

# Setting the Course ANNUAL REPORT 2003 of Innovation



Safety Economy Education

G T R I

**Georgia  
Tech**  **Research  
Institute**



*Creating Solutions Through Innovation*

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# lead·er·ship

(lēd'ər-ship') *n.*: Guidance; direction.

Leaders establish standards of excellence. They innovate.  
Their work defines the future.

At GTRI, the pursuit of excellence, innovation, and an  
exciting future are energized and enabled through  
collaboration with our customers.

We lead together, inventing technical solutions to  
important and challenging problems facing Georgia,  
the nation, and the world.

We are helping to define the twenty-first century  
research university.

We are.....

# Setting the Course of Innovation

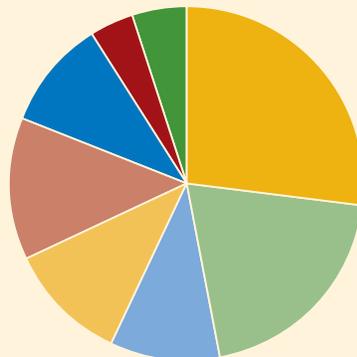


# Letter from the Director

Since its creation in 1919, the Georgia Tech Research Institute (GTRI) has been an integral part of one of the world's great research universities, the Georgia Institute of Technology.

We provide our customers with leading-edge technologies, innovative solutions, a passion to advance knowledge and solve problems, and access to the tremendous talent and resources that come with being part of a research university. We play a vital role in educating and training Georgia Tech students. Each year approximately 250 co-op students, student assistants, graduate research assistants, and interns get first-hand, real-world experience at GTRI, under the watchful eyes of our engineers and scientists.

**GTRI FY 2003 Major Customers**  
(% of Research Expenditures)



U.S. Air Force	26.9%
U.S. Army	19.7%
State of Georgia	9.8%
Other Department of Defense	10.8%
Industry - Federal Subcontracts	13.5%
U.S. Navy	9.9%
Industry - Commercial	4.2%
Federal Non-DoD	5.2%

In short, GTRI blends the theoretical with the practical—a philosophy that has characterized Georgia Tech since it opened its doors to students in 1888. We perform research for customers while educating the students working with us. We blend a desire to learn with a firm grasp of scientific and engineering concepts. We strive to surpass our customers' expectations every day. We set the course for innovation.

I believe this culture of innovation and the benefits it provides are a vital part of defining not only the twenty-first century research institute, but the twenty-first century research university. Our diverse array of experience is an important part of achieving excellence and leadership in both realms.

During 2003, we set the course of innovation in a number of areas:

This year, GTRI marked its thirtieth anniversary of developing solutions in food technology with construction of a new Food Processing Technology Building. The first phase of the space will open during summer 2004, housing work in automation technology, information technology, and environmental systems. (p. 12)

GTRI led the XSS-10 spacecraft mission for the Air Force Research Laboratory at Kirtland Air Force Base, New Mexico. The XSS-10 was a first-of-a-kind, low-cost "microsatellite" that demonstrated autonomous operations with newly developed guidance and control software during a twenty-four-hour mission. (p. 6)

Advanced aerospace technology is being applied at GTRI to improve dental air-abrasion technology, which is used to remove tooth decay. Researchers also are exploring the possibility of using the technology in reverse mode to fill a tooth and administer fluoride. (p. 10)

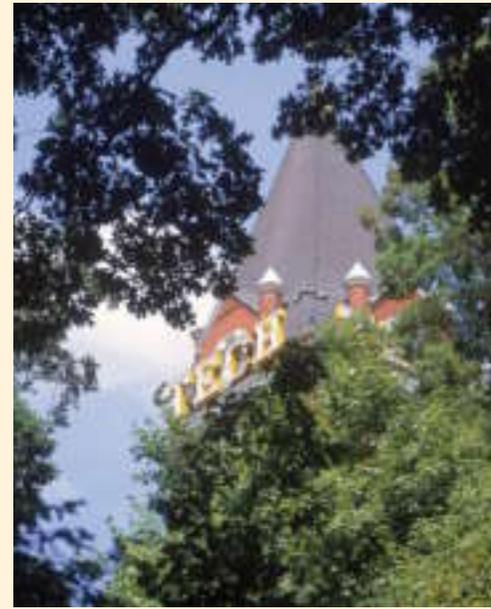
Our researchers explored the realm of extremely low frequency sound to determine whether thunderstorms, tornadoes—and humans in motion—create consistent, recognizable, or unique infrasound signatures that announce their presence. (p. 4)

We are helping to develop new decoy flares to protect larger military aircraft. These magnesium flares, which burn white-hot when dispensed by flying aircraft, confuse the infrared tracking systems used by missiles. (p. 7)

GTRI and campus colleagues are developing closed-cell foam that expands when exposed to fire. This insulation, which can withstand fire up to 100 times longer than existing products, could be commercialized within a year. (p. 12)

The Georgians Accessing Technology Education (GATE) program brings together people from all over the state to develop computer skills and job readiness. GTRI researchers advised on how grant money could be spent, offered technical assistance, and also helped evaluate the program's success. (p. 17)

Many of our employees voluntarily use skills and abilities they have honed at GTRI to assist their communities. Throughout this report, you will read features on dedicated employees who have improved their corners of the world outside of work. (pp. 5, 7, 9, 11, 13, 15, 16, 17)



In addition to these and many other examples of innovation, GTRI has continued its impressive growth in sponsored research awards. In FY 2003, the awards totaled more than \$117.2 million, a 2 percent increase from \$114.9 million in FY 2002. As I have only served as a Georgia Tech vice president and GTRI director since September 2003, these stellar technical accomplishments and growth are a testament to both the outstanding staff at GTRI and the leadership that preceded me. It is a tremendous privilege to be part of Georgia Tech and to lead GTRI.

*Dr. Steve Cross  
Vice President  
Georgia Institute of Technology  
Director, Georgia Tech  
Research Institute*

Setting the Course  
of Innovation in

# National Defense

## A Bird's-eye View of the Battlefield

Soldiers in battle are always trying to discern what's in front of them—their victory and survival can depend on it.

