"This scholarship is one of the largest of its kind in the country among design schools," says Ski Hilenski, director of development for the college. "This is the first time a sponsor has made a commitment to our architecture program for an extended period of time." GT
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The Age of Biology

As the millennium approaches, scientists at Georgia Tech and elsewhere are engineering a healthier human

By Hoyt Coffee
Photography by Billy Howard and Gary Meek

When Georgia Tech graduated its first students in 1890, they entered a "real world" on the cusp of a new century, an era that challenged them with creating and building all manner of modern machinery. With the advent of the 21st century, a new generation faces a new challenge. Today's students, graduates and researchers must turn their attention to the ultimate machine—the human body. "Many people believe the next decade will be defined as the 'Age of Biology,' not only from the business standpoint, with huge new markets, but from a rich intellectual pursuit," says Bill Todd, IM '71, president of the Georgia Research Alliance. "It is important for Georgia Tech to marry its strengths in engineering to biology." The Institute's contribution to the burgeoning field of "biotechnology"—more specifically biomedical technology—involves more than just engineering, although engineers of every stripe play a vital role in understanding the physical human, from hip joints to DNA molecules. For example, computer scientists are needed to handle the enormous data generated by research efforts like the Human Genome Project, and to help investigators at the molecular level visualize their work.

Post-doctoral student Chris Haught works with pipetting media to grow skin cells for insulin research conducted in Athanassios Sambanis' lab.
Likewise, policy makers play a part, dealing with the ethical issues of genetic engineering, while the multibillion-dollar biotechnology enterprise will require educated businessmen.

“By the year 2015, biotechnology as a commercial enterprise will be a $600 billion industry and one of the largest employment segments in the United States.”

work where you use the strength of our engineering program with the growing strength of our sciences, particularly our biological sciences and computer sciences, and put them together in a way that allows Georgia Tech to enter a very important field,” says Georgia Tech President Wayne Clough. “Literally every college has a part to play.”

At the core of the effort are the scientists conducting pure research in biology, life chemistry and the atomic bases for life processes, investigators whose findings will be the foundation for further discoveries and applications that may dramatically alter the nature of life on earth.

“The fundamental discoveries in biosciences made at Georgia Tech and elsewhere will change the pattern of life in ways comparable to the chemist’s invention of antibiotics and the physicist’s invention of the computer chip,” says Dr. Gary B. Schuster, dean of the College of Sciences. “Engineers will take the discoveries of biologists, biochemists and biophysicists and turn them into devices and products that will change forever the world our children and grandchildren will live in.”

Aging Research

The biotechnology playing field is vast today, covering applications ranging from erosion control to artificial skin. And its biomedical branch is growing exponentially as health scientists use more and more technology in the assault on disease and disability, situations bound to be exacerbated by the “graying of America.”

According to a Census Bureau report, “65+ in the United States,” the number of Americans over 65 years of age, 33 million today, will grow to 53 million by 2020 and to 80 million by 2050. Growth estimates for those termed the “oldest old,” those over 85, predict today’s 3.5 million will increase to 7 million by 2020. In fact, among the nation’s 76 million baby-boomers, one turns 50 every 7.5 seconds.

“We’re steadily increasing life span, but as we do, we’re running into more and more complicated situations with regard to disease and quality of life issues,” Clough says.

In 1994, America’s total healthcare bill reached nearly $950 billion, according to a report by the Office of National Health Statistics, and that amount is growing by 6 to 7 percent a year. Statistics gathered by Ernst & Young show the U.S. biotechnology industry increased from a net value of $52 billion in July 1995 to $103 billion in September 1996.

“By the year 2015, biotechnology as a commercial enterprise will be a $600 billion industry and one of the largest employment segments in the United States,” Clough says. Such statistics are not lost on Georgia Tech students. Recognizing the potential for lucrative careers in biotechnology and biomedical technology, students “have been voting with their feet” for comprehensive educational opportunities in the field.

“We are seeing increased student enrollment at the undergraduate and graduate levels in the biosciences,” Schuster says. “In fact, biology is busting at the seams.

“Employers literally have been begging for our graduates. I had the personal experience of having a recruiter for a pharmaceutical company ask if I would put him in touch with stu-
Parker H. Petit, ME '62, MS EM '64, is helping fund the research that offers breakthroughs in human recovery.

Heathdyne, where he developed the world's first home physiological monitoring device, used worldwide in the management of infants at risk for SIDS. The Marietta, Ga., firm evolved into an international corporation with 1,200 employees, providing home obstetrical care and maternity management services. In 1995, Heathdyne was split into three publicly traded companies: Heathdyne Technologies, Heathdyne Information Enterprises and Matria Healthcare.

In November 1997, Pittsburgh-based Respironics Inc., a medical device company, agreed to acquire Heathdyne in a $370 million deal that is expected to be completed by March 31. Petit will become a director of the new company.

Petit is also a founder of CytRx Corp., an Atlanta biotechnology company. In 1994, he was inducted into both the Technology Hall of Fame of Georgia and the Georgia Tech Academy of Distinguished Engineering Alumni. An International Business Fellow, he is a 1981 recipient of the Humanitarian Award from the Société Française De Bienfaisance.

A co-op student at Georgia Tech, Petit served on the Student Council, the Interfraternity Council and Honor Board. He was president of Pi Kappa Phi. After earning his master's, Petit served a tour of duty in the Army to fulfill his ROTC commitment, then began his career as an aerospace engineer. He has also earned a master's in business administration degree with a concentration in finance from Georgia State.

Petit serves on the Campaign for Georgia Tech Steering Committee, Georgia Tech Mechanical Engineering Advisory Board, the Georgia Tech-Emory Biomedical Engineering Council, Management of Technology Corporate Council of Advisors (since 1991), Georgia Tech Advisory Board (1986-92), Ivan Allen College Campaign Planning Committee (1991), and the 25th Reunion Committee. He is a former trustee of the Alexander Tharpe Fund.
Continued from page 22

students who will finish graduate degrees in bio-science in the next two or three years. He wanted to interview them now and offer them jobs before other companies learned about them.”

Biological Expansion

While Georgia Tech’s involvement in biotechnology has received more attention of late, especially with the creation of a joint department with Emory University, the Institute’s efforts in the area date back nearly two decades—part of a wave of new research in the field.

“What has been happening over the last half of the 20th century is an explosion in biology, and in biology at the cellular and molecular level,” says Don Giddens, former dean of the Johns Hopkins College of Engineering and an architect of Tech’s new biotechnology center. “The tremendous advances in biology are somewhat comparable to the advances that took place in physics in the first half of the 20th century.”

Although there had been some previous research, the “explosion in biology” reached Tech in the mid-1980s with the establishment of the Parker H. Petit Distinguished Chair in Engineering and Medicine and the Bioengineering Center, says Dr. Ajit Yoganathan, director of the center.

“That was a stepping stone,” Yoganathan says. “The ‘85 chair and the recruitment of Bob Nerem (who holds the Petit chair) and a group of young faculty helped us.” Over time, Petit, ME ’62, MS ME ’64, has committed $6 million to biotechnology at Tech.

Areas of Growth

Also critical in growing the center to its current 22 faculty and 90 graduate students, as well as the establishment of the Emory/Georgia Tech Biomedical Technology Research Center in 1987, was a 1985 study by McKinsey & Co. for the nascent Georgia Research Alliance. The study identified biotechnology as one of three areas in which the state should focus economic development efforts, along with telecommunications and sustainable technology.

A more recent study by the Metro Atlanta Chamber of Commerce’s “Dream Team,” a group of business and academic leaders, focused on four thrust areas for target marketing over the next four years by the Forward Atlanta Campaign: telecommunications, biotech and biomed, computer-related services and high-tech manufacturing, says Joy DeVries, IE ’82, senior project manager for the chamber.

“One of the things that we have going for Atlanta already is the resources that are coming out of Georgia Tech and Emory from the academic and R&D side that make biotech a natural fit for a target industry for Atlanta,” DeVries says. “Another reason is the strength we have in biotech and biomed fields from a private industry standpoint, companies that have either spun out of the university environment or entrepreneurs who have come here and want to be associated with a university.”

According to a 1993 KPMG/Georgia Biomedical Partnership study, Georgia is home to at least 230 companies involved in life sciences, and Susan Walcott, a geographic information systems professor at Georgia State, says Atlanta has 171 biotechnology companies.

Also important for developing biotechnology efforts at Tech and in the city is the presence of a substantial health-related infrastructure already. For instance, Atlanta is home to the Centers for Disease

“There’s no question this biotechnology revolution is going to have a lot to do with economic development in the future.”

Tina Conti, a graduate student in the School of Chemistry and Biochemistry, prepares a sample of nucleic acid for a two-dimensional NMR experiment used to determine a three-dimensional structure.
Control and Prevention, the American Red Cross, the Yerkes Primate Research Center, the American Cancer Society and the Arthritis Foundation. Even the Carter Center has had a hand in biomedical applications, providing the worldwide distribution for a river blindness drug donated by Merck.

In 1993, the Whitaker Foundation, founded to promote the application of engineering and physical sciences to medicine, gave Tech a $3 million Biomedical Engineering Developmental Award, which Nerem predicted “will definitely take us to the next level.” That prediction is on its way to coming true; in the latest rankings by U.S. News and World Report, Tech’s bioengineering program was ranked No. 10 in the nation.

**Federal Dollars**

Today, Tech is getting increased research support, despite a general decline in federal dollars and a highly competitive atmosphere, in part because of refocusing research efforts toward more productive areas, including biotechnology. Federal statistics show that in 1995, three federal agencies provided the bulk of support for academic research, with the lion’s share (53 percent) coming from the National Institutes of Health, followed by the National Science Foundation (15 percent) and the Defense Department (12 percent).

In a comparison of research dollars across disciplines, health-related research has steadily enjoyed increased support without the ups and downs that plague space science, energy or other sectors that fall into—and out of—favor. An analysis by the American Association for the Advancement of Science of the fiscal 1998 budget approved by Congress shows that while defense research rated a 2.8 percent funding increase—and energy-research funding actually declined 9.7 percent—appropriations for health-related research increased 7.1 percent. And at the National Institutes for Health federal projections indicate a steady growth rate of 6 to 7 percent over the next five years.

The Georgia Research Alliance has spent more than $72 million over six years to accelerate development of the state’s biotechnology initiatives, and the industry is earmarking more of its income to research and development.

“Funding from external sponsors for biosciences is at an all-time high,” Schuster says. “And several research spin-offs have been patented and are being developed as commercial products.”

While pure science is important to the field, research dollars are also targeted to economic development, a stated objective of Tech’s plan.

“There’s a lot of money and energy spent in biomedical research,” Giddens says. “There’s no question this biotechnology revolution is going to have a lot to do with economic development in the future, and we would certainly like for Atlanta and the state of Georgia to share in that.”

According to Mark Samuels, the president and chief executive officer of SpectRx who served as chairman of the Georgia Senate Biomedical Study Committee, much of the economic development challenge involves correcting misconceptions about the state.

“One of the things that was apparent to me when I tried to form Laser Atlanta and SpectRx was there wasn’t enough recognition in Georgia of the enormous potential for these types of companies,” says Samuels, Phys ’82, MS Phys ’85. “And I felt we needed to bring some of the ideas to the forefront, not just to people in Georgia, but to people nationwide, that Georgia wasn’t just peanuts and Vidalia onions—that there’s quite a bit of technology here.”

Working with the Georgia Biomedical Partnership and the CEO Roundtable, Samuels has helped reduce the barriers to biotechnology start-ups, such as raising venture capital, protecting intellectual property and “getting technology out of the lab and into the hands of entrepreneurs, where it can be used to create opportunities for Georgians.” Technology transfer was key to Samuels’ success. Working out of the Advanced Technology Development Center on Georgia Tech’s campus, and using technology licensed from Tech, Samuels founded Laser Atlanta Optics. He later discovered similar technology could be used to monitor diabetics, creating a product for SpectRx.

