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ResearchHorizons

High-Tech Highway for Rural America

"Virtual corporation" delivers video and high-speed data over telephone wires of small, independent telephone companies.

By Jane M. Sanders

Don't let the slow pace of rural Hart County, Ga., population 18,000, fool you. Yes, it has only four stoplights in the county seat of Hartwell. And you can still call the local pharmacist in the middle of the night to get an emergency prescription filled. What's surprising is Hart County's status as the testbed for a new technology that may give bragging rights to rural Americans.

Traditionally, rural America lags behind urban areas in consumer technology. But now a new technology for delivering simultaneous digital television, high-speed Internet access and telephone service – all via regular copper telephone wire – is operational far from the hubbub of the big city.

photo by Gary Meek

Developed primarily by engineers at the Georgia Tech Research Institute for mPhase Technologies Inc., based in Norwalk, Conn., the technology is a system incorporating Digital Subscriber Line (DSL) communications combined with sophisticated digital signal processing and filtering. mPhase Technologies and a related company Microphase Corporation have contributed key components based on years of experience with signal telemetry and filtering. The results of this team effort form the basis for the Traverser Digital Video and Data Delivery System (DVDDS).

The product has undergone beta testing with Hart Telephone Company in Hartwell since last fall, and this summer, the company has been installing the DVDDS for 1,000 of its customers. Plans call for expansion as mPhase increases production this fall. The Traverser system will cost consumers about the same amount they are paying for cable television and DSL service combined – from $75 to $100 a month.

Pharmacist Bill Rogers had the Traverser installed in his Hartwell Pharmacy so he could watch televised sports events, track packages on the Internet and establish a Web page where customers can order prescription refills. (300-dpi JPEG version - 356k)

"The system is, in a word, phenomenal," says Hartwell attorney Walter Gordon, who participated in the beta test. He uses the Traverser in his office for high-speed Internet access and occasionally for digital TV. "... I hope the system is fully deployed here in Hart County, as I know many of my friends want the same access speed I enjoy."

Hartwell pharmacist Bill Rogers also sings the Traverser's praises. "The TV picture clarity at my store is much better than I have at home where we have regular cable TV," Rogers says. He had the system installed in his Hartwell Pharmacy so he could watch televised sports events, track packages on the Internet and establish a Web page where customers can order prescription refills.

Gordon and Rogers agree that the deployment of such cutting-edge technology to a rural area before it's available in metropolitan areas is quite unusual. "But it's not surprising given the progressive nature of my local, independent phone company," Gordon says.

It is exactly this pioneering attitude that makes the 1,200 or so small, independent telephone companies in rural America the initial market for the Traverser DVDDS, says David Klimek, chief technology officer for mPhase.

"Independent telcos can usually make decisions quickly, and they want to remain competitive by offering video through telephone wire," Klimek says. "Then they can compete directly with the cable companies. Eventually, mPhase will go after the Baby Bells, but they want to see if the technology is proven and if it's a moneymaker."

Working hard to make that scenario a reality is a sort of "virtual corporation" including mPhase and its parent company Microphase, the Georgia Tech Research Institute (GTRI), contract manufacturer Flextronics International Inc. (famous for manufacturing the Palm Pilot) and its outsourcers. The involvement of Hart Telephone Company in beta testing is also vital, researchers say.

Before signing on GTRI engineers in April 1997, mPhase developed the basic modem

technology for streaming data to a DSL transmitter, then sending it over copper wires, receiving it and displaying it on a television screen in a laboratory. Since then, Microphase has also developed a basic filtering technology that separates ordinary telephone signals from the high-frequency signals required for video programming and high-speed Internet delivery.

But to get the concept out of the laboratory, into a factory and then into homes, company executives realized the need for the electronics expertise and manufacturing design resources available at Georgia Tech. In something of a coincidental meeting at a Washington, D.C., airport, mPhase officials discussed the concept with Tech researchers. And a month later, GTRI officials had signed what became their largest-ever commercial contract and their first-ever concept-to-production contract.

photo by Gary Meek

The Traverser DVDDS delivers simultaneous digital television, high-speed Internet access and telephone service over a single copper phone wire. GTRI principal research engineer Dr. Ron Bohlander, left, and mPhase CEO Ron Durando discuss the advantages of the Traverser at the SuperComm 2000 trade show in Atlanta. (300-dpi JPEG version - 304k)

"We were prepared for mPhase because we had brought in some bright, young staff from the telecommunications industry," recalls Dr. Ron Bohlander, a principal research scientist at GTRI. "They had some fresh ideas and had created some critical inventions in our GTRI labs for DSL distribution of video programming to homes.... Then we happened to run into mPhase with the need for this technology."

Since then, GTRI has done most of the research and development for the Traverser - transforming mPhase and Microphase's basic technologies into a system that would economically supply many telephone company customers.