Now, a GTRI project is developing a novel way for small ground units to see past obstacles. Called the “reconnaissance round,” it would enable soldiers to use small artillery weapons almost like a periscope. They could fire a transmitting device skyward and send images of nearby terrain back to a laptop computer, which is standard equipment now among infantry units.

Currently, a ground unit requiring aerial information has to go up the chain of command to request satellite images or aerial photos from an unmanned aerial vehicle such as Global Hawk. The process is time-consuming, and equipment use is expensive. By contrast, the reconnaissance round promises to be quick, convenient, and relatively inexpensive at \$1,200 per device.

<http://gtresearchnews.gatech.edu/news-release/recon-round.htm>.



Top: Components of the reconnaissance round—the laptop computer displays a typical image provided by the device. Bottom: This black and white photograph, taken from a prototype reconnaissance round, shows a person standing in a sod farm near Atlanta.

## Enhancing Security Through Infrasond

Is the sound generated by a person's movement as unique as his or her fingerprints? GTRI researchers are exploring the realm of extremely low frequencies to find out.

Infrasound—frequencies below ten cycles per second—falls well below the range of human hearing. But, just about any object that moves through the air generates detectable infrasound.

Because few of the low-frequency waves are absorbed by atmospheric humidity, a large or severe motion can generate infrasound that travels thousands of miles. In fact, infrasound microphones can detect a nuclear test blast a continent away.

Researchers have been studying the sounds created by thunderstorms and tornadoes to see if the events create a consistent or recognizable low-frequency signature. The work could lead to earlier

detection of these often devastating acts of nature.

In addition, a GTRI team is applying the principle to investigate the possibility of measuring the aerodynamic “noise” created by people as they walk. Infrasound is generated in front of and behind a walker, and is influenced by an individual's size and gait. Using ultra-sensitive microphones, researchers hope to determine if a person's walk results in an infrasound frequency pattern unique to that individual. Using the same strategy, the researchers are examining the infrasound signatures of vehicles.

If successful, the research could be useful for security or other restricted-access situations. It could also help identify moving vehicles from a distance, a capability that could be of considerable help in an urban warfare situation.

## New Cockpits for SH-2G Helicopters

With help from GTRI, something old is turning into something new for the Royal Australian Navy (RAN). Human factors engineers at GTRI are part of a team that is stripping the RAN's fleet of SH-2G Super Seasprite helicopters down to the airframe and completely rebuilding them into state-of-the-art flying machines.

The GTRI researchers, working as subcontractors to Kaman Aerospace Corp., are focusing on cockpit details—from the placement of controls to the development

of computer software screens that will comprise the heart of the new flight systems.

One of the project's toughest challenges is that the aircraft must accomplish its missions with a crew of two, rather than the crew of three that is typical for this type of helicopter. The sensor operator position has been eliminated, and the tactical coordination officer (TACCO) must operate the sensors and communications systems, while also serving as co-pilot. GTRI is responsible for ensuring that the workload

of the TACCO and the pilot remain within acceptable limits.

Four computer display screens, as well as advanced flight and control electronics, are replacing mechanical gauges, switches, and other cockpit devices used in the decades-old helicopters. The SH-2G(A) Super Seasprite will be used for maritime surface surveillance, anti-surface warfare, and search-and-rescue missions.

<http://gtresearchnews.gatech.edu/news-release/SEASPRIT.html>



Left: Human factors engineers at GTRI are helping to rebuild the Royal Australian Navy's fleet of SH-2G Super Seasprite helicopters into state-of-the-art flying machines. Above: GTRI is focusing on cockpit details, from the placement of controls to the development of computer software screens for new flight systems.



### When the Nation Calls, GTRI Employees Respond

Some GTRI personnel contribute to national defense through our research and some assist outside the office as well.

As a member of the U.S. Army Reserve, LTC **Rusty Roberts** (Retired) was mobilized during Operation Noble Eagle in November 2002. During his yearlong tour, he served as the Officer-in-Charge of the Installation Operations Center at the U.S. Army Signal Center at Fort Gordon in Augusta, Georgia. Using the latest information technology, he designed and developed a world-class operations center, integrated with IP-based and closed-circuit cameras; networked computer workstations with projection capability for fifteen Crisis

Management Team members; and developed primary and backup communications systems with secure capability.

As a result of two evaluations, the Fort Gordon Operations Center was judged to be the model operations center for the Training and Doctrine Command (TRADOC). Roberts earned the Army Meritorious Service Medal for his achievements.

A West Point graduate who served as a U.S. Army Signal Corps officer for ten years, Roberts has been program manager and project director for several U.S. Army, Navy, and Air Force related programs and individual projects. He retired from the U.S. Army Reserve in 2003. Roberts is associate director for business development for the Information Technology and Telecommunications Laboratory at GTRI and also manages a U.S. Navy research program.



**Above:** The 24-hour XSS-10 mission demonstrated autonomous operations with newly developed guidance and control software. The expedition also revealed some “lessons learned” that are being incorporated into a follow-on mission called XSS-11, a one-year test of the technology. **Right:** The XSS-10 spacecraft—compared in appearance to a Buick transmission—launched from Cape Canaveral in late January 2003. It was a first-of-a-kind, low-cost “microsatellite” carried aloft via a second-stage, modified Boeing Delta II rocket.



## Small, Low-cost Satellite Demonstrates Autonomous Operation

The successful completion of an experimental mission, using a miniature, sixty-eight-pound satellite in early 2003, was an important first step in the development of a technology that promises to dramatically decrease launch costs and extend the capabilities of uninhabited space vehicles.

Under the Intergovernmental Personnel Assignment (IPA) program, GTRI led the XSS-10 spacecraft mission for the Air Force Research Laboratory at Kirtland Air Force Base. A low-cost “microsatellite” carried aloft via a second-stage, modified Boeing Delta II rocket, the XSS-10 was the first of its kind. The 24-hour mission demonstrated autonomous operations with newly developed guidance and control software.

Operating autonomously eliminated much of the personnel costs of ground support for the satellite, resulting in a relatively inexpensive launch cost of \$4 million (compared to \$20 million for a traditional space vehicle launch).