“The thing that’s helping us a lot is you’re starting to see some successful companies in the area,” he says. “As these get bigger and become more successful, that will make a big difference.”

**A Unified Approach**

With the establishment of an academic department jointly educating Georgia Tech and Emory students in biotechnology, with cooperative research in concert with seven universities and colleges, with the creation of the Parker H. Petit Institute for Bioengineering and Bioscience, with the impending construction of a $30 million biotechnology complex on campus, and with a No. 10 ranking for bioengineering already under its belt, Georgia Tech is poised to lead in the Age of Biology.

Exactly where it will lead remains uncertain as scientists probe the most mysterious of realms.

“The potential for these advances to have an impact on humankind is really tremendous,” Giddens says. “There is all sorts of new knowledge that’s coming out exponentially on the biological side of things. It’s critical that Georgia Tech, which is so strong in engineering, be in the forefront of biotechnology in the next century. The handwriting is very clear.”

GT
Georgia Tech is at the center of a crossroads, a junction where man and machine meet, where science becomes medicine and unlikely alliances pave new avenues.

From across the full range of scientific inquiry, researchers from a wide spectrum of not only departments, but also institutions are converging to create the Parker H. Petit Institute for Bioengineering and Bioscience.

From Georgia Tech, Emory University, the Medical College of Georgia and elsewhere, they are fitting together engineering and biology, electronics and chemistry, to salve humankind's harshest frailties.

**Biomaterials**

To meet the need for new medical materials, scientists are manipulating nature on the molecular level. For example, Elliot Chaikof and Peter Ludovice are working toward materials to help regenerate cardiovascular tissue by incorporating critical signaling molecules that cause certain cells to migrate. Others are designing films aimed at making drugs more selective and more effective.

**Biomechanics**

Using advanced imaging and monitoring techniques, researchers such as David Ku, Ajit Yoganathan and Don Giddens are studying the fluid mechanics of blood flow to help design such things as improved artificial heart valves. Raymond Vito, meanwhile, is investigating the mechanical properties of arteries, veins and ligaments, and Robert Goldberg is working with mechanically stimulated bone growth.

**Cellular Engineering**

Revealing life at its most basic level, scientists are testing the characteristics of individual cells and their reactions to physical forces. Robert Nerem, for instance, is looking at the effect of blood flow on the biology of cells lining the inferior of blood vessels, while Timothy Wick is studying factors that contribute to sickle-cell anemia or malaria. Robert Cargill is investigating the effects of external mechanical forces on cells, particularly as it relates to brain injury.

**Drug Design and Delivery**

In an age of designer drugs, scientists at the Petit Institute have taken giant steps in the treatment of cancer, AIDS, hypertension, stroke, emphysema and neurological disorders. Leon Zalkow and Edward Burgess have already synthesized 125 candidates for treating AIDS and tumors, and new research is beginning regularly. James Powers, meanwhile, is synthesizing compounds to help fight emphysema and coagulation disorders, and Sheldon May is designing and testing new drugs to treat neurological disorders, hypertension and inflammation. Delivery of drugs to the system is the interest of Mark Prausnitz, who is using new techniques such as electric fields, ultrasound and microscopic devices.

**Imaging**

As doctors ask for better ways to see inside without a scalpel, Institute researchers like Ku and Yoganathan are...
Tech researchers are looking at new uses for already advanced procedures, such as using ultrasound to detect disease.

providing answers with their multi-mode studies. But their colleagues are taking imaging research in other directions as well. Paul Benkeser is looking at new uses for ultrasound in detecting disease, while Norberto Ezquerra studies artificial intelligence in an effort to improve human analysis of MRI or PET results. Larry Hodges shares that goal in his computer vision research.

Molecular and Cell Biology

As the basis of all medicine is the cell, even more basically the molecule, investigators are looking closely at their interactions. Professor Richard Ikeda is studying specific interactions between DNA and RNA, which carries messages from the genetic strand.

Focusing on individual reactions with enzymes and iron, Ikeda may help end heavy metal poisoning. Yury Chernoff is using a similar model to study a type of protein connected to neurological disorders, research that could advance treatments for Alzheimer’s disease. Other protein research by Jung Cho, Peggy Girard and Raymond Borman may help in the understanding of other illnesses that strike the elderly.

Quantitative Analysis and Modeling

Applications of computing to biological problems are paying dividends in the newly emerging field of bioinformatics. Mark Borodovsky, for example, is further developing pattern recognition methods that led to the software called GeneMark, used in genome sequencing since 1992. In fact, GeneMark made possible the first completely sequenced genome of a free-living organism, a flu germ.

Computer modeling in various forms is at work in practically every biotech lab at Georgia Tech, as the desktop computer has become indispensable to scientists.

Structural Biology

Also paying off is the work of Loren Williams on the information-transmitting abilities of nucleic acids, perhaps important to the continued development of chemotherapy agents. Genetic studies using molecular biology protocols are also under way by Stephen Quirk and Roger Wartell, the latter possibly useful in battling leukemia. Meanwhile, Gary Schuster and Mostafa El-Sayed are advancing knowledge of DNA with studies of photoenzymes, compounds that cleave to DNA when irradiated with light.

Interactive Biomedical Technologies

Humans must interact with biomedical technology, and that’s the basis for many research projects under way and proposed. For instance, advanced telecommunications and computing technology allows doctors to train in virtual environ-
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The Art and Science of Healing

The natural processes are awarded a growing respect from the scientific community

By Gary Goettling
Photography by Billy Howard

lop off a starfish's arm, and it will grow a new one. If a chameleon loses its tail, a replacement will grow from the stump. Though such regenerative power is not uncommon in the animal world, its degree is comparatively limited in humans—limited, but not absent. New skin will form over a wound; broken bones mend themselves. Amazingly, the human liver will regenerate even if cut to about half its original size. Why do some cells regenerate while others do not? Can the process be augmented in humans? How can technology help scientists discover new ways to fight disease? Those are some of the questions that occupy Georgia Tech researchers working under the umbrella term of biomedical engineering. They are looking for answers in nature, especially in the astoundingly complex functioning of the tiny machine that comprises all living matter—the cell.
The fundamental question is: Why are cells engineered the way they are? asks Dr. Robert Nerem, who holds the Parker H. Petit Distinguished Chair for Engineering in Medicine at Tech and is an Institute professor in the schools of Mechanical and Chemical Engineering. "Maybe the Great Creator knows something we don't, and we should be learning from the systems that are already working all around us."

Nerem's specialty is tissue engineering, a new discipline that involves "the development of implant substitutes that employ natural biological materials and living cells," Nerem says. "It's taking what we have learned through the biological revolution of the past 25 years and putting it to practical application in medical implants.

"Rather than create a synthetic substitute for certain body tissue, we are trying to mimic the biological world as much as possible. In some cases we will do that by simply using biological materials and taking advantage of the body's self-healing capability."

Virtually every human tissue has been targeted for engineering, including parts of the nervous system, skin, liver, pancreas, blood vessels, cartilage, bone and muscle.

Skin research has progressed the furthest—skin substitutes that involve living cells. The material is, in fact, skin cells that have been cultured on a biodegradable fabric. The cells grow into a full layer of skin that can be laid like a Band-Aid onto severe burns or ulcers to promote skin regeneration.

Through research at the new Georgia Tech/Emory Department of Biomedical Engineering, Nerem says the next breakthroughs may occur in the development of cartilage, followed by blood vessels and heart valves—even bioartificial organs.

Hiding from the Immune System

The creation of viable bioartificial organs fuels the technology of cell engineering being pioneered at Georgia Tech.

"We try to manipulate the function of cells so they exhibit the desired properties in the bioartificial substitute we are trying to prepare," says Dr. Athanassios Sambanis, an associate professor in chemical engineering.

The manipulation can be done through genetic engineering or by controlling the cells' environments, he explains. Then the cells are placed into an artificial construct, and implanted into the organism where, if all goes according to plan, the new cells behave like the cells they have replaced.

Sambanis' research model is the development of a bioartificial pancreas. Using a controlled-environment approach to manipulate cell function, he believes he has found a way around one of the biggest problems in all such implants—the body's tendency to reject foreign tissue.

"We encase insulin-secreting, glucose-sensitive cells in a semi-permeable membrane that allows the passage of glucose and other low molecular weight nutrients into the cells and allows the passage of insulin out of the cells," he says.

"But the membrane excludes antibodies and lymphocytes. In other words, we manage to 'hide' the cells from the immune system without really compromising their function. That way we can implant these cells without having to suppress the patient's immune response."

Key to the success of this technique is in engineering a membrane with precisely the right molecular structure to allow or exclude passage of specific substances. It's a painstaking process.

"We do a lot of diffusion-reaction modeling in terms of simulating behavior and also to determine optimal values for some key design parameters," Sambanis says.

The research also involves fundamental studies in the biochemistry of the encapsulated cells, where the cells are maintained in "bioreactors" that mimic the in vivo environment. A magnetic resonance imaging spectrometer allows researchers a non-invasive way to evaluate the levels of intercellular metabolites.

Rather than a complete new organ, Sambanis envisions the first bioartificial pancreas as an alternative to insulin injections—perhaps an injection of microcapsules with cells in the peri-toneal cavity every year or two. Besides the conve-
Tech research scientist Dr. Shengqui He and doctoral student Shehab Hashim use Doppler ultrasound to study mitral valves in a left-heart simulator.
“We have the ability to regenerate part of a limb. But whereas some animals can do it on their own, we have to employ engineering principles to allow it to occur in humans.”

Harnessing Bioscience to Fight Disease

A different biotechnological way of treating disease is employed by Dr. Leon H. Zalkow, a Regents' professor and Vasser-Wooley chair in the School of Chemistry.

Zalkow's work in the search for new cancer-fighting chemotherapeutic drugs is based on “the discovery of drugs that will intercept the signals that inform cancer cells to divide and metastasize,” says Zalkow. “These drugs are derived from natural sources and by synthesis, and are modified as needed based on molecular modeling.”

Interdisciplinary collaboration, a distinguishing mark of much biomedical engineering activity, is evident in Zalkow’s efforts, which are conducted as part of a nationwide Drug Discovery Group. He collaborates with pharmacologists, as well as with bioengineers at Tech for the molecular modeling and metastasis.

“You can’t work on such an important disease as cancer—or any disease, in fact—just as a chemist or just as a biologist,” Zalkow says.

For instance, a field researcher may forward to Zalkow a medicinal herb from China that holds potentially useful compounds. These are isolated or perhaps synthesized, then passed along for testing.

“The entire process is a joint effort that requires biological, chemical and computer-modeling input,” Zalkow explains.

Seeding a Natural Process

Fostering a more “natural” approach may be also applied in orthopedic situations involving a skeletal defect. Dr. Robert Guldberg is working on several strategies to enhance bone regeneration to correct such defects, including a procedure called distraction osteogenesis, more commonly referred to as limb lengthening.

“Let’s say someone is born with a leg-length discrepancy, or perhaps been in an auto accident and lost several inches of a leg bone,” explains Guldberg.

“Orthopedic surgeons can cut through the long bone and, using an external fixture or brace, keep the cut ends very close to each other. The body will start to fill in the gap with new bone cells and tissue. As the bone ends are separated a little bit every day, the body keeps adding new cells and tissue. Through this procedure, you can actually add as much as six inches to a person’s limb length.

“So in a sense, we have the ability to regenerate part of a limb.” Guldberg says. “Whereas some animals can do it on their own, we have to employ engineering principles to allow it to occur in humans.”

A more sophisticated technique is being explored to help the body repair or replace a particular tissue, and may even offer a means for growing complex structures such as organs.

The process involves creating a biocompatible, biodegradable mesh or scaffold that is seeded by the body’s own cells, Guldberg says. The scaffolding provides an anchor for the invading cells, allows the cells to receive nourishment, and provides a template for their growth pattern. The cells generate new functional tissue through the normal processes of cell-division called mitosis and matrix synthesis, following the size and shape of the scaffold.

Eventually the cells form their own matrix and the scaffolding degrades, leaving fresh, viable tissue.