Meanwhile, mPhase has promoted the concept, raised the capital, contacted customers and marketed the product.

Hart Telephone Company joined the team effort in 1998. "We provide several different services – Hart Telephone Company, Hart Cable and Hart GlobalNet ISP," explains Michael McInerney, executive vice president for Hart. "We wanted to know how we could we expand our video product and put DSL into the marketplace. So we found mPhase

through our research. We read about their product and talked to executives there. They liked us because we're in Georgia, we have all the services they wanted to test and we were willing to try it."

Alpha and beta testing followed as GTRI engineers developed several generations of prototypes. As the testing proved successful, mPhase moved forward with plans to manufacture the product. Last summer, mPhase signed on Flextronics to manufacture the Traverser DVDDS and its consumer component, the Traverser Intelligent Network Interface (INI). The design of access electronics for use in telephone company facilities, more prototype systems and the design of a box to contain the INI were the next steps leading to mass production. This began with the manufacture of 1,000 INIs a month this past summer and is now on the increase.

Because the DVDDS is a complicated system, GTRI engineers have been working closely with Flextronics as the manufacturer implements the design specifications provided by researchers.

"These are complex products," Bohlander says. "We verify that the design has been implemented correctly and test the first boards produced. A lot of conversations have taken place to adjust the design to reduce costs and make it easier to manufacture."

The fruits of these efforts by GTRI are not only a satisfied customer in mPhase, but an increased value to its other commercial customers because of what its engineers have learned as a participant in this "virtual corporation," Bohlander adds.

Though all parties involved predict a bright future for the Traverser, they acknowledge there are still some hurdles to jump. For one, most television programming is still delivered to distributors in analog, rather than digital, format. Though that conversion is expected to occur eventually, mPhase officials have recognized the advantage of acquiring their own source of digital TV programming now to make their product more attractive.

For the beta testing in Hart County, Hart GlobalNet downlinked digital programming - basically seven Discovery channels – from HITS (Head-end in the Sky), an AT&T venture. Also, Hart Telephone has digitized some analog programming from its cable company. To gain better control over the delivery of digital television programming for the long run, mPhase has joined with AlphaStar, which has converted an old military satellite tracking station into a commercial video uplinking facility. AlphaStar and mPhase are

arranging to jointly offer more than 50 channels of popular programming, such as that from ESPN and HBO, to telephone companies (telcos) who purchase the Traverser DVDDS. McInerney says Hart plans to purchase this service.

photo by Gary Meek

The Traverser DVDDS system has undergone beta testing at Hart Telephone Company in Hartwell, Ga. Executive vice president Michael McInerney says the Traverser allows the company to expand its customer base without further investment in infrastructure. (300-dpi JPEG version - 335k)

Then there's the time pressure and product appeal involved in beating the competition. Companies such as iMagic TV and Viagate are offering a different set of solutions with a different system architecture.

"Most competing systems are offered with VDSL (very high bit rate DSL), and we use RADSL (rate adaptive DSL)," Bohlander explains. "Because of their faster bit rate - we're at 4 to 6 megabits per second, and they're at 25-26 megabits per second – they must transmit programming over a shorter distance. We have a 12,000- to 14,000-foot range from the telephone company's node to the customer's home. They can only reach about 3,000 feet."

All the technologies have some limitations, researchers point out. While the shorter distance limits the service area for iMagic and Viagate, it also allows those companies to deliver more than one program per phone line. While the mPhase system can transmit only one program at a time over a single phone line, most newer homes have two pre-installed phone lines that could both be used to deliver two programs to two televisions equipped with Traverser INIs in a home, Bohlander says.

Klimek acknowledges the fierce competition in his industry. But he speaks without hesitation about the Traverser's potential for success.

"We feel we have an interesting niche in the market," Klimek says. "The Traverser is low cost and very robust. It can deliver up to 400 digital channels. It's not based on asynchronous transfer mode (ATM), a common transport means for telcos, nor is it software-based. The Traverser works directly through the phone system. It's a good offering."

For telcos, who have the copper wire infrastructure already in place, the Traverser is an opportunity to expand their customer base without a large investment of time and money in coaxial cable, McInerney says. "This made sense from the 'get go' to us because we've already got the (telephone wiring) infrastructure," he adds.