The microsatellite had capabilities similar to larger satellites, but its three-foot-long by eighteen-inch circumference required developers to shrink its communication system from twelve and a half to two pounds and reduce its power needs to one-tenth of a previous model’s requirements. Also, developers pre-programmed the navigation and maneuvering operations of the XSS-10 into the microsatellite’s on-board computer, allowing it to operate autonomously. With help from on-board cameras, the XSS-10 gathered real-time data to update the software’s algorithms autonomously, once the vehicle was in orbit.

The expedition also revealed some “lessons learned” that are being incorporated into a follow-on mission called XSS-11, a one-year test of the technology, which is scheduled to launch in late 2004. <http://www.gtresearchnews.gatech.edu/reshor/rh-ss03/sp-xss.html>

## New Labs to Advance Fuel Cell Research

The Center for Innovative Fuel Cell and Battery Technologies is advancing a number of research projects for clean, portable power—enabling a new breed of ground and air vehicles and powering soldiers in the field.

After opening a prototype lab last year, the Center will open another 1,000-square-foot facility at GTRI’s Cobb County Research Facility this fall. While the first lab focuses on specific components of fuel cells and batteries, the new lab will be devoted to complete fuel cell systems.

Fuel cells convert chemical energy directly to electrical energy. More environ-

mentally friendly than many existing energy sources, fuel cells face performance and cost issues that must be resolved before they become a major energy source in the mainstream market.

By providing appropriate infrastructure and equipment, the new lab will allow GTRI scientists to move beyond simple devices and conduct large-scale modeling. This is important because a stack of fuel cells needed to operate a complete power system has properties different from a single cell. Researchers will also be able to conduct a variety of sophisticated performance tests—from precise measurements

of chemical constituents to evaluating electrical power under dynamic loads.

Another benefit of the new lab will be the juxtaposition of components and systems-focused research, which should create new synergies for the Center and help scientists translate their ideas into actual prototypes more quickly. <http://www.gtri.gatech.edu/atas/specialprograms.html> and <http://gtresearchnews.gatech.edu/newsrelease/POWERING.htm> Video: <http://www.gtri.gatech.edu/pubs/videos2003.html#FUEL>



A British C-130J launches flare countermeasures prior to landing at the reopened military runway at Baghdad International Airport on July 1.

## Protecting Big Birds

Man-portable air defense missile systems (MANPADS), which use infrared sensors to seek the heat of jet engine exhaust, pose a major threat to military aircraft. Although MANPADS have been around for three decades, they've become a bigger threat in recent years due to their increased sophistication and relative ease of use. An estimated 500,000 MANPADS exist, posing particular danger to the large military aircraft that refuel fighter planes and transport troops, due to their size and slower speeds.

To protect these big birds, GTRI engineers are working with the U.S. Air Mobility Command and the Air National Guard to develop new decoy flares. Decoy flares are made of magnesium and burn white-hot when dispensed, confusing the infrared-tracking systems of enemy missiles.

In May 2003, GTRI researchers evaluated new flare patterns for fighter planes including the A-10, F-15, and F-16, followed by another field test in July for four larger aircraft—the C-5, C17, C-130 and MH53. Besides flares, GTRI researchers continue to work on other countermeasures, such

as directional infrared countermeasure systems (DIRCM). These jamming systems use laser beams to inject a signal into the tracking systems of incoming missiles, which causes them to fly away from the aircraft. <http://gtresearchnews.gatech.edu/newsrelease/flares.htm>



### Surpassing Standards for Achievement

Senior research engineer **Bill Melvin** serves his country in everything he does: in his research, his leadership in professional organizations that support those involved in security-related research, and his service to the U.S. Air Force as a reserve major.

Melvin's U.S. Air Force Reserve service was recognized this summer during a ceremony at Wright-Patterson Air Force Base in Ohio, at which Melvin was presented the 2002 Air Force Material Command Engineering and Technical Management Reservist of the Year Award. As a reservist, Melvin assists the U.S. Air Force in developing advanced sensor systems.

Melvin is a senior member of the Institute of Electrical and Electronics Engineers. He has served as a U.S. lecturer on the NATO-sponsored series covering Military Applications of Space-Time Adaptive Processing, has published more than ninety research articles and reports, and holds three U.S. patents related to signal processing. In the meantime, he is writing proposals, managing projects, and conducting research.

Simply put, Melvin is among the cream of the crop of young researchers in the country. GTRI is proud to count him as one of our own.

Setting the Course  
of Innovation in

# Health and Safety

FalconView has been used by the U.S. Forest Service to plot forest fires and plan the drop of flame retardant into affected areas.

## FalconView Makes Valuable Non-Combat Contributions

For nearly ten years, the U.S. Air Force and other branches of the armed forces have relied on FalconView, a GTRI-developed multimedia mapping system that displays elevation maps, charts, satellite-produced data, and geographically referenced overlays. The award-winning system is an integral part of the Portable Flight Planning Software.

FalconView's low cost and portability have made it useful for preflight military planning, briefing, and situational awareness, as well as for in-flight purposes. However, FalconView has also found valuable non-combat uses. For example, it was used by the U.S. Forest Service to

plot the forest fires that ravaged the western United States during the summer of 2002, and to plan the drop of flame retardant into affected areas. The system was also used by the U.S. Navy to map whale sightings for an environmental study. FalconView also serves as the primary geographic information display system for the Airship Whale Search Network ([www.lashwhalesearch.org](http://www.lashwhalesearch.org)).

GTRI researchers are currently involved in migrating FalconView components to the Joint Mission Planning System for the Department of Defense.

[http://www.gtri.gatech.edu/ittl/csit/proj\\_falconview.html](http://www.gtri.gatech.edu/ittl/csit/proj_falconview.html)





GTRI researchers are working with colleagues at Georgia Tech to develop a land mine detection system that uses high-frequency seismic waves to slightly displace soil and objects in it. A non-contacting radar sensor then measures the results, creating a visual representation that reveals hidden land mines.



## Exposing Buried Danger

Millions of land mines are buried worldwide; such mines were responsible for an estimated 16,000 injuries and deaths in 2002.

GTRI is assisting researchers in Georgia Tech's Schools of Electrical and Computer Engineering and Mechanical Engineering with the development of a landmine detection system that could ultimately prevent thousands of deaths and injuries each year. This system uses high-frequency seismic waves to slightly displace soil and objects in it (less than one ten-thousandth of an inch). A non-contacting radar sensor then measures the results, creating a visual

representation of the displacement to reveal hidden land mines.