Variations in tissue mechanical properties such as stiffness can be achieved by manipulating the scaffolding’s chemistry and microstructure.

One approach to mimic complex biological properties uses rapid prototyping technology to manufacture the microstructure of biocompatible scaffolds.
layer by layer. These scaffolds might then be seeded with cells in vivo, or outside the body and then implanted, Gulberg adds.

The efficacy of the scaffold-seeding approach has been boosted in recent years by the identification of human cells with multiple potentials. Derived from bone marrow, these cells—called undifferentiated cells because they have not yet assumed a specific function—have the ability to become the cells that make new bone, cartilage or muscle.

"You can seed these multiple-potential cells into a particular site, and the local signals in that site from surrounding tissue will tell those cells to become bone-forming cell or cartilage-forming cells," says Gulberg.

The beauty and promise of the scaffold-seeding technique is its ability to create three-dimensional structures.

Cells grown in a flat dish tend to behave as individual cells whereas cells cultured in a three-dimensional space are more likely to assume the characteristics of a particular tissue. In particular, cartilage, once grown flat, is almost impossible to shape into joints.

Also, cultivating three-dimensional tissue structures is the first step toward tissue engineering's ultimate goal—bioartificial organs.

**The Inside View**

Among the most important technologies in the biomedical engineering toolbox is the array of imaging techniques including X-rays, ultrasound, computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) and single photon emission computed tomography (SPECT).

While each provides a non-invasive way of looking inside the human body, they differ markedly in their science and the information they provide. X-rays reveal dense matter such as bones and tumors. Ultrasound, familiar to many expectant parents over the past decade, uses reflected sound waves to image soft tissue. CT, formerly called CAT, works like an X-ray machine, but the images are sharpened and refined by computer. MRI provides still images of tissue and organs based on a spectroscopic technique that obtains microscopic chemical and physical information. (An offshoot, called fast MR or fMR, provides a series of images like a motion picture and shows an organ functioning.) PET scanners are used primarily to analyze metabolic processes by measuring the flow of radioactive isotopes through the body or a particular organ. SPECT employs a similar technique to image organs and blood flow.

"These modalities have their own plusses and minuses and complementary characteristics," says Dr. Norberto Ezquerra, an associate professor in the College of Computing. "The one you choose for any particular situation depends upon the kind of clinical information you want, as well as the kind of tissue you want to image."

Ezquerra works with imaging technology to help in the diagnosis of disease, primarily of the heart and brain. He also uses the technology to create life-like, three-dimensional computer models of organs for surgical training simulators.

One of the newest uses of imaging technology may be found in the operating room.

"On a monitor above the operating table, you could have a computer-built model of a particular organ superimposed on the actual X-ray image," Ezquerra says. "The enhanced visual display allows the surgeon to more effectively and accurately get to, say, a tumor."

The monitor could also present different views—a top view or a cross-sectional view—to help the surgeon visualize the area in three dimensions. Also, the 3-D structures can be displayed using transparencies so layers of different types of tissue can be visualized.

In addition to enhancing the visual display, computer-based models can also provide quantitative information about target...
areas such as the size, shape and other physical characteristics. Recent advances in modeling techniques can also support user interaction and manipulation of the models, which can aid in training physicians.

"Being able to look at an area in different ways, as well as being able to interact and manipulate the structures of interest, provides additional information with which to make more comprehensive clinical decisions," Ezquerra says.

Ace of Hearts

MRI and ultrasound are also useful for studying the circulatory system in the biomedical technology area known as biomechanics.

"Blood is the medium by which all transport—oxygen transport, metabolic transport—takes place within the human system. It's the conduit by which materials are exchanged. Therefore, understanding how it works is of primary importance to understanding how the human body functions," says Dr. Ajit P. Yoganathan, a professor in the schools of Mechanical and Chemical Engineering, and director of Tech's Bioengineering Center.

To underscore the ubiquity of blood to the human organism, consider that every normal living cell in the body—with the exceptions of bone, cartilage, cornea, testicles and inner ear—is no more than 20 microns away from a capillary—a distance about one-third the thickness of a human hair.

Yoganathan is particularly interested in applying engineering principles to solving a variety of blood flow-related problems dealing with the heart, including congenital defects, left-ventricle abnormalities and heart valves.

The left ventricle deserves special attention because it is the heart's workhorse, a muscular pump that squeezes blood through the body's thousands of miles of arteries and capillaries. The right ventricle pumps blood only to the nearby lungs for oxygenation.

With MRI, or more precisely, fMR, "you can actually see the dynamic motion of blood flow," Yoganathan says. Problems can be detected because "patterns of blood flow vary depending on whether the area through which it is flowing is normal or abnormal."

Blood-flow dynamics can also be studied with other techniques such as computer-generated simulations and mathematical models.

Yoganathan's laboratory is responsible for groundbreaking research and development of improvements in mechanical and bioartificial heart valves. But there is always room for improvement.

Analysis of the interaction between heart valves and blood flow can point to designs with the built-in efficiency of natural valves; the development of biomaterials could lead to devices far more durable than the 10- to 15-year life span of mechanical valves.

"We are trying to understand the function and mal-function of these devices," he says, "and their strengths and weaknesses from an engineering point of view so that better designs can be made."

The Intuitive Art

The benefits from biomedical engineering are intertwined. The first and obvious benefits come from the potential for improved treatment of injury and disease. The second is philosophical, and concerns the insight imparted from an approach to science rooted in discovery as well as invention—the idea that working with and learning from nature is ultimately more productive than trying to circumvent or override natural processes.

That approach has already amassed a staggering amount of new knowledge—and respect—about the way our bodies work. And the best is yet to come.

"Medical science is evolving," Yoganathan says. "What we know today is a lot different from what we knew 30 years ago—and there's a lot more we need to learn. As technology improves, we have better methods of doing the measurements, and from those we get a better understanding of how these biological systems work, and how we can keep them working."

The poet W.H. Auden put it another way: "Healing is not a science, but the intuitive art of wooing nature." GT

Gary Goettling is a freelance science and technology writer in Tucker, Ga.
Real Solutions

Research yields breakthroughs in diagnosis and treatments

By John Dunn

Biomedical research at Tech is making breakthroughs in not only detecting human imperfections, but repairing them.

Dr. David Ku, a professor in mechanical engineering at Tech and professor of surgery and director of the vascular lab at Emory, is helping lead the effort.

Because hardening of the arteries results in the death of nearly one out of every two people in the United States, it is important to diagnose and treat the disease early. The standard procedure is to X-ray dye injected into the artery—a diagnostic technique that is not only painful, it can have adverse consequences: A few patients have suffered strokes.

An alternative is to use Magnetic Resonance Imaging. However, current MRI images are only 60 percent accurate in detecting diseased arteries. Following five years of research, Ku and his students have developed a neural-net technique that produces 98 percent accurate images.

“We’re ecstatic,” Ku says of the results, which are based on clinical data. “A patient can have an MRI outpatient study with no known risks, and there is no need to have any injection.”

Ku is now involved in making the technology compatible to the various makes of MRI machines. After that, Tech plans to license the technique to various manufacturers.

Tech has also developed a biomaterial that could be used in bypass surgery to replace blood vessels in the legs or heart. The conduits used in bypass surgery in the legs now only last two-to-three years, Ku says. There are no substitute blood vessels for the heart.

In 1997, Ku’s research group designed a new vascular graft—a blood vessel substitute—that is compliant, much like a normal artery, and produces the proper blood-flow pattern. The graft made from this biomaterial is being patented through Tech.

The biomaterial has a broader application than the cardiovascular system, Ku says. It can replace cartilage, which makes it a potential treatment for rheumatoid or osteoarthritis.

“Right now, there is no replacement for cartilage on the market,” Ku states. “For people with osteoarthritis and rheumatoid arthritis, the choices are live with pain, with medication, or get a knee replacement.”

Cartilage eventually is destroyed in cases of osteo and rheumatoid arthritis, and the biomaterial has the right mechanical properties to support the weight of the body and replace the spongy cushion that acts as a shock absorber, eliminating pain, Ku says.

A graft of the biomaterial developed at Tech was implanted in a dog in November and in a sheep in December, Ku says. “It seems to be working fine. We are trying to mold this biomaterial into the shape of cartilage so that we can actually perform an implant.

“The biomaterial will allow cells to grow into it and work and behave normally,” Ku says. The body does not incorporate plastics, which are hydrophobic and do not assimilate water. “The material we are using is hydrophilic—it’s water loving, and it is primarily water, which is what body tissue is. The cells like it much better. Next we’re trying to make it porous so that cells can grow in the material, then we put growth factors into our biomaterial to accelerate the healing. That’s where the next development stage of tissue engineering will go for our biomaterial.”
Bio-Tech Leaders

Four professors are leading Georgia Tech's research in biotechnology

By Victor Rogers
Photography by Gary Meeke

Robert M. Nerem ➤

- Director, Institute for Bioengineering and Bioscience
- Institute Professor, Schools of Mechanical Engineering and Chemical Engineering
- Parker H. Petit Distinguished Chair for Engineering in Medicine
- Bachelor's 1959, University of Oklahoma; master's 1961, Ph.D. 1964, Ohio State University

Dr. Nerem joined Georgia Tech in 1987 as the Parker H. Petit Professor for Engineering in Medicine. In 1995 he became director of the Institute for Bioengineering and Bioscience. Nerem is the author of more than 80 refereed journal articles, and he is past president of the International Union for Physical and Engineering Sciences in Medicine and the International Federation for Medical and Biological Engineering (1988-91). He was founding president of the American Institute for Medical and Biological Engineering, is a past chairman of the U.S. National Committee on Biomechanics (1991-94) and is currently the technical editor of the ASME Journal of Biomechanical Engineering (1988-97). Nerem was the Konrad Witzig Memorial Lecturer for the Cardiovascular System Dynamics Society in 1986, and the ALZA Distinguished Lecturer for the Biomedical Engineering Society in 1991. He is a member of the National Academy of Engineering and the Institute of Medicine of the National Academy of Sciences. He has received the H.R. Lissner Award from ASME and an honorary doctorate from the University of Paris. His research interests include biofluid mechanics, cardiovascular devices, cellular biomechanics, mammalian cell culture engineering, vascular biology and atherosclerosis.

Don P. Giddens ➤

- Chair, Emory-Georgia Tech Department of Biomedical Engineering
- AE 1963, MS 1965, Ph.D. 1967, Georgia Tech

After a five-year tenure as dean of engineering at Johns Hopkins University, Dr. Giddens returned to Tech in July to chair the Emory-Georgia Tech Department of Biomedical Engineering. "This is a piece of academic life that I've missed," says Giddens, who in 1985 initiated the Emory-Georgia Tech Biomedical Technology Research Center. Before leaving for Johns Hopkins, Giddens served for 25 years on the faculty and administration of Tech. He became a Regents' professor in 1982 and served as director of the School of Aerospace Engineering. His research interests involve fluid mechanics as applied to understanding the origins, detection and treatment of cardiovascular disease. His investigations with laser Doppler velocimetry and pulsed Doppler ultrasound showed the potential importance of flow disturbances in the early detection of carotid artery atherosclerosis. Current research includes investigations of the effects of fluid dynamics on vascular function and vessel adaptation, and patency of small caliber vascular grafts. Giddens is a Fellow of the American Society of Mechanical Engineers, the Council on Arteriosclerosis of the American Heart Association and the American Institute for Medical and Biological Engineering. He received the H.R. Lissner Award from ASME in 1993 and was the ASME Thurston Lecturer in 1996.
Sheldon W. May

- Regents' Professor, School of Chemistry and Biochemistry
- Director, Biosciences Center
- Associate director, Institute for Bioengineering and Bioscience
- Bachelor's 1966, Roosevelt University; Ph.D. 1970, University of Chicago

Dr. May is editor of the international biotechnology journal, Enzyme and Microbial Technology, one of the leading scientific journals in biotechnology and bioengineering. He is also editor of the "Biochemical Engineering" section of the journal Current Opinion in Biotechnology. He has published more than 125 scientific papers and has been a consultant to major corporations. His particular biotechnology research emphasis is the production of "designer" biopolymers and enzyme technology. In 1990, Professor May's group discovered a new enzyme, Peptidylamidoglycolate Lyase (PGL). He was named an Alfred P. Sloan Foundation Fellow for 1977-1981, and received an Eli Lilly National Faculty Award in 1975. He was named a Fulbright International Senior Research Scholar in 1985-86 and spent this period at the Weizmann Institute of Science. He has also been a visiting professor at the CNRS Centre de Neurochimie in Strasbourg, France, and the Marine Biological Laboratory in Woods Hole, and received the Sigma Xi Research Award. Dr. May is interested in rational, molecularly based approaches to problems in neurochemistry and in the development of novel enzyme effectors and in basic mechanistic studies on enzymes involved in the biosynthesis, metabolism, interconversion and regulation of neurotransmitters, neuroregulators and biologically active neuropeptides and peptide hormones.