Bohlander explains the appeal further: "When you offer telephone companies a way to not only bring DSL and the Internet to the market, but also digital television, that really triples their revenue potential. It's our belief that if you get the nose of the camel under the tent with the video that's very attractive, then telephone companies will sell more DSL as well. DSL is getting a lot more popular, but it's still a slow sale by itself."

photo by Stanley Leary

GTRI senior research engineer Tim Strike, pictured here in his lab, and principal research engineer Dr. Ron Bohlander are working closely with Flextronics International Inc. as the manufacturer implements the Traverser design specifications provided by researchers. (300-dpi JPEG version - 610k)

Another edge for telephone companies is the limitations imposed by the power line infrastructure, says GTRI senior research technologist Tim Strike. "Cable and telephone companies lease space on power poles by the foot, and that space is limited," he explains. "So it's hard for competing cable companies to be on the same pole. Telephone companies are already there, and the company that is there first gets the customer's business."

For the consumer, Traverser's appeal is multifaceted. "It's the quality of the picture," Bohlander says. "And people tend to trust their telephone supplier to provide reliable service. Also, you get local channels without having to pay an extra fee or buying extra hardware like you have to do with satellite television. It's the simultaneous delivery of telephone service, digital television and high-speed Internet."

One more point for the consumer, Klimek adds, is that the Traverser delivers high-quality digital TV on a standard television set. It does not require an expensive high-definition set. The Traverser INI will even convert its digital signal to the analog format needed by most televisions manufactured before 1998, yet still deliver digital-quality television, Bohlander adds.

If the Traverser succeeds as its developers predict, it could dramatically affect the

competition between telcos and cable companies – ultimately benefiting the rural, and eventually the urban, consumer, the virtual corporation participants say.

Beyond U.S. borders, there is interest in the Traverser from telcos in Mexico, China and Turkey, Klimek says. And one company in South Carolina is adapting the Traverser for use as an in-plant digital television training program.

Already, the Traverser has been recognized as a hot new product. It was a finalist for the SUPERCOMM 2000 trade show's SUPERQuest Most Promising New Enterprise Network Technology/Network Infrastructure Systems and Services Award this past summer.

All of that is just fine to Bill Rogers and other Hartwell beta testers, but the real proof of the pudding is the Traverser's reliable delivery of the services they need and want. "I just want my ESPN," Rogers admits.

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ResearchHorizons

The Sound of Deadly Danger

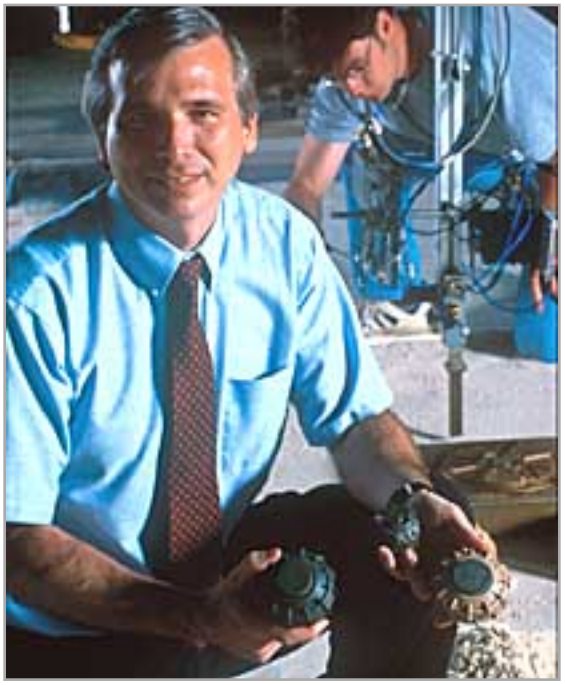
Researchers combine acoustic waves with radar to detect buried land mines.

By John Toon

By simultaneously using sound waves to create tiny soil disturbances and precision radar to measure the resulting movement, researchers at the Georgia Institute of Technology have developed a new method for detecting land mines buried in the soil.

The technique could be combined with other advanced location methods to create a new generation of land mine detector able to find different types of buried weapons across a broad range of soil and environmental conditions. The work was sponsored by the U. S. Army Research Office and the Office of Naval Research, and was described at the 139th meeting of the Acoustical Society of America in Atlanta in June.

photo by Gary Meek



With more than 100 million land mines buried throughout the world causing some 26,000 injuries and deaths each year, the stakes are high. But existing mine detectors do not work under all conditions, and have particular difficulty finding small anti-personnel mines made mostly of plastic.

"Detecting land mines is a very difficult thing to do," says Dr. Waymond Scott, an associate

professor in Georgia Tech's School of Electrical and Computer Engineering. "Every existing method for mine detection has conditions under which it will work very well and conditions under which it will fail."

Dr. Waymond Scott shows examples of the deactivated low-metal mines that can be detected with the experimental system shown behind him. The mines range in size from tiny anti-personnel weapons to anti-tank mines nearly a foot in diameter.

Scott and collaborators Peter Rogers, Gregg Larson, James Martin and George McCall – all of Georgia Tech's School of Mechanical Engineering – use a transducer to create seismic waves that travel through the soil containing land mines. This special class of elastic waves causes the soil and everything buried in it to be displaced slightly.