This seismic wave system presents distinct advantages over existing electrical wave techniques. Although metal detectors and ground penetrating radar (GPR) can locate metal mines, these devices do not work under all conditions—especially in detecting the small, plastic anti-personnel mines that have become more prevalent in recent years. Moreover, metal detectors and GPRs are often thrown off by ground clutter, such as rocks, sticks, and soda cans, resulting in many false alarms. Yet, because

plastic land mines have different mechanical properties than soil and common types of ground clutter, the seismic waves can accurately locate them.

This summer, researchers traveled to Skidaway Island off the Georgia Coast to conduct their eighth field test, which yielded promising results. An important accomplishment there was assessing techniques for faster measurements, which will be useful as researchers develop a prototype for more extensive field tests.

[http://gtresearchnews.gatech.edu/news\\_release/MINES.html](http://gtresearchnews.gatech.edu/news_release/MINES.html)



## Taking Care of Business—and the Environment

Thinking big about small things is something **Jud Ready** does well at work—and after work.

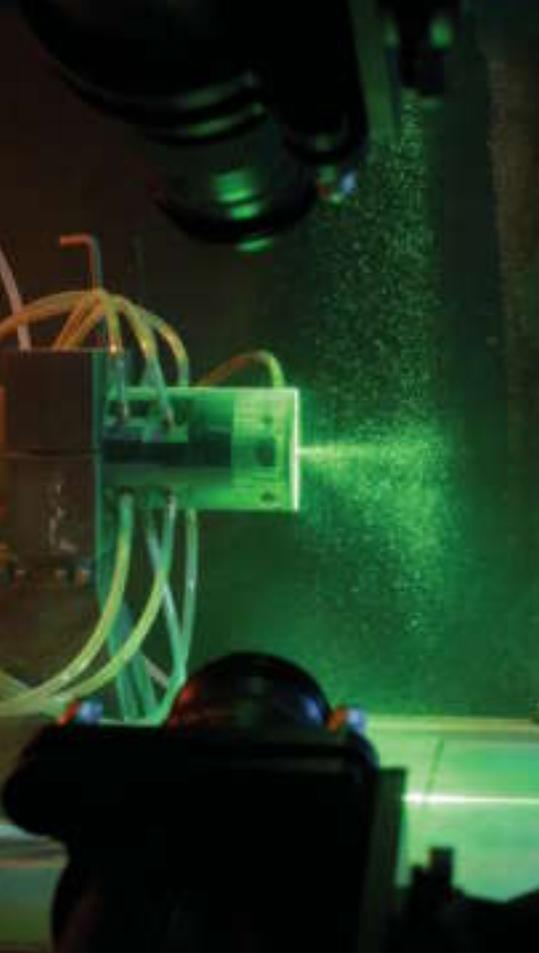
At GTRI, he has plans to create supercapacitors out of tiny carbon nanotubes, which would perform consistently and reliably for everything from powering spacecraft to creating flat-panel displays. After work, he thinks about cleaning up and preserving a tiny tributary to Peachtree Creek in Atlanta.

As a graduate student at Georgia Tech, Ready formed an Adopt-A-Stream volunteer group in 1997 to clean and monitor the health of the tiny stream near Georgia Tech—a stream the group named “Underwood Brook” after a nearby park. Underwood Brook is vulnerable to many types of pollution, such as oil and gasoline runoff and paper trash debris from the commercial area around Howell Mill Road and I-75.

The program slowed down after Ready left school, but he got it going again in late 2000 when he returned to work in Atlanta and bought a home on the stream. His work protecting the stream and documenting runoff problems that threatened it moved the Georgia Environmental Protection Division to present him the 2001 Red Flag Award.

Now a dad, he continues his diligent work protecting Underwood Brook from runoff and other pollutants not just for himself, but as a gift to a future generation. His young daughter, Vivian, likes skipping stones on the brook, and she and Ready recently found a box turtle at the brook—a small sign of renewed life in a formerly dying habitat.

[http://cyberbuzz.gatech.edu/asm\\_tms/ubaas.htm](http://cyberbuzz.gatech.edu/asm_tms/ubaas.htm), <http://www.riversalive.org/newsletters/March%20April%202002.pdf>



## Using Aerospace Technology for Smarter Dental Tools

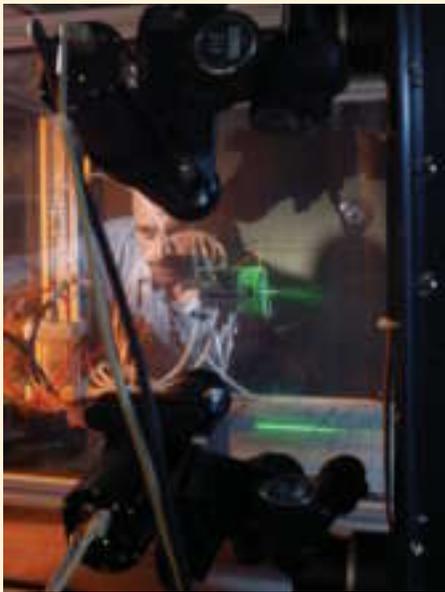
Dental air abrasion technology, which uses aluminum oxide particles to remove tooth decay, has been around for about sixty years. Although this technique appeals to patients because it's relatively painless and noiseless, it has many drawbacks limiting its acceptance among dentists. For example, abrasive material must be contained and then removed; reflected particles can damage healthy neighboring teeth; and most decay can be difficult to remove.

GTRI researchers are applying advanced aerospace technology to improve the particle laden jets used in air abrasion treatment. By employing active and passive flow concepts, researchers seek to reduce the number of particles used in the air abrasion process, while better controlling the direction of the particles. A closed-loop feedback system will prevent the device from removing healthy tooth material.

Another goal of the project—a collaboration with the Medical College of Georgia—is

for the tool to reverse modes from material removal to material replacement, allowing the same device to remove decay, fill a tooth, and administer preventive fluoride treatment. This smart, one-step tool will help dentists provide faster, better treatment, and ultimately lower costs for oral health care.