Ajit P. Yoganathan

- Regents' Professor, Schools of Chemical Engineering and Mechanical Engineering
- Director, Bioengineering Center
- Co-director, Emory-Georgia Tech Biomedical Technology Center
- Bachelor's 1973, University College, University of London; Ph.D. 1978, California Institute of Technology

Dr. Yoganathan is Regents' professor of Chemical and Mechanical Engineering, director of the Bioengineering Center and the Emory-Georgia Tech Biomedical Technology Center, and associate director of the Institute for Bioengineering and Bioscience at Georgia Tech. Recipient of the 1997 H.R. Lissner Award, Yoganathan has been active in cardiovascular fluid mechanics, cardiovascular devices and biomedical engineering for the past two decades. He has conducted pioneering fundamental research and published extensively on the fluid mechanics of artificial heart valves. His recent work uses cardiac Doppler ultrasound and magnetic resonance imaging to non-invasively study blood flow patterns in the heart. This has led to breakthrough techniques that permit quantitative analysis of valvular regurgitation and valvular stenosis. Yoganathan's research is supported by government, private and industrial organizations. In 1988, he received the Edwin Walker Prize from the Institute of Mechanical Engineers, U.K. In 1992, he was elected a founding fellow of the American Institute of Medical and Biological Engineering and spent six months in Denmark as a visiting professor of the Danish Research Academy.
A Natural Selection
Georgia Tech and Emory pair as a biotechnology powerhouse

By Michael Terrazas
Photography by Gary Meek and Billy Howard

In a move as natural as it is groundbreaking, Georgia Tech and Emory University have combined their expertise to create a joint academic department in the exploding field of bioengineering, and the result is a program that enters the fray almost immediately as one of its toughest contenders. It's hard to imagine an industry more integral to the next century than biomedical engineering; already the technological advances outstrip even the most fantastic imaginations, and the task of refining scientists' capabilities will prove just as crucial as discovering new ones. It will require people to recognize limitations and look to dialogue and cooperation as tools—indeed, the Georgia Tech and Emory department is more than just another degree track; it is a model for the kind of teamwork necessary to compete in an age of stripped-down budgets and specialization. But as obvious as this pairing may look, it is just as unprecedented in bioengineering. Georgia Tech and Emory mark what could be the first partnership ever in this field between a public university and a private institution, says the department's first chair, Don Giddens, who has a joint appointment and reports both to the dean of engineering at Tech and the dean of medicine at Emory.
Chemistry graduate student Scott Chasse measures the relative migration of protein through a special gel to determine the protein's molecular weight.
I'd be surprised if it isn't unique," says Giddens, who comes back to Atlanta after serving for nearly five years as dean of the Johns Hopkins College of Engineering. "There are a couple of examples within a university system of different institutions forming a joint department—University of California-Berkeley and University of California-San Francisco, for example—but I'm not aware of any other place that's public-private."

As dean of engineering at Hopkins, Giddens oversaw what is considered the finest bioengineering program in the country, if not the world. Another plus for the new joint department is that it not only has Giddens, it can also call on the expertise of Emory Vice President for Health Affairs Michael Johns, former dean of medicine at Johns Hopkins.

"At Hopkins, biomedical engineering was really a department that straddled both the school of medicine and the school of engineering, and that's very helpful for me," Giddens says. "But all the faculty lines were in the school of medicine.

"Mike and I agreed that we would start adding faculty lines in engineering to provide some growth opportunities, and we would start emphasizing some areas that were not covered in the department already. So we've already been through that kind of thinking, where you have a real joint department. A lot of the planning here is based on that experience."

"We have taken enormous steps forward in establishing Georgia as a biotechnology capital," Johns says.

Roots

Though Emory and Georgia Tech have been collaborating informally in biomedical research for the better part of two decades, the new joint department had its concrete beginnings in 1987 when Giddens was chair of aerospace engineering at Tech and Bill Todd, IM '71, was vice president for hospital administration at Emory. The two realized the potential of biomedical technology and how their respective schools were tailor-made for a joint venture. Together they helped found the Emory-Georgia Tech Biomedical Technology Research Center to spur research in the field; the two schools together have chipped in about $4 million for seed grants since the center's inception, and that money in turn has resulted in more than $10 million in private gifts.

In 1995, the two schools realized the second objective of the center—furthering academic pursuits—by establishing a joint M.D./Ph.D. program in bioengineering, with the medical degree awarded by Emory and the doctorate in bioengineering from Tech. Currently, six Emory faculty and 22 from Georgia Tech are involved in graduate bioengineering education. In the seven-year dual-degree program, students spend the first two years doing pre-clinical work at Emory, three years at Tech working on the doctorate and the final two years back at Emory.

Tech's Ajit Yoganathan has been co-director of the research center since Giddens went to Johns Hopkins in 1992, and he says the center will continue its work in tandem with the new academic department since the center has spawned research across an array of fields. Yoganathan also chaired Tech's graduate bioengineering program before the formation of the new department, and though it is not determined yet whether he will join the faculty of the joint department, he will remain co-director of the research center and is excited about the new department's potential.

"In the 21st century, the driving science is going to be biology," Yoganathan says. "Both Georgia Tech and Emory are well poised to capitalize on this."

Emory's Michael Johns: "We have taken enormous steps in establishing Georgia as a biotechnology capital."
medical engineering in the 21st century, we needed to have this department. Currently, Tech is ranked tenth in the country; we would like to be in the top five, and the only way to do that is to really identify and focus our efforts.”

Not coincidentally, both men centrally involved in founding the research center also participated in forming the joint department. As mentioned, Giddens is its inaugural chair, and, as president of the Georgia Research Alliance, Todd’s job is to foster cooperation between academia, state government and private industry.

Founded in 1991, the GRA works to develop partnerships between the above entities in the three areas of bioengineering, environmental technology and telecommunications. Todd helps broker some of the more than $700 million in research dollars that flow annually through the GRA’s six member institutions: Tech, Emory, University of Georgia, Georgia State, Medical College of Georgia and Clark Atlanta. Todd even helped recruit Giddens back from Johns Hopkins.

“I’ve had conversations with Bill over the past few months, and he was clearly supportive and thought [my appointment] was a good idea,” Giddens says. “He has a history of being in favor of Emory-Tech collaborations, and at the GRA they see this as fitting right into their strategic plans.”

“I think it’s a very wise strategy—it’s exactly what needs to be done,” Todd says. “Many futurists believe the early 21st century will be described as the ‘Age of Biology.’ We in Georgia do not want to be left out of this most robust part of the economy in the next generation. The GRA will help both universities to fund and recruit the most distinguished eminent scholars, with the finest laboratory facilities and the most modern and sophisticated scientific instrumentation and equipment.”

One of the GRA’s goals is not only to establish and enhance academic work, but to parlay that work into new industry that will drive the local economy. To illustrate how the process can work, the Norcross, Ga., pharmaceutical firm AtheroGenics was born out of biomedical research funded in part by the GRA and carried out by research-ers from both Emory and Georgia Tech. Since its founding in 1994, Athero-Genics has become one of the hottest investments for venture capitalists in the country, netting some $15 million in just three years.

"Many futurists believe the early 21st century will be described as the 'Age of Biology.' We in Georgia do not want to be left out of this most robust part of the economy."

Ernesto Garcia: The director of Emory's PET center will be part of the joint center.

Tech and Emory hope to have about 100 graduate students between them enrolled in the joint department in five years; there are no plans to make bioengineering available to undergraduates, although it seems inevitable in time.

Yoganathan says Tech’s current bioengineering program attracts only “cream of the crop” graduate students, as Giddens says the department at Hopkins did. He adds that new degree tracks are definitely in the future, particularly a joint Ph.D. between the two schools. “That’s part of the function of the department,” Giddens says, “to develop some curricula, some degrees.”

To speak of physical resources, very soon they will be considerable. In the near term, Tech has pledged 15,000 square feet of space for the new department, and Emory is earmarking administrative space. But scheduled for dedication in the fall of 1999 is the new Parker H. Petit Institute for Bioengineering and Bioscience, the first step in what could become a “Bio-complex” on the Tech campus. A 125,000-square-foot facility, the new building will be devoted to research, Giddens says; it will in-
clude, among other capabilities, cell culture equipment, a surgical suite for small animal studies with housing, temperature-controlled rooms and a computer biomodeling lab. But Giddens adds that his department is submitting a proposal to the Tech administration for an addition onto the new building that would provide classroom space.

A Master Plan

Emory is currently going through a master-planning process scheduled for completion in the first half of 1998. Now wrapping up its precinct study phase, the planning process has identified spaces for numerous new buildings, more than one of which have been earmarked as potential research facilities for health sciences. The new joint department will have space in one or more of those new buildings.

Along with the quality of students and facilities, the third component of building a top program will be the faculty and their research. The joint department hopes to have 18 faculty employed within five years, 12 from Georgia Tech and six from Emory. Yoganathan says no more than three of those 18 will be current faculty, which means 15 new hires.

"This is a tremendous addition when you consider that we have almost 25 faculty in our current bioengineering program between Tech and Emory," Yoganathan says. "In five years we'll have 40 faculty whose major research activities and teaching activities will be in biomedical engineering."

But which areas of bioengineering those faculty will work in remain to be determined, according to Giddens. He has asked for recommendations for a panel of faculty from both schools to look at the strengths, weaknesses, opportunities and other aspects of the two schools' programs, and then they will go after researchers and scholars working in the optimal fields.

"All this will happen, I hope, within two or three months," Giddens says. "It's not going to be a yearlong study. There's a nice shopping list of things that would be obvious, things related to imaging, information technology, neurosciences, some additional investments in the cardiovascular area, which is already strong, but that's not an exhaustive list."

"This is an opportunity for us to break new ground," Yoganathan adds. "Tech currently has a strong program in tissue engineering—this new department is not going to hire all tissue engineering people. But on the converse side, we're not going to try and cover the waterfront. Biomedical engineering is a vast area, and we feel we need to pick and choose some areas where we can make a major contribution."

When the eminent faculty start moving to Atlanta is when Tech and Emory's new joint program will build its reputation. In the last U.S. News & World Report rankings, Tech was named the fifth-best engineering school nationwide, and Emory was ranked No. 19 among medical schools. It is only a matter of time before two schools that already excel in their respective fields also excel in a joint effort.

"Our aspiration is to catch Johns Hopkins, which has been the No. 1 institution in biomedical engineering for many years," Yoganathan says. "Even though some people know about it, I don't think they realize the magnitude of this commitment on the part of both Emory and Georgia Tech."

"In five years from now, I would hope this department will be one of the top three or four bioengineering programs in the country," Giddens says. "And we have a good, legitimate shot at doing that." 

Michael Terrazas, a former assistant editor for the Georgia Tech Alumni Magazine, is a senior editor at Emory.
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Bruce Gunter is renovating buildings and revitalizing lives

By John Dunn
Photography by Gary Meek

Bruce Gunter's pinstripe suit has been his most important tool in building homes for the homeless and working poor.