That tiny movement in the surface of the soil – less than one micrometer (one ten-millionth of an inch) – can be detected by electromagnetic waves from a small radar system that scans just above the surface of the soil.

"The properties of the mine are very different from the properties of the soil around it," Scott explains. "That causes the displacement around the mine to be different from the soil, because of a very strong interaction of the waves with the mine."

The technique differentiates mines from other buried objects, such as rocks or sticks, because of the different mechanical properties of the mines. The interaction and unique resonance created by the waves interacting with the mines' hollow shell and their complex trigger and explosive mechanisms make them stand out from other solid objects.

This ability to differentiate mines from other buried objects reduces the risk of false alarms, and could give the new technique an advantage over other detection methods.

"There are so many things in the ground that can look like mines," Scott says. "The problem is often not finding the mine, but differentiating it from the clutter around it."

The technique has been shown to sense soil movement through light vegetation and ground cover such as pine straw, and may be able to sense soil movement through denser ground cover.

Using a pit containing 50 tons of damp sand, the researchers have demonstrated they can detect seven different types of buried mines. The deactivated weapons range from small anti-personnel mines just a few inches in diameter planted near the surface to much larger anti-

tank mines buried more deeply.

These experimental results closely match computer modeling done to help the researchers understand the complex interaction between the elastic waves in the soil and buried objects.

Before the technique can be practical, however, researchers have many hurdles to overcome. First, they must study the wave interaction in many different soil types and environmental conditions. Now, for instance, the elastic waves have only been studied in damp compacted sand. Different soil types and conditions may require different frequencies and adjustments to detection methods.

The detection process must also be made much faster. To facilitate that, the researchers have begun developing a beam-forming array that would eliminate the need for the radar to make several scans above the soil surface. They are also considering an ultrasonic technique for detecting soil displacement.

photo by Gary Meek

Using a pit containing 50 tons of damp sand, Georgia Tech researchers have demonstrated they can detect seven different types of buried land mines. Dr. Gregg Larson, left, Dr. Waymond Scott, right, and graduate student Christoph Schroeder, background, are detecting the deactivated weapons by simultaneously using sound waves to create tiny soil disturbances and precision radar to measure the resulting movement.

The waves now must be propagated by a transducer source placed in contact with the soil. The researchers are investigating non-contact wave sources, such as an electric arc, loudspeaker, microwave, laser and water jet.

The system will also have to be made portable and robust enough to work reliably under rough field conditions.

Ultimately, Scott expects the acoustic-electromagnetic detection method to be combined with other technologies, such as detectors that sniff the chemicals given off by explosives in the mines, existing metal detectors and ground-penetrating radars. He believes only a combination of methods will offer reliable results over a wide range of devices and conditions.

The combined acoustic-electromagnetic detection technique had been proposed as far back as the 1960s, but only recently has technology become available to do it.

"The complicated structure of the soil makes it difficult to detect buried mines," Scott explains. "You could put this mine 1,000 miles out in space and be able to detect it more easily than if you put it one centimeter under the soil. That's because space is a more uniform medium."

The researchers hope to field test a prototype system within several years, but say it will be longer before the technique can be used to locate and remove the live mines buried worldwide.

Also participating in the research are Christoph Schroeder, Ali Behboodian, Kangwook Kim, Seungho Lee, Andrew Overway and Cheng Jia, in the School of Electrical and Computer Engineering, and Blace Albert, Fabien Codron and Andrew Slack from the School of Mechanical Engineering.

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ResearchHorizons

Sorry, Wrong Number

Century-old math rule ferrets out modern-day digital deception.

By T.J. Becker

Tempted to fudge some numbers on your tax return? Better not. Benford's Law might catch you.

Once considered a mathematical oddity, this century-old rule is causing a stir in fraud-busting circles, thanks to Dr. Ted Hill, a Georgia Tech mathematics professor whose 1996 proof paved the way for numerous real-world applications. From financial documents to clinical trials, Benford's Law is becoming a valuable tool to smoke out cheaters.

photo by Gary Meek

To illustrate the probability theory behind Benford's Law, mathematics professor Dr. Ted Hill, center, and students toss the dice. Hill constructed a rigorous mathematical proof of Benford's Law, which maintains that certain digits will show up more often than others in certain sets of data. Benford's Law has numerous real-world applications, including income tax fraud detection. (300-dpi JPEG version - 326k)

What's known in mathematical lingo as a "probability distribution," Benford's Law maintains that certain digits will show up more often than others in certain sets of data. For example, "1" should appear as the first non-zero digit about 30 percent of the time, "2" as the leading digit about 18 percent of the time and "9" only 4.6 percent.

"It's not so surprising to have digits show up unequally, but it is striking to have a law that predicts