<http://www.gtresearchnews.gatech.edu/reshor/rh-f03/dental.html> and <http://gtresearchnews.gatech.edu/newsrelease/DentAART.html> Video: <http://www.gtri.gatech.edu/pubs/videos2003.html#DENTAL>



Top left: Close-up of flow control equipment used by GTRI researchers in their experiments. Above: To gain better control over the particles used in dental air abrasion technology, GTRI researchers are experimenting with passive and active flow control techniques commonly used in aerospace engineering.

## System Warns Motorists of Upcoming Work Zones

Highway safety has long been a subject of study at GTRI, where researchers are completing a three-year program for the U.S. Department of Transportation involving tests of the patented Safety Warning System (SWS). The SWS relies on an advanced radar detector that uses both radio and radar components to alert motorists to real-time hazards, dangerous weather, and other traffic conditions with an audible alarm, a text message, and/or a synthesized voice message.

During 2003, U.S. beta-test users received more than 200 SWS transmitters, which give oncoming motorists a 30-second advanced warning of work zones and the presence of emergency vehicles. HERO vehicles, which aid stranded motorists on Atlanta-area interstates, also received transmitters.

The SWS also involves using Doppler radar technology to increase highway safety. During 2003, researchers conducted field tests to determine if the SWS radar component could be used to help prevent tractor-trailer truck rollover crashes by warning drivers if they are approaching a curve too fast. <http://gtresearchnews.gatech.edu/newsrelease/SWS.html>

## Providing Earlier Warning of Severe Weather

Much of the United States is hit regularly by tornadoes and other dangerous weather. GTRI scientists are researching how to maximize the ability to predict when and where severe weather will strike.

Researchers at Georgia Tech's Severe Storms Research Center (SSRC) have been using state-of-the-art Warning Decision Support Systems that apply advanced image processing, artificial intelligence, neural networks, and other algorithms to Doppler radar data. A central goal is to maximize the warning time before a tornado strikes.

During 2003, the Georgia Tech Severe Storms Research Tracking Room at GTRI's Cobb County Research Facility collected weather-related data using a new lightning channel detection passive radar system. The goal is to study whether cloud-to-cloud lightning could serve as an early warning of impending tornadoes. This system uses the signals that are scattered from the plasma that forms when lightning discharges in the atmosphere.

In addition, the low-frequency tornado listening system installed at the Cobb County Research Facility was equipped with new infrasonic microphones. This research, supported by funding from the Georgia General Assembly, listens for pressure wave-type signals below the range of human hearing, which could aid in the early detection of tornadoes. <http://gtresearchnews.gatech.edu/newsrelease/SSRC2.html> Video: <http://www.gtri.gatech.edu/pubs/videos2003.html#SSRC>

## Home Monitoring Test for PKU Patients

Researchers in GTRI and Georgia Tech's School of Chemistry and Biochemistry are helping MetGen Inc., an Atlanta startup company, develop a home-monitoring test for phenylketonuria (PKU) patients.

PKU is a metabolic genetics disorder in which the body is unable to utilize phenylalanine, an essential amino acid. Left untreated, PKU can cause brain damage and mental retardation in newborns. Doctors began screening newborns forty years ago, using the Guthrie test to detect PKU. When PKU patients follow a strict diet—one that avoids or reduces foods with protein—they can have normal development and lifespan. Yet, when phenylalanine levels become too high, PKU patients can suffer movement disorders, such as tremors, seizures, and hyperactivity.

Treatment of PKU is complex because it requires frequent monitoring to determine phenylalanine levels in the blood. Home testing methods do not currently exist, forcing PKU patients to visit a treatment center for blood monitoring, which can be inconvenient and expensive, especially for individuals who require routine testing. Large pharmaceutical companies haven't pursued home testing kits because PKU affects only a small sector of the population—about one out of every 10,000 births in the United States.

The MetGen testing device will feature a reagent strip similar to tests that allow diabetes patients to monitor their glucose levels at home. Clinical testing is slated to begin in early 2004 and researchers hope to commercialize the PKU home monitoring test by spring 2004.

## Improving School Air Quality

GTRI researchers are investigating air quality in schools to help facility designers and managers provide healthier environments for children. In one project, GTRI researchers studied humidity and its impact on mold and other indoor pollutants that can cause discomfort and respiratory illness, negatively affecting children's health and ability to learn.

Researchers measured air quality in ten "healthy" schools that had no history of indoor air problems. Five of the schools had conventional cooling systems and five had advanced humidity control systems. The study statistically shows how inadequate humidity control is linked with mold growth and other contaminants. In fact, it provides hard evidence that supports two standards of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers: 1) an outdoor air ventilation rate of fifteen cubic feet per student; and 2) a relative indoor humidity rate of 30 to 60 percent.

Providing scientific data to back up air-quality standards is important because schools lack funds, and the competition for available dollars is intense. The GTRI study provides important reasons to invest in advanced ventilation and cooling systems and underscores the need to properly



A GTRI study statistically shows how inadequate humidity control is linked with mold growth and other contaminants. These substances can cause children discomfort and respiratory illnesses, negatively affecting their health and ability to learn.

operate and maintain these systems. Indeed, for schools with advanced humidity control systems, absenteeism averaged 9 percent less than schools with conventional systems.

Health issues aside, the study shows how high humidity levels can damage school media centers, hardwood floors, carpeting, and ceiling tiles. GTRI researchers continue to analyze data from the two-year study, which was funded by the Department of Energy. They're also doing outreach by speaking to schools and making presentations at facility association meetings.

<http://gtresearchnews.gatech.edu/reshor/rh-ss01/rnoteS01.html>



## Recycling Computers for Families in Need

If you're reading this annual report, it's probably safe to say that you've never wanted for access to a computer in recent years. However, computer and Internet access are necessities that not everyone has. GTRI's **Jack Wallace** is trying to change that in his corner of the world.

Wallace helped arrange for a Norcross, Georgia, company, American Megatrends (AMI), to donate 102 old computers to the Gwinnett County Department of Family and Children's Services (DFACS). He asked FreeBytes, a non-profit organization that refurbishes donated computers and peripherals and gives them to non-profits, to help him fix up the machines. Gwinnett County DFACS purchased

modems and Wallace scrounged hard disks and researched free Microsoft Office-compatible software. FreeBytes installed the modems, disks, and software and tested everything.