A 1976 industrial management graduate of Georgia Tech, Gunter is a founder and chairman of the board of Progressive Redevelopment Inc., an independent, nonprofit company that transforms old or abandoned buildings into affordable housing for low-income tenants.
"What we’re trying to do is get homeless people on a job track. We need to get them where they can work."

I’m in pinstripes because when you raise money—even for homeless people and poor people—you have to go to banks,” he explains. “The resource communities need to have confidence and comfort with you, so I never leave the pinstripes behind—it’s an essential tool of my trade.”

He’s been so effective that an Atlanta Journal-Constitution newspaper headline praised him for “having a heart for the homeless.”

**Action for the Homeless**

Gunter, 43, also has been spearheading development of a multiservice center in Atlanta to help homeless people “get back on their feet.” Working with the Homeless Action Group, a loosely knit organization of service providers, businessmen and community leaders, Gunter initiated plans to establish a multiservice center in renovated industrial buildings to provide temporary shelter, job placement, alcohol and drug treatment, and other services to benefit homeless people.

The $2.5 million service center would be located in three renovated buildings scattered across a three-and-a-half acre campus. Just east of the downtown connector that weaves through Atlanta, it would be fenced, attractively landscaped and include a pavilion.

The project is not a done deal.

“We received funding commitments from the city, state and federal governments for half of our startup money,” Gunter says. “We’ve applied to major foundations for the balance.”

A development project of Progressive Redevelopment, it is bringing together business, government, nonprofit organizations and churches to address the homeless situation, Gunter says.

“The important thing about the center is permanent placement,” Gunter says. “In most cases, what we’re trying to do is get homeless people on a job track. If you are healthy and you can work, we need to get you where you can work.” The service center would provide training and help in résumé preparation.

**The Dignity of Work**

The biggest calamity contributing to the large number of homeless people, he contends, has been the disappearance of decent-paying, blue-collar manufacturing jobs—the kinds of jobs that would enable a low-skilled worker to support a family while the spouse cares for the children.

Homelessness and poverty are not moral choices people make, but more the product of economic factors, Gunter states.
Room with a View
Imperial offers Tech grad a new "sense of dignity"

Call him George. He doesn’t want to use his real name. The industrial engineering degree he earned from Georgia Tech hangs prominently on the wall of his efficiency apartment in The Imperial, a faded Atlanta landmark that has been restored as low-income housing. It was just one week after he received his degree in 1980 that he suffered a nervous breakdown.

"I’m ashamed to have a degree from Georgia Tech and to have done so poorly in life," he apologizes, straightening up things around the room, making it more presentable for a photograph. "I’ll be 40 next month. But even with all the complications I’ve had, I can still get a job with that degree."

The view from his sixth floor room faces north, across Interstate 75-85, toward affluent Buckhead.

"When I was a student, I used to look out across Midtown and dream about building tall buildings in Atlanta," he says. "At night, I sit here and smoke cigarettes and drink coffee and look out at the buildings."

Since graduation, he has held more than 30 different jobs, working for some top companies: Northern TeleCom, BellSouth, Delta Air Lines, AT&T and even the Georgia Tech Research Institute.

“My skills are rusty now, but I’m good at what I do,” he says. “I just cannot handle the political stresses of people and their egos. And when they start flaring up, it stresses me out, and stress triggers my symptoms. I have a psychosis or nervous breakdown and go into the hospital. I become embarrassed, or people become afraid of me and what I represent.

“A lot of people who are logically minded—especially engineers and hard scientists with math and physics backgrounds—rely on their powers of reasoning and powers of logic to solve life’s situations, and even love situations.”

Love illustrates his point, he says, because it defies analysis, parameters or logical structure.

“When you start with mental illness, you deal with a lot that isn’t logical. Even though it has brought me a great deal of misfortune and suffering, I feel like I’m a better person because of it. I have learned to trust my feelings. Your feelings are like the barometer that guides you and measures your dealings in life. I’ve become much more in touch with my feelings, and I’ve learned to rely on my mind less, because my mind is afflicted with mental illness.”

During the past 18 years, he says he has experienced some of Atlanta’s worst housing conditions.

“I’ve had to live in horrible situations—boarding houses with crack addicts and prostitutes and real dangers,” he says. “One boarding house in particular had a communal bathroom. I would take care of my toiletry needs, go to my room and lock the door because of all the dangers lurking within the building just outside my room. I’ve been in community housing situations where there are a lot of people with mental illness, drug addicts, alcoholics—and so very little privacy. There’s usually two to a room. It’s a real bad situation.”

He has been a tenant at The Imperial since it opened in December 1996. His apartment is furnished except for his television and microwave and includes a kitchenette, refrigerator and private bathroom.

“This is a Godsend,” he says. “This has given me dignity, something that has been missing in my life for a long time.” — John Dunn
To be self-sufficient, a person needs a permanent place to live and a permanent job, he says. The service center would help people get both.

In addition, to be independent, a person needs good health. Under the classification of health, Gunter places both addiction and mental illness, and that requires support services, which the center would also provide.

**Re-establishing Socialization**

Homeless people lack a network,” Gunter says. “They don’t have many friends; they don’t have family; they’re flat-out all alone. You must re-establish their socialization. We use words like ‘program’ to describe that, but what you are talking about is getting somebody with a name and a story to have a friend—to have somebody that they can connect to who will, incidentally, also hold them accountable and address them by their first name.”

And, he says, homeless people need such basic things as an address—some place to get their mail, and a place where someone can return a phone call.

“There are a lot of little things you must do when you try to rebuild an identity—and a whole person,” Gunter says. “But there are no easy answers.”

Solutions to the homeless problem require moving beyond placing the blame and making it a morality issue or a security issue. Low-income families and individuals make up 30 percent of Atlanta’s population, Gunter says. A recent Research Atlanta study showed that on any given night there are 11,000 homeless people in the Atlanta region.

“We tend to say they brought it on themselves,” Gunter observes. “Clearly some of them did, and clearly with many of them, their behavior contributes to their situation. We tend to see them as the homeless—as though they are just one big mass of people with all kinds of problems. But we overlook the fact that each homeless person is an individual tragedy and is entitled to dignity and compassion.”

Progressive Redevelopment has 19 projects throughout Georgia, 17 in the metropolitan Atlanta area—representing about 1,500 units that provide housing for low-income families.

It is, Gunter says, a record “unmatched by any nonprofit in the state of Georgia.”

The organization’s office is located on the 10th floor of The Walton, one of its most notable transformations. Located at Walton and Cone in downtown Atlanta, it was an old hotel that had been converted into apartments and,
before going bust, into condominiums. It was abandoned when Progressive Redevelopment bought it. Nine floors of The Walton have been converted to affordable housing for 128 tenants.

“As a developer, we buy land or a building, finance it, renovate it, and put people in it,” Gunter explains. “In most cases we stay on as the owners.”

Carol Collard, vice president of Resident Development, said the company has a co-op plan for some tenants, who after a period of 15 years will have an opportunity to own the property. “That is the beginning of wealth building,” she states. “I have found that many of the working poor are not poor in spirit; they just need opportunity.”

“Nobody, in any neighborhood, ever says, ‘Great, let’s do some low-income housing,’” Gunter says. “That’s part of what we have to overcome. And the way we overcome that is to do it well. Well built, well run affordable housing can be a good neighbor—as it should be.”

**Life at The Imperial**

There is no example of Gunter’s success more spectacular than the old Imperial Hotel, a landmark on Peachtree Street that had become an abandoned eyesore. Built in 1910 as a businessman’s hotel on the northern edge of downtown, it became a casualty of center-city deterioration.

In 1990, the abandoned structure became a symbol of the homeless plight in Atlanta. About 100 homeless activists and “squatters” occupied the building, leaving only after Mayor Maynard Jackson promised to construct low-income housing.

In 1994, Gunter says Progressive Redevelopment purchased the eight-story building to convert it into low-income housing. “We received all kinds of support for developing The Imperial—including from the mayor and business community,” he says.

The facility underwent a $9.5 million redevelopment and opened Dec. 19, 1996, as The Imperial on Peachtree, a 120-unit single-room apartment building. The building has a 24-hour front desk attendant and card-key entrance. Units are restricted to individuals earning no more than 60 percent of the Atlanta median annual income, which in 1996 was $22,320. There are 35 units available to house formerly homeless people with special needs, which are provided by Mercy Mobile, an affiliate of St. Joseph’s Mercy Care Services. Support services are a hallmark of Progressive Redevelopment.

Financing of the project includes $4.3 million from the
"Putting together government with bank loans and syndicated equity—it's like seeing sausage made."

sale of investor tax credits to National Equity Fund, and public funding from the city of Atlanta, state Department of Community Affairs and the Federal Home Loan Bank. The extensive collaboration of public and private partners includes a complex layering of funding through more than a dozen lenders, including permanent financing via Fannie Mae and Standard Mortgage.

Gunter is the architect of some of the state's most complicated real-estate deals—those arranging financing for low-income housing.

**Miracles Can Happen**

Financing low-income housing can be as complicated a real-estate transaction as there is," Gunter says. "You are mixing public-sector financing—government programs with the attendant red tape together with bank loans and syndicated equity. It's like seeing sausage made—you don't want to know how it's done."

Gunter calls it "a cruel paradox," but the lower the income, the more complicated the deals. "They are fiendishly complicated," he says. "That's one reason not much is done. In addition to limited funding and the politics, there are not enough people with skills to put these things together."

The renovated Imperial was voted "Best in Atlanta Real Estate" in rehabilitation by the *Atlanta Business Chronicle* and received an "Award for Excellence" for historic preservation from the Urban Design Commission.

Many of its residents see in the renovated Imperial their own chance for a new start.

"When I found The Imperial, a change came—a miracle happened," says Larry Clark, who had lived in substandard housing conditions since coming to Atlanta in 1994.

"I was in a very depressed stage of my life when I found out about The Imperial," Clark says. He works in nursing part-time and pays 30 percent of his salary toward the rent; the balance is subsidized by the government. "In less than a year, I've been able to get myself back on focus. Because I found this place, I've been able to pull myself back together."

A native of Atlanta, Gunter says Georgia Tech was the only school he considered. He graduated with high honors, fifth in his class and "didn't have a clue" concerning the career he wanted to pursue.

"I was a ski bum in Colorado for a year," he laughs.

He returned to Atlanta and joined a consulting firm where he worked for two years before attending George Washington University on scholarship, where he earned his master's degree in business administration with a concentration in finance.

"It was a heady time," he says of his experience at
George Washington, a time that coincided with Jimmy Carter’s term as president.

Even with his master’s in business administration, Gunter was undecided about his career path.

“I decided to bicycle across the country,” he says. “I was still single, with no responsibilities and no money. I knew it would be a unique opportunity.”

During the next two months, Gunter rode a 10-speed bike from the coast of Georgia to the coast of Oregon, traveling back roads and camping out at night.

“It was a great way to see the country,” he says. “I traveled from southeast Georgia through the west, on to Oregon and then down the coast of California. It was an extraordinary experience.”

He returned to Atlanta and joined The First National Bank of Atlanta as a small-business loan officer. In 1985, he left the bank to found The Social Responsibility Investment Group, and served as chief financial officer of the investment advisory firm.

“Our idea was green investing—socially conscious investing,” Gunter says. “The idea was that it is fine to make money, but how you make it and for what purpose is important, too. We invested in companies that had good workplace records, sound environmental practices and the like. And we were making market returns at the same time.”

In the mid-1980s, Gunter met Millard Fuller, the founder of Habitat for Humanity. “It was a profound experience,” Gunter says. “Millard is an extraordinary person. I became involved with Habitat for Humanity and helped build a house. I organized my church to build another house, and became more and more involved. That led me to understanding more about housing as an issue. Habitat was my entree into affordable housing.”

Gunter serves on the executive committee of the board of directors for Habitat for Humanity International. In 1986, he was named one of “The Ten Outstanding Young People in Atlanta,” and in 1996, he received the Common Cause of Georgia Citizenship Award.