Wallace then did the heavy lifting, hauling the refurbished computers to DFACS, which distributed them to needy families, along with CDs offering trial Internet access. Any machines not needed by DFACS were used to fix other systems or for other FreeBytes projects.

Why put in all this work? The "Digital Divide" between the haves and have-nots of the world is a real and serious problem, Wallace says. He likes knowing that some families in his county who could never dream of buying computers now have them—and that their kids are getting a head start doing research for school, or can now play computer games on the machines he salvaged.

Setting the Course  
of Innovation in the

# Economy



The Food Processing Technology Research Building, set to open this summer, will house work in automation technology, information technology, and environmental systems.

## Food Processing: Thirty Years of Service and Still Going Strong

The Georgia Poultry Federation approached the Georgia Institute of Technology thirty years ago for help with a noise abatement problem. The relationship grew and has resulted in substantial research-based competitive benefits to the poultry industry—as well as fostering the Agricultural Technology Research Program (ATRP), ranked one of the top programs of its kind in the United States.

This summer, a \$9.4 million Food Processing Technology Research Building will open to house ATRP work in automation technology, information technology, and environmental systems.

A second phase of the building planned for the future will house food safety, human factors, and bioprocessing research. Food processing researchers at GTRI also are pushing the development of cost-effective imaging, advanced imaging sensors, integrated optical sensors, and other technologies for all aspects of the food processing industry. <http://www.gtresearchnews.gatech.edu/reshor/rh-f03/atrp.html> and <http://atrp.gatech.edu/> Video: <http://www.gtri.gatech.edu/pubs/videos2003.html#ATRP>

## New Foam Advances Fire Protection

When fire strikes, every second counts toward saving lives and property. Working with scientists from Georgia Tech's School of Textile and Fiber Engineering, GTRI researchers are developing a new insulating technology: a closed-cell foam that expands when exposed to fire. This insulation can withstand fire up to 100 times longer than existing products.

Its applications include insulation for commercial buildings, lightweight coatings for aircraft shelters used by the military in

overseas deployments, interior coatings for aircraft engine bays, and thin linings for firefighters' suits.

The foam combines existing closed-cell foam technology and pyrolyzing polymers (polymers that are altered by heat), but uses an innovative mixing procedure. With support from RBX Corp., GTRI is developing a manufacturing process for the foam, which could be commercialized within a year. <http://www.gtresearchnews.gatech.edu/reshor/rh-f03/rnoteF03.html#rnote1>

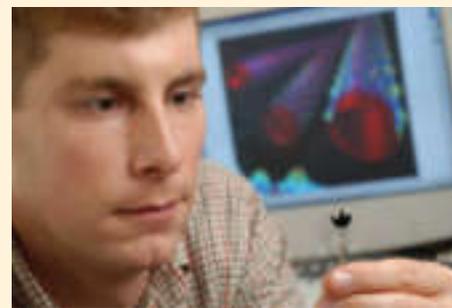
## Using Carbon Nanotubes to Store Electrical Charges

Batteries and capacitors are used to store electrical energy, but both devices have limitations. GTRI scientists are developing a new way to store electrical charges—supercapacitors based on carbon nanotube (CNT) technology. Such devices would provide more power, increased energy density, and longer life.

Capacitors are made of two electrodes immersed in an electrolyte with a material separating the electrodes to prevent

electrical conduction. CNTs are ideal to use as the active material for a capacitor because their tiny dimensions provide more surface area for storing electrons, which exponentially increases capacitance—the amount of power that can be stored.

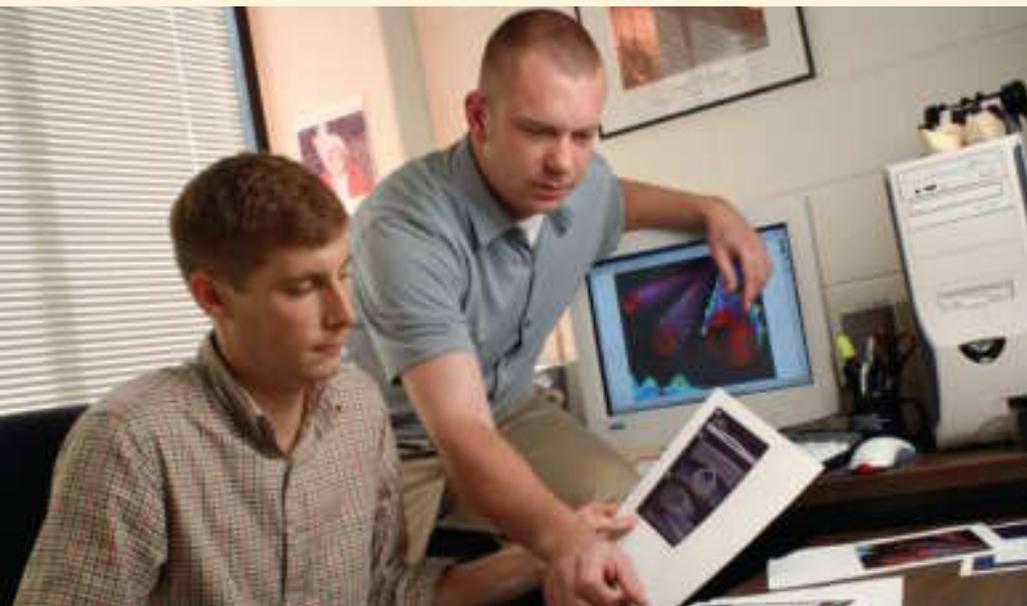
First discovered in 1991, CNTs can be thought of as a hexagonal network of carbon atoms rolled to form a seamless cylinder—a sort of “chicken wire” lattice of graphite. This material has tremendous electrical,



thermal, and structural properties; however, few products have hit the commercial market yet. One challenge of working with CNTs is controlling chirality (how the carbon nanotubes are twisted) because the specific conducting properties of CNTs can vary, depending on their formation.

GTRI researchers plan to produce CNTs in-house, creating CNT-based supercapacitors that perform consistently and reliably. Such supercapacitors could provide a lightweight power source for spacecraft or power sophisticated laser systems that shoot down enemy missiles. CNTs could also be used for flat-panel displays, electric field generators, solar cells, no-loss motor windings, and numerous other applications.