He and his wife, Kathie Day, a 1978 industrial management graduate from Tech and a home builder, have a family of three children, and live in Atlanta’s Inman Park. They are members of St. Luke’s Episcopal Church in Atlanta.

Moved by Faith

It is his faith, Gunter says, that motivates him. “I’m a Christian. As I understand my faith, it calls me—it commands me, actually, to look after my neighbor and to tend to those who are hungry and naked. It’s a radical gospel that calls us to do these things. And it’s an order, not a suggestion, if you take it seriously.”

In 1989, Gunter was a founding member and president of the board of Progressive Redevelopment. In 1992, he also became executive director.

“It took for me,” Gunter says. “I had a business background, business perspective and a finance degree. You don’t find many MBAs in this area. It’s mainly peopled by good-hearted folks who want to help the poor. I found myself being needed and my skills highly valued in this area.

“I had gone from banking and money managing to being a developer,” Gunter says. “But it was a peculiar kind of development. I found I immensely enjoyed it. It gave me great satisfaction. It drew upon every skill that I had. Not only that, I found my voice.

“The politics of these things are as important as the economics,” Gunter says. “I didn’t pick up those skills at Georgia Tech. You must get a sense of the politics: In this regard, I’ll gladly be labeled as a manipulator—Machiavellian. You have to know when to duck, when to play to the moral card, when to combat the stereotypes.”

In January, Gunter leaves the organization as president and executive director to become chief financial officer for The Urban Group, a residential development firm. His involvement with Progressive Redevelopment continues as chairman of the board. The organization has grown to nine staff members, most of whom have master’s degrees.

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Jason Morgan set earth science on a new course with his contributions to plate tectonics theory

By Erika Archibald
Photography by Laura Sikes
It was one of those rare times in the history of science—a time of excitement, of new data and new discoveries coming forth almost daily. And, finally, it was a time of breakthrough.

It was, in fact, a time of revolution, one of the few true scientific revolutions of this century. The time was the 1960s, and the discoveries were those that would soon lead to our understanding of how the surface of the Earth works, how the continents and oceans were formed, how mountains and volcanoes evolve, why and where earthquakes happen.

The revolution brought forth the now widely accepted, overarching theory called "plate tectonics," which suggests that the upper level of the earth is divided into a number of rigid pieces, or plates. The concept has, in turn, revolutionized the earth sciences in this century.

At the forefront of it all, thinking faster and better than almost any other scientist out there, was a young Georgia Tech physics graduate, W. Jason Morgan.
“As far as I could see—as someone very close to what was going on—Morgan independently formulated the concept of plate tectonics.”

Putting Together the Puzzle

As is often the case at times of unfolding scientific sea changes, numerous scientists were working along related lines of thought, trying to analyze and interpret new data—in this case from the ocean floor—and the new theories that were being suggested to explain it.

While doing post-doctoral work in geophysics (the study of the earth using the tools of physics) at Princeton, Morgan became very interested in this new data from the ocean floor, much of it being provided by ships from the Navy. An office mate, scientist Fred Vine, who had already done significant work in explaining the story of the ocean floor through magnetic anomalies, encouraged Morgan to follow his new ideas about ocean formation and what was happening at the mid-ocean ridges and at the trenches, two areas now understood to be plate boundaries.

As it happens, other scientists were working on the same data, each coming up with various parts of what is now seen as a larger puzzle. The question of who was actually first in conceiving the idea of plate tectonics is, therefore, hard to answer, since several scientists were approaching the concept independently.

"I like to think of myself as the first," says Morgan, who recently received an honorary doctor of science degree from Harvard University recognizing his crucial role in formulating the theory of plate tectonics.

"Jason’s contribution was seminal, of enormous importance," says Vine, whose own work laid a foundation for the work of Morgan and others. Vine, who is now dean and professor of environmental sciences at the University of East Anglia in Norwich, England, shared an office with Morgan at Princeton in the late 1960s when this work was in its heyday.

“As far as I could see—as someone very close to what was going on—he independently formulated the concept of plate tectonics,” Vine says, describing Morgan as “truly one of the fathers of the plate tectonics revolution.”

A Plate Tectonics Primer

Plate tectonics is the widely accepted, all-encompassing theory that suggests the upper level of the earth—the lithosphere—consists of a number of somewhat rigid pieces, or plates.

These plates move about relative to one another on an underlying viscous layer called the asthenosphere. The interactions of the plates at their boundaries accounts for the formation of most of the earth’s geographical features, such as mountains and oceans.

Near the beginning of this century, German scientist Alfred Wegener championed the idea that one supercontinent—Pangaea—had broken up into the separate continents we know today, but these ideas lost their champion when Wegener was killed while on an expedition. Wegener had derived his ideas from studying the geography of the Atlantic coastline and the continuity of certain geological features across continents.

During the 1950s, paleomagnetic studies and new data from the ocean floors began to re-establish the idea of continental drift, and that of seafloor spreading.

In the late 1960s, W. Jason Morgan and a few other scientists published ideas that, within a few years, were developed into the ideas of plate movement and boundary interactions—plate tectonics.

Nowadays, plate tectonics is to earth sciences what the understanding of atoms and molecules is to chemistry. It is the basic process by which geological activity, like earthquakes and volcanoes, is understood. In explaining how the earth’s surface works, through plate tectonics, geologists can now also offer practical information on where earthquakes will occur and how large they will be, or where mineral resources are most likely to be found. Plate tectonics also suggests what will happen to various parts of continents—like the Atlantic Ocean plunging beneath the United States—but the questions of when are still way beyond what is known.

In addition, plate tectonics has significant implications for the study of life on Earth since the various geographical features of earth have certainly influenced the development of species. However, plate movements do not seem to be limited to our planet. Research has suggested that Venus appears to have had plates, although they seem to have slowed down to a near stop right now. The moons of Jupiter have also been studied for plates.

Unexplained questions derived from these studies may lead to new understandings of what is happening on Earth, of why it is happening, and of where this is all leading.
A Questioning Mind

What led Morgan to conceive of this all-encompassing concept of plate tectonics? Well, according to Morgan, most of his ideas come from pure theorizing. He began with the oceanographic data, theorizing about what was happening at mid-ocean ridges and at the trenches, two areas now understood to be plate boundaries. Within two years, he says, these ideas about the oceans were well accepted, but their implications for explaining the continents came a bit more slowly. After some presentations and articles on oceans, he turned toward the rest of the earth, gradually coming up with the idea of plates.

When asked to describe himself as a scientist, Morgan says he is very intuitive and theoretical, as opposed to being primarily a field scientist or a mathematician, for example—although he is certainly highly capable in those areas.

“One thing that differentiates him from almost all his peers is that he is always willing to question what almost everyone takes for granted,” says Morgan’s son, Jason P. Morgan, who has become a respected geophysicist in his own right and who has started working on some projects with his father.

“My dad, more than anyone I know, seems to be willing to take the approach of always wondering, ‘How else could this be?’ That may be linked to why he has some of the best insight and intuition into how things might work. He’s continually questioning—but not to the point were it might paralyze him—what most people take for granted,” even when the ideas are his own.

“If you ask about plate tectonics, almost everyone was thinking this means the plates are rigid blocks,” Morgan Jr. explains. “But my dad was always wondering how rigid are these blocks? They might not be completely rigid. And, only 15 years later, there was a minor realization that this was true. So, even though he invented the idea of rigid plates, he didn’t believe it like it was gospel.”

A native of Savannah, Morgan started out his scientific career at Georgia Tech, where he majored in

As material from the mantle surges upward, it forces apart the continental plates and creates new ocean floor. The continent drifts across the upper mantle, colliding with other continents or ocean floor. When that happens, one plate has to give, either riding up over the other plate or under it. Mountains, earthquake-prone faults or volcanoes can be the result.
physics, graduating in 1957. He credits several Georgia Tech professors, including Vernon Crawford, who later became chancellor, and J.Q. Williams, with encouraging him to change his major from mechanical engineering to physics. After serving two years in the Navy, Morgan went on to graduate school at Princeton, obtaining his doctorate in 1964. He is now professor of geophysics at Princeton and holds the Knox Taylor Chair of Geography there as well. His work has also taken him to various research institutes and field sights around the world, from Iceland to Hawaii.

**New Data, New Challenges**

Some 30 years since his first theories were formed, Morgan says work in the plate tectonics field is as exciting as ever because a whole new set of data is coming in—this time not from the oceans but from the skies, an outgrowth of space research and the use of satellites. Morgan explains that it is now possible to measure the location of any point on the Earth to within a centimeter, or even a millimeter, and that repeat measurements year after year show how one point moves toward or away from another point. This data is going to revolutionize tectonics, he says. Just as the magnetic ocean data in the 1960s showed how plates were pulling away and, thus, how oceans were evolving, the new data from space will show how fast a mountain range is going up or how much the Western states are pulling apart.

The tectonics revolution continues in other ways as well, say Morgan and his son. The duo has now teamed up to bring a new element into the study of geophysics—chemistry. Geophysics provides a general picture of the Earth’s mantle (where the boundaries are), but the rocks from the mantle—

their chemistry—can provide really detailed data, if you know how to interpret them, Morgan says.

“The attempt is to use the chemistry of the rocks to test a model of the flow pattern of the mantle,” he says.

Morgan’s son, who earned a doctorate in geophysics from Brown University and is now a professor at the Scripps Institute of Oceanography, is the chief author of their joint effort to incorporate their geochemical data into a model of Earth convection. They expect to present this work to the academic community before the end of the year.

Morgan’s son, working in the field some 30 years after the heady early days of the tectonics revolution, says that geophysics is really still a wide-open field. “We have a picture that there are revolutions in science, and then you sort of just fill in the cracks. But my view is that plate tectonics was a revolution describing a behavior of the system, but not understanding the dynamics of how the thing happens.”

“In fact, I feel that geologists, for about 20 years, have had this untrue impression—and my dad feels the same way—that the problem is solved because we know how the surface is moving and because we know so much about what that means for mountains, volcanoes. Many people think the problem is solved because we can describe it. But, as a physicist, it isn’t known until you know why it’s happening.”

Today, says Morgan Jr., with the explosion in new tools like the space data, the time is ripe for more of the revolution. Unfortunately, this false belief that all the big questions are solved means that it’s hard to get funding for truly progressive—or aggressive—research, he says. “We’re not encouraging risk at all. It’s very natural, but it’s extremely frustrating compared to the way it was in my dad’s heyday.”

**Value in Teaching**

In addition to his continuing work in the field of tectonics, and the work of his son, Morgan continues to influence the field through his teaching at Princeton. Each year, he teaches a large freshman course on earthquakes and volcanoes, as well as a techniques course on geophysics. One of his favorite classes is a small freshman seminar in which he travels with the students to the Sierra Nevada mountains in California to do the laboratory portion of the class.

Several of his students have become active researchers in the field of plate tectonics and have worked on such problems as the nature of propagating rifts on the sea floor and the study of micro-plates along the mid-ocean ridge. Teaching and research influence each other in another way too, says Morgan. “Sometimes students will ask questions you didn’t ask, which makes you go back and study even more. You realize you do not know the answer to what they have asked, and you try very hard to get the answer before the next class.”

So, whether the revolution is seen as over or not, the influence of one aggressively thoughtful Georgia Tech grad on how we understand our Earth will certainly be ongoing—through new research, through his son, through his students and through the general idea-building process of science, in which one intriguing idea begets another. GT

Erika Archibald, Ph.D., is an assistant professor of journalism and English at North Georgia College and State University. She formerly served as an editor for Atlanta Magazine and as public relations director for Zoo Atlanta.
“Even though Morgan invented the idea of rigid plates, he didn't believe it like it was gospel.”

Morgan and senior geology major Morgan Crooks look over geologic maps in the Geology Library at Princeton.
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Banking on Prosperity
Jim Lientz sees his NationsBank job as more than counting money; its essence is to profit the community

By Karen Hill

Fresh out of college, Jim Lientz went to work for a bank because it was the only place that would hire him for a few months while he waited for his Army orders for active duty. One tour of duty and 31 years later, the 1965 industrial management graduate is still there.