<http://eoeml-web.gtri.gatech.edu/jready/>



**Top right:** GTRI scientists are developing a new way to store electrical charges—supercapacitors based on carbon nanotube (CNT) technology. **Above:** GTRI researchers plan to produce carbon nanotubes in house, creating from them supercapacitors that could provide lightweight power sources for multiple uses.



### Turning a Passion Into a Habit

One morning a week last fall, you wouldn't find **Greg Kiesel** at his desk or in his lab. Instead, he was at a Grady High School table, tutoring 15- and 16-year-olds in Algebra II, then driving to GTRI and working late in the evenings on his projects.

Kiesel volunteered through MOVE, Georgia Tech's student volunteer organization. Why? It's a habit—and a passion. He wants today's students to develop a more intuitive understanding of fundamental, basic math—because many of today's better information age jobs aren't available to those lacking it.

Kiesel says he knows through tutoring he is making a small, personal contribution toward improving the futures of the young people he assists. He also experiences a big reward when a student truly comprehends a concept and isn't just working problems by

rote anymore. There's a spark in their eyes, he says. And who knows? It might be a small spark that ignites a passion for math education in future generations.

Work continues at Atlantic Station, a project that involves revitalizing what had been a brown-field area in Atlanta's Midtown neighborhood.



Georgia Tech researchers have developed a water disinfection system that improves food processing industry performance.

## Unique Water Disinfection System Can Help Industry

GTRI is developing an improved technology to disinfect water—one that offers benefits for a number of industries. The project is being conducted in collaboration with Georgia Tech's School of Chemical Engineering.

The hallmark of the new disinfection system is a unique mixing process. Conventional disinfection methods typically run water through long channels past a series of ultraviolet (UV) lights to kill bacteria. However, UV lamps don't have much penetrating power, meaning that water farther from the lamps may retain bacteria.

In contrast, the new disinfection system features two small cylinders with water passing through a gap between them. The smaller cylinder rotates inside the larger one, creating vortices that push water closer

to UV lamps and increase microbial disinfection. Because this technology requires less light energy and increases the exposure of bacteria to UV lamps, the system is more efficient and less expensive to operate. Having completed successful lab tests, researchers are now beginning field tests and will use a new pilot-scale model that can treat five gallons per minute.

Although the disinfection technology was initiated to help fruit and vegetable processors, it shows promise for a number of other water-treatment applications, and may also extend to other liquids, serving as an alternative to the pasteurization of fruit juices or recycling marinades used to flavor meat. <http://gtresearchnews.gatech.edu/reshor/rh-w03/water.html>



## Sustainability Center Helps Communities and Developers

Sustainable urban redevelopment is a complicated issue involving civil engineering, transportation, energy and water supply systems, law, economics, and more. To help developers and communities better understand this multifaceted subject, GTRI launched the Center for Sustainable Urban Revitalization (CSUR) earlier this year.

CSUR provides outreach in three ways: 1) helping developers and communities better understand issues and make decisions that are economically, environmentally, and socially friendly; 2) conducting research such as evaluating "green" building materials and building disaster-resistant communities; and 3) providing knowledge and resources to help communities clean up hazardous waste sites and brownfields.

One of CSUR's initial undertakings has been to assist Jacoby Development Inc. with Atlantic Station, its 138-acre, mixed-use project in Atlanta's Midtown neighborhood. Atlantic Station sits on the former site of Atlantic Steel mill, previously one of Georgia's largest brownfields. Today, the property is a model for sustainable redevelopment, using building practices and construction materials that will reduce pollution and energy consumption. <http://gtresearchnews.gatech.edu/news/release/csur.htm>

## New Test for Cardio Toxicity

Halocarbons, the compounds used in some fire extinguisher systems, medical inhalers, and hair sprays, are not dangerous by themselves. Yet, when combined with adrenaline, which is produced by the body in situations of mental and physical stress, halocarbons can lead to arrhythmia and even cardiac arrest.

The current method for assessing the toxicity level of halocarbons relies on animal testing, but this protocol is expensive and inaccurate for predicting cardio toxicity in humans. In cooperation with Emory University and Georgia Tech's Biomedical Engineering Department, GTRI is developing a new in-vitro assessment tool to measure the cardio toxicity of halocarbons.

This new test will use heart cells taken from unborn rats. Researchers will culture those cells, then monitor their electrochemical response when exposed to different levels and combinations of halocarbons and adrenaline. This tool will help designers of fire protection systems, the cosmetic industry, and drug manufacturers to conduct tests that are more accurate and less expensive.

This interface system is so user friendly that DEK named it the Instinctiv™.



## User Interface Helps Global Manufacturer

Today's competitive manufacturing environment requires the highest levels of efficiency. And, though sophisticated automation can give manufacturers an edge, the equipment is only as effective as the humans operating it. GTRI researchers have helped DEK, an international machine manufacturer based in England, to improve the user interface on screen printers the company produces for circuit-board and electronics assembly.

User interfaces, the commands or menus that allow people to communicate with computers or electronic devices, are critical to nimble manufacturing. Machine operators must keep equipment in constant motion—for if production stops or even slows down, it can be costly to manufacturers.

One of GTRI's goals was to create an interface that expands the role of machine operators. The resulting new interface saves time and streamlines production by using graphics to reduce machine operators' dependence on language; embedding training materials in the interface so operators don't have to reach for a manual whenever they have a question; and reducing errors.

The interface also provides troubleshooting tips to help operators solve problems on their own instead of calling in process engineers. In fact, the new interface is so user friendly that DEK has named it the Instinctiv™. A beta version of the new interface debuted this spring at the APEX manufacturing show in Anaheim, California, and is being tested in two of DEK's critical markets. <http://gtresearchnews.gatech.edu/newsrelease/dek.htm>



## Fighting Fire with Volunteerism

A childhood interest in public safety has morphed into a win-win volunteer position for GTRI's **Christina Baxter** with the Douglas County Fire Department. Baxter gathers data and experience for her GTRI research and helps make her community a safer place; Douglas County firefighters benefit from being part of some of the newest training and analysis in their field.

Baxter volunteers as a Hazardous Materials Technical Adviser for the Douglas County Fire Department. Her specialties at GTRI include emergency response technologies in the areas of emergency management, fire fighting, and hazardous materials.