There is a difference: In the beginning, in his hometown of Savannah, Ga., he was a combination paper shuffler and errand-runner—"basically, doing whatever anybody asked me to do," he says. Now, he's president of the NationsBank Mid-South Banking Group, overseeing all activities in Georgia, Tennessee and Kentucky for the nation's third-largest banking company, with $280 billion in assets. Lientz is responsible for about $20 billion of those assets and 8,000 employees.

After returning from the Army in 1968, Lientz married Peggy Hall, the sister of his Tech roommate, and began work in Atlanta for C&S Bank, which three decades later would become NationsBank. Then, with three young daughters in tow, he moved to Savannah to become president of the C&S bank there, returned to Atlanta to head the international section of corporate banking, then all of corporate banking, moved to Columbia, S.C., as state president; he returned to Atlanta as president of the Georgia bank in 1993 and assumed his current responsibilities in 1997.

The Army, by comparison, only sent him to Fort Bliss, Fort Lewis and Korea.

"We'd like to stay in Atlanta," the 53-year-old Lientz says. His office on the top—the 55th—floor of the NationsBank skyscraper in Atlanta provides a panoramic view of the Tech campus. "This is our home."

Despite the breadth of his responsibilities, it's the hometown touches of banking that Lientz loves.

"This is such a people-oriented business. I enjoy the positive impact we can have on a community, from helping people buy their first home to helping entrepreneurs grow their companies to the point of taking them public," he says. "Our real job is to help people realize whatever their dreams are."

"Back in 1966, when I first got to know the people at the bank, I was struck by the fact that they enjoyed what they were doing and the opportunities they had to make an impact."

Lientz sees his job as a leader and economic developer. Aside from winning accounts for NationsBank or overseeing the nuts-and-bolts work of banking, he's also a watchdog of...
sorts. "When you have prosperity, you can make a lot of other good things happen," he says. "People in the Southeast are fortunate. But we have to be vigilant to continue our prosperity. A lot of other places would love to win what we've got. We need the right leadership to continue in the position we enjoy."

For years to come, he adds, the region will benefit from Atlanta hosting the 1996 Summer Olympics. NationsBank was a $40 million sponsor of the Games, in which Georgia Tech played a vital role.

"There aren't many places in the world now where the people wouldn't recognize Atlanta, Georgia, very quickly," Lientz said. "The Games also gave Atlanta the culture of a 'can-do' community.

"And, personally, I like looking out my window and seeing all the new dorms at Tech and the new swimming center" that were built for the Games and now benefit Tech.

He's proud of the close ties between his alma mater and employer, noting that many bank executives are Tech grads and many serve on campus advisory boards.

"Technology is critical to the future of banking, and we're very focused on hiring Georgia Tech graduates," Lientz says. "We want to be their employer of choice."

Lientz also notes that his company is sponsoring the Georgia Tech-Sam Nunn-NationsBank Forum, a spring 1998 conference featuring Nunn, the former senator from Georgia and recognized national defense expert. The focus of the conference will be information security.

Lientz also has a master's in business administration from Georgia State University and is a graduate of the Advanced Management Program in Harvard University's Graduate School of Business.

He is a member of the board of directors of NationsBank, Georgia Power, Cerulean companies; board of councilors of the Carter Center; President's Advisory Council at Georgia Tech; chair-elect of the Georgia Chamber of Commerce for 1998; chair-elect of the metro Atlanta Chamber of Commerce for 2000; president of the Governor's Development Council; and a trustee of several economic development agencies and three educational institutions.

Growing up in Savannah, two forces pushed Lientz toward Tech.

"During the really good football years, '51 through '53, I became a Tech fan," he said. "Also, my dad is an engineer, and he had a pretty strong feeling that unless you have an engineering degree, you don't have an education. Well, I don't have an engineering degree—industrial management is about as close to a business degree as Tech has—but I do have it from an engineering school."

Some lessons from Tech have stuck through the ensuing decades.

"I learned how to accomplish things under pressure—and believe me, I felt plenty," Lientz says with a laugh. "I also learned to keep plugging away—it's the only way I survived some courses. It's easier to abandon something than to continue; learning how to just keep working has been very beneficial. Persistence, hard work and time management are values that Tech helped me develop. I also learned something about having fun, which I still believe is very important."

"Sometimes, I look out this window and see the Tech baseball team playing, or the track team practicing, and think about when I was trudging around on campus," he says, gesturing toward tiny figures visible on campus. "I didn't think—nor did my professors—that I'd ever have an office like this." GT

Karen Hill is an Atlanta freelance writer.
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Corporations with in-house libraries are also customers, including jet-maker Gulfstream Aerospace, think-tank RAND Corp., car-maker Ford and camera-maker Eastman Kodak.

China may become the company’s next big market, as its government is making the updating of information systems a key part of its overhaul of higher education. "There’s a tremendous thirst over there for the experiences we’ve had," says Young, who recently spent a week in China at a conference for 150 universities.

The software is available in English, Spanish, French, Greek and, soon, Chinese.

SIRSI software also guides library patrons through the World Wide Web, with the software acting as a "tour guide" and answering questions ranging from which other libraries contain information on certain subjects to what books at a certain library are available, or have been checked out.

"For example, someone working at his or her home can access Emory University's library, get whatever information is sought there, then use Emory's SIRSI connections to get to the Library of Congress," Young explains.

Young became interested in library work during his graduate studies at Tech, a natural fit since Tech's computer-science program was founded by a librarian, Dr. Vladimir Slamecka.

"Even though it was a computer science program, it was oriented toward information management, and I became very interested in that," Young says. He began working in Tech's library, doing computer work. After graduating, he became manager of the library's systems department.

"I really enjoyed it, but my wife and I wanted to live in a smaller environment than Atlanta," Young says. "We looked around and found Huntsville, which is very similar to Atlanta but about one-tenth the size."

Murdock, a Tech student working in the library, soon joined them. They lived sparsely in the early days, taking computer consulting work only when necessary to pay bills, concentrating as much as possible on developing and selling their software.

"We were traveling around the country, knocking on doors," Young recalls. "Our backgrounds were all technical; we had no sales or marketing people. We just had the hope that by having the 'better mouse-trap,' we would succeed."

They sold just one or two systems in each of their first three years, as word of their product spread. "But in the fourth year, we hit a magic plateau, about 10 systems," he says. "Now, we're up to 120 a year." Prices range from $20,000 to $1 million.

SIRSI continues to rely on that basic software package, fine-tuning it each year to keep up with changes in customer needs and technology. It runs on either UNIX- or NT-based systems, and Windows '95.

One of the biggest changes in information management, Young says, is the interest libraries have developed in hooking up with each other.

"Eighteen years ago, libraries were very focused on customers being able to get each library's own information off the computer. Now, the biggest focus is on contacting the rest of the community in a seamless fashion."

Libraries also are working to help customers find the most reliable sources of information on the Internet, he adds.

"Libraries are trying to contribute the assurance that the information you're using is really accurate and valuable to your task," Young says. "If you sit down on your own and start looking, you can be overwhelmed with extraneous informa-
What libraries are doing is offering interrelated quality assurance, or prequalified information—kind of like having a guide take you out in the wilderness, showing you the natural beauty but avoiding the dangers and the dead-ends."

SIRSI is renovating for its new headquarters three historic, downtown Huntsville buildings that have been vacant for almost a decade: an old Kresge’s, Woolworth’s and dress store. “We’re the first high-tech business to move back downtown,” Young says. “It will be a homey, comfortable place. We’re in a research park now, which is a ‘dress clothes’ place, and we’re more of a ‘blue jeans’ company.” GT

Narrow Niche
Nancy Mueller wins Georgia’s Young Engineer Award
By Joy McIlwain

Growing up to be a pipe-stress specialist certainly wasn’t on Nancy Mueller’s top-10 list when she was a child. And neither was becoming an engineer.

But Mueller, ME ’89, went on to win the Georgia Society of Professional Engineers’ Young Engineer Award for 1997. The annual award is given to a Georgia engineer under 35 who has demonstrated superior engineering achievement and civic responsibility, and who has advanced the engineering profession.

It was in junior high that Mueller began to think about engineering. “I was so math and science oriented,” she says, “it just seemed the right thing to do.”

When she began investigating engineering schools, Georgia Tech was her choice for two reasons: It was close to home, and it was “the best academic value for the money.”

She began in chemical engineering, but found it too abstract. “It wasn’t for me,” she says. “I need to be able to see and touch things.” She switched to mechanical engineering.

“Georgia Tech taught me how to think and to reason,” Mueller says, pausing to choose her words carefully. “It also taught me the value of hard work.”

Those traits, she says, have been invaluable in her career as an engineer. She is now with Stone & Webster in Atlanta.

In her first job after graduation, Mueller discovered the comparatively narrow field of pipe stress. “I kind of happened into it,” she says. “It wasn’t familiar to me at all, but it was a skill that the company needed at the time.

“One of the engineers took me under his wing and taught me how to calculate stresses. I knew about pipe specification, theory and concept, but I didn’t know this whole separate area existed.”

It was a perfect fit, she says: hands-on, working with calculations and results-oriented.

In addition to its mathematical base, it is a job that calls for imagination and creativity. She does her calculations totally by computer.

Facing a pleasant foliage-filled courtyard, she works from a 22-inch high resolution screen that comes complete with a Yellow Jacket screen saver, and inputs a number of variables to see whether a planned pipe design will work.

She points to a current project, a Florida sugar mill, as a particularly daunting task. “The pipe just goes everywhere,” Mueller says. “If one branch moves, then another gets out of sync. It’s quite a challenge to get them to work in concert.”

Mueller has ambitions to become a project manager. “I’d like that—being able to see the big picture, to have an overview of the whole project.” GT

Joy McIlwain is an Atlanta freelance writer.

Young Engineer Award-winner Mueller: An expert in the specialized field of pipe stress.
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A prototype RADAR flashlight that can detect a person hiding behind walls and doors may one day make crime-busting safer for police officers, prison guards and others.

The device uses radar and a specialized signal processor to detect movement. The RADAR flashlight discerns respiration from up to three meters away, with no physical connection between subject and radar.

The development is part of a family of technologies that can also detect a heartbeat, says Gene Greneker, a principal research scientist at the Georgia Tech Research Institute.

"Based on respiration signature alone, the RADAR flashlight allows us to detect a stationary individual behind a solid wooden door, or an eight-inch block wall," Greneker says. "These qualities make the flashlight potentially useful to police officers in ambush situations and to prison guards doing bed checks."

The Georgia Tech-funded project uses a narrow radar beam of about 15 to 20 degrees to detect the body movement generated by breathing.

The technology may help locate people in a room during a hostage situation or find survivors in the rubble of earthquakes or accidents.

The amount of electromagnetic radiation exposure from the flashlight is small—10 times less than the leakage level for microwave ovens in the United States. That's about the same amount of exposure a person receives when walking under a microwave door opener on an automatic door.

For now, the signal processor is outside the flashlight-sized casing, and the respiration signature is displayed on a monitor driven by a computer-based radar signal processor. By incorporating high-speed signal processing technology, Greneker plans to make everything small enough to fit inside the flashlight housing.

The RADAR flashlight has some advantages over other technologies. "The signal from the RADAR flashlight will penetrate clothes and detect respiration," Greneker explains. "In fact, it requires a body movement of only a few millimeters to detect human presence."

Research that evolved into the RADAR flashlight began in the mid-1980s, with the patenting of a frequency-modulated radar for remotely checking vital signs of battlefield wounded before risking medics' lives. The technology also was tested to monitor vital signs of soldiers clothed in chemical or biological warfare suits, without requiring them to risk contamination by removing the protective gear.

Recently, Greneker developed a prototype vital-signs monitor in hopes of displaying the heartbeats of archers and rifle competitors during television coverage of the 1996 Centennial Olympic Games. Such athletes are believed to sense their heartbeats and shoot between them to avoid the slight body movement—and potential shooting inaccuracy—created by each pulse.