As a result of Baxter's GTRI research connection, the emergency management, fire, and sheriffs' departments of Douglas and neighboring Carroll County recently participated in a GTRI-funded program on building disaster-resistant communities. Baxter and colleagues Scott Spencer and Jim Mykytyn—who are full-time firefighters and part-time GTRI employees—were recognized by the Institute of Fire Engineering for this work.

Douglas County Fire Department personnel were part of exercises at Georgia Tech, as well, including a 2002 emergency response demonstration for President George Bush on campus. The Douglas and Carroll County public

safety agencies have served as pilot groups for numerous other programs funded by outside customers.

Baxter likes feeling that she has helped enhance the Douglas County residents and visitors. She also enjoys the team spirit and sense of community common in fire departments, and working with giving individuals who will risk their lives to save others.

Setting the Course  
of Innovation in

# Education



## Safety Training for Hispanic Construction Workers

Labor demographics have changed dramatically in Georgia during the past decade, with a tremendous increase in the number of Hispanic workers. Because recent immigrants may accept jobs without having experience or a full understanding of the associated hazards, they are at greater risk for injury. In fact, the majority of construction fatalities in metro Atlanta occur among Hispanic workers.

To help remedy the situation, GTRI has created a special training program entirely in Spanish to educate Hispanic construction workers on safety rules and regulations from the Occupational Safety and Health Administration (OSHA). The program focuses on fall protection, scaffolding, trenching and excavation, electrical hazard, and material handling—five areas where the most injuries and deaths occur.

To accommodate workers with different degrees of education and language skills, GTRI created materials in a variety of



Above: Safety materials for educating Hispanic construction workers can be posted at job sites like this one. Inset: A researcher and a safety officer examine safety education materials, which were created entirely in Spanish for Hispanic construction workers.

formats, including workplace posters and hazard bulletins; pamphlets for foremen and supervisors to use during informal “toolbox” meetings; computer presentations for formal job orientations; and detailed presentations geared to supervisors and trainers who already possess a certain degree of safety expertise.

The printed and digital materials are free and are being distributed throughout building associations, statewide and regional OSHA offices, and the Hispanic Chamber of Commerce. They can also be downloaded from [www.oshainfo.gatech.edu](http://www.oshainfo.gatech.edu). GTRI researchers are now working on a series of seminars for Hispanic construction workers to further advance safety awareness. <http://gtresearchnews.gatech.edu/newsrelease/osha.htm>

## A Moving Exhibition

The 2003 Cow Parade Atlanta featured the work of GTRI graphic artists **Elaine Baran** and **Kathy Gilbreath**. Their proposed design for the clay cow was chosen from among 500 submissions. The bovine beauty Elaine and Kathy created with house paint and sealed with polyurethane was christened “Heartsfield.” Its meadow of bright red heart-shaped flowers artistically represents the name of Atlanta’s Hartsfield-Jackson International Airport.

Proceeds from the auction of the 149 cows displayed around the city during summer 2003 benefited the American Cancer Society and TechBridge, an Atlanta non-profit that helps other non-profits use technology to better serve the community. Cow Parade Atlanta attracted an estimated 3.5 million viewers and created an economic impact of \$36 million for the city. <http://atlanta.cowparade.net/>

SeaMaven gives students early exposure to the marine ecosystem and related issues, such as pollution and saltwater encroachment—even if they don't live near the ocean.

## Bridging the Digital Divide

Last year, GTRI worked with four Georgia communities to set up special technology centers that help residents gain technology literacy and bolster job skills.

Known as Georgians Accessing Technology Education (GATE), the project was initially funded by the U.S. Department of Education and resulted in fifteen centers in Gainesville, Calhoun, DeKalb County, and Peoplestown, an inner-city neighborhood in Atlanta. These centers are typically located in schools and feature state-of-the-art computers, digital cameras, scanners, and Internet access. Participants can sign up for classes ranging from basic computer skills to job readiness, including resume writing and GED preparation.

As the project facilitator, GTRI played a broad role, from helping communities understand how grant money could be spent, to providing technical assistance. GTRI also met with groups from the four communities every quarter to evaluate the program's success. In just one year, the GATE program served 5,848 participants and evidenced numerous success stories. For example, one woman, who worked as a waitress, was so encouraged by her ability to learn that she enrolled as a nursing student at a local college.



## Ocean Management for Middle School Children

GTRI researchers are creating a unique interactive Web site that will give middle school students a chance to become amateur scientists and learn about ocean management. Dubbed "SeaMaven," the project is in collaboration with the Skidaway Institute of Oceanography (SKIO).

SKIO has access to several naval flight training platforms about sixty miles off the coast of Georgia, and has equipped these platforms with instruments to make a variety of observations. GTRI will upload this data on the SeaMaven Web site, enabling students and teachers to take a virtual tour of a 5,700-square-kilometer area of the U.S. southeastern continental shelf; record near real-time measurements of atmospheric

and oceanographic conditions; and engage in electronic forums to discuss ideas and projects generated by their observations.

The goal is to give land-bound students early exposure to our marine ecosystem and related issues such as pollution and saltwater encroachment. Students can use SeaMaven on their own or work in groups to create hypotheses and science projects. For example, they might study how the depth of the continental shelf affects tides or how dissolved oxygen changes with the seasons.

Funded by the National Science Foundation, SeaMaven is expected to launch in spring 2004. A group of Georgia math and science teachers will begin initial user testing this fall.



### Preparing Students for Real World Research

GTRI employees are making our laboratories a great place for engineers of the future to work, learn, and grow, according to the Massachusetts Institute of Technology's School of Engineering (MIT). MIT and its Undergraduate Practice Opportunities Program (UPOP) recognized GTRI with a 2003 UPOP Internship Excellence Award, along with fifteen other organizations and companies.

Researcher **Doug Denison** hosted the first UPOP student from MIT in 2002. GTRI's **Alan Golivesky** (left) fostered the relationship with MIT as he built GTRI's formal internship program. During 2003, students from MIT, Georgia State University, and the University of

Puerto Rico joined their Tech peers in gaining hands-on, real-life research experience at GTRI. Researchers **Wiley Holcombe** and **John Schultz** supervised the students, whose experience led to the UPOP award.

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