This application ascertains heartbeat signals 30 meters from the subject, giving rise to some interesting possibilities, Greneker noted.

"This version of the system might be used as a biometric identification tool," he said. "For example, if it could be shown that an individual's radar heartbeat signature is stable over long periods of time and is unique to an individual, the remotely sensed heartbeat could serve as a 'fingerprint' of sorts."

Greneker also wants to explore ways to even further reduce clutter—undesired and uncontrolled signals originating from something other than the target. Clutter may be many times stronger than the desired target's signal, requiring radar signal processing to reduce or eliminate it.
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Camouflage Computer?
Scientists have created a warrior wardrobe that can detect combat wounds and monitor vital signs

By Victor Rogers

The old military issue T-shirt and dog tags are taking on new meaning and could someday save lives on the battlefield, thanks to a new "woven computer" developed by Georgia Tech.

Created for the Navy Department, the "Sensate Liner for Combat Casualty Care" uses optical fibers to detect bullet wounds and special fibers to monitor vital signs during combat. The T-shirt functions like a computer, with plastic optical and conducting fibers woven throughout the fabric.

"The idea is to send a 'signal' from one end of the plastic optical fiber to a receiver at the other end," said Dr. Sundaresan Jayaraman, a professor in the School of Textile and Fiber Engineering and the principal investigator of the project. "If the light from one end does not reach the other end, we know the Sensate Liner has been penetrated (i.e., the soldier has been shot)." A signal bounces back to the first receiver from the point of penetration, helping the medical personnel pinpoint the exact location of the soldier's wound.

The receiver is a Personal Status Monitor (PSM)—the 21st century version of a dog-tag—and is worn at hip-level by the soldier. In a combat situation, the plastic optical fiber senses the penetration of a bullet and sends the information to the PSM. The soldier's vital signs—heart rate, temperature, blood pressure, etc.—are monitored in two ways: through the sensors woven into the T-shirt and through sensors on the soldier's body, both of which are connected to the PSM.

Information on the wound and the soldier's condition is transmitted from the PSM to a medical triage unit somewhere near the battlefield. The triage unit then dispatches the appropriate medical personnel to the scene.

"The Sensate Liner can help a physician determine the extent of a soldier's injuries based on the strength of his heartbeat and respiratory rate," Jayaraman said. "This information is vital for assessing who needs assistance first during emergency situations in which there are numerous casualties."

In addition to military applications, the Sensate Liner or its monitoring component alone could be used by law enforcement personnel, astronauts, athletes—even to protect sleeping children from Sudden Infant Death Syndrome.

The Sensate Liner, which is still in the development phase, is expected to cost between $25 and $35. Testing of a prototype is scheduled for next spring in coordination with the Navy.

Victor Rogers is a writer in the Tech Communications office.

Into fabric (left) are woven optical fibers that can transmit information on the wearer's physical condition. When worn (above), it could save lives of soldiers or police officers wounded on duty.
Material Potential

New polymeric membranes could cut refinery pollution, provide energy source

By John Toon

A new type of heat and chemical resistant gas-separation membrane under development at Tech may allow oil refineries to recover significant amounts of hydrogen while cutting pollutants.

"We have jumped a very large hurdle in having a material that is chemically and thermally resistant while retaining very attractive gas-transport properties," said Dr. Mary E. Rezac, assistant professor in Georgia Tech's School of Chemical Engineering. "There could be a very large commercial market, but there are a number of technical hurdles still ahead of us."

The research is sponsored by the Environmental Protection Agency, the National Science Foundation and Georgia Tech.

Conventional polymeric gas-separation membranes lose mechanical strength at temperatures above boiling and can be damaged by reactive components in gas streams, Rezac noted. But tests show that the new polymers are stable at four times that temperature and are not significantly affected by the chemical contaminants.

Previous attempts to produce stronger membranes failed because increasing the density of the membrane film decreased its gas permeability, said Dr. Haskell Beckham, assistant professor in Tech's School of Textile and Fiber Engineering.

Because of its cost, the material developed and tested by the Georgia Tech researchers is unlikely to be used commercially. But Beckham and his graduate students are experimenting with ways to make similar, but less costly, materials do the same job.

Rezac believes the new membranes could make the recovery of hydrogen from petrochemical processes economically feasible. The temperature of refinery gas streams—containing hydrogen, propane, methane and other hydrocarbons—exceeds the thermal operating range of current membranes, and cooling those streams can cost more than the recovered materials would be worth.

If the new system can operate at high temperatures, unaffected by gas stream contaminants, the industry could recover hydrogen the Department of Energy has estimated would be worth several hundred million dollars per year.

"If we can achieve these types of separations, we can reduce operating energy, waste production and the pollutants going into the atmosphere," Rezac said. "The dollar value of the hydrogen is significant, but there are external issues in terms of recycling and pollution control that are just as important."

Beckham believes there may be other applications for like materials, such as dental fillings and high-strength composites.

John Toon is a writer with the Economic Development Institute at Georgia Tech.
You Can Increase Your Gift to the Annual Roll Call through your company's matching gift program

An alumnus in each of the 113 companies listed here has agreed to rally company support for the 51st Georgia Tech Roll Call by sending a special matching gift mailing to all alumni within the company. The Roll Call matching gift program is ideal for companies that employ 10 or more Georgia Tech alumni who want to increase their contribution to Roll Call.

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The companies listed here were leaders in raising $1.37 million in matching gift money for last year's record-breaking Roll Call Campaign. The 51st Roll Call matching gift goal is $1.5 million, accounting for 21.4 percent of the $7 million we intend to raise, in partnership with your company's matching gift program, you have the opportunity to make this goal a reality and to increase your support of Georgia Tech academics.

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The Natural Philosopher

Regents' Professor Raymond Flannery probes the dark reaches of the "forbidden region"

By Shawn Jenkins

athed in soft light from a large panoramic window and the peaceful undertones of classical music, Raymond Flannery's surroundings seem more conducive to philosophy than the collisions, fusions and Big Bangs of physics.

"It is philosophy," the theoretical physicist contends. "It's 'natural philosophy'—man's relationship in the universe. It isn't just little models of how atoms behave; new physics reveals new ways of thinking."

A native Irishman and Regents' professor of physics at Georgia Tech, Flannery admits to a passion for his "philosophy"—a passion visible in his occasional attribution of human characteristics to the atomic structures he studies.

"The nice thing about bosons is that they like to get together; they're gregarious," he says. "Whereas fermions are anti-social; they're loners. They're like little electrons and positive ions, each likes to keep apart. They don't like to get involved."

Flannery, who came to Tech in 1971, hopes to leave his passion with students: "I've seen the little light go on in students' eyes, and that's a good experience because it means you're doing something right.

"Sometimes when you say things—and maybe you repeat it in a different format or present it in a different way—you can suddenly see the dawn of appreciation coming to the students. It's not what you said, but the way that you said it that tapped into their own experience."

Flannery recalls one of those illuminating moments in his own life. It came while he was developing his theory of "three-body ionic recombination," for which he recently received the American Physical Society's Allis Prize.

"This happened to be the first microscopic theory [of its type] that explained how positively and negatively charged ions can come together in a background gas and produce uncharged neutral species," Flannery says. "It's a unified theory. I achieved it in about three or four months one summer in Atlanta. Lots of people had tried it; in fact, it was a problem that goes back 80 years. I just wasn't getting it.

"But at each stage I knew I was onto something. And the further along I got with the problem, the more the excitement of the chase entered into it. I made many deviations. Finally, I wrote down one big equation—that's when the light came on. It was actually a blinding experience in this sense: Not only did the equation satisfy the criteria that I'd originally set up, it also pointed to new phenomena and research—stuff that I hadn't even thought about."

The potential of advanced technology to turn Flannery's hypotheses into reality is an exciting prospect for him. One of the big mysteries he is attempting to unravel with the help of this technology is that of "missing mass" in the universe.

"There's a lot of missing material out there that we can't account for," he says. "We refer to that as being the 'dark matter' because we have no way to get a handle on it."

Part of this "dark matter" is antimatter. Formed as a part of all matter created during the Big Bang, it is an occupant of what is termed by scientists as the "forbidden region."

"At low densities and high temperatures, atoms and molecules exist as vapor," Flannery explains. "At very high densities and lower temperatures, they become condensed into either solid or liquid matter. But there's a 'forbidden region' at lower densities and ultra-cold temperatures where nothing was supposed to exist.

"Labs have produced anti-electrons, which are positrons, and anti-protons, which have the same mass [as normal protons] with a negative charge. They form these in accelerators and at low temperatures. What I'm involved in is trying to find the best way to get these antiprotons and positrons together so that their overall reaction will produce antihydrogen, a form of antimatter."

If produced, Flannery says, antimatter would not only serve as a tool

The Flannery File

- **Born:** Jan. 8, 1941, in Clady, County Derry, Northern Ireland.
- **Education:** B.Sc., The Queen's University, Belfast, Northern Ireland, 1961; Ph.D., The Queen's University, Belfast, Northern Ireland.
- **Personal:** four children: Clare, 24; Una, 23; Deirdre, 21; and Conor, 18.
- **Achievements:** American Physical Society's Will Allis Prize for the Study of Ionized Gases, 1998; honorary member of the Royal Irish Academy, 1997; Georgia Tech Distinguished Professor Award, 1995; Sigma Xi Award for Sustained Research, 1992.
- **Leisure Interests:** Reading, tennis and squash. Flannery takes his squash seriously. "I don't play squash to keep fit, I keep fit to play squash," he says.
for testing some of the most basic principles of theoretical physics, but could become the rocket fuel source necessary for interplanetary travel.

A more concrete example of the impact of advanced technology on Flannery's work has been its use in a recombination process associated with the Bose-Einstein Condensate. A new entity, the Bose-Einstein Condensate is a coherent gas analogous to the coherent beam of photons of a laser. It has been produced in ultra-cold temperature conditions, which cause its atoms to behave less like particles and more like waves. With the possibility for new technologies—atom quantum optics, high-precision atom manipulation—the production of the Bose-Einstein Condensate signifies a small footprint on the soil of the "forbidden region."

Flannery's achievements and vision can be attributed to great educators. "Both my parents were schoolteachers. They inspired me to look at things in different ways," he says. "In high school I had two tremendous teachers, Father Eamon Tierney, a mathematics teacher, and a physics teacher, Tim Creedon. They were just superb in teaching me a very clear kind of thought."

Flannery studied at the University of Belfast's School of Applied Mathematics and Theoretical Physics, renowned for its atomic and molecular physics program and faculty during the late '50s and early '60s. "It was a very exciting intellectual time," he says. "One of the leaders was Sir David Bates—one of the foremost theoretical physicists; he gave me a terrific sense of confidence in my own ability. Then, when I went to Harvard, Alex Dalgarno, a professor at the Center for Astrophysics, was also inspirational. They had the greatest impact on my modern development. My road without those two people would've been quite different."

Can modern science answer global questions about man and the universe—questions of existence? Flannery gives an emphatic, "yes." He quotes fellow theoretical physicist Albert Einstein. "'Religion without science is blind, and science without religion is lame.' The two things come together well," he says. "I was asked one time when I was giving a lecture in astrophysics, 'Do you believe in God?' I said, 'God is that 10^-40 of a second (the duration of the Big Bang) and Mozart's concerto in A major.'"

Careful to point out the enigmatic nature of theoretical physics, Flannery admits the need to recalibrate his perspective on the universe now and then. He gestures to a photograph of a spiral galaxy that hangs on his office wall. The picture is inscribed with a quote from Hamlet, Act I, Scene 5: "There are more things in heaven and earth, Horatio, Than are dreamt of in your philosophy."

"This is what keeps me anchored," he says. "We are, even with all our great technology, still just little pebbles in the sand."
The multi-talented Buzz proves that Yellow Jackets get around better in the skies as he floats in on the dedication of the Roe Stamps Student Athletic Field in October. To prove his fantastic flying was no fluke, Buzz also dropped in from on high before the Georgia Tech/Georgia game.

Photo by Shawn Jenkins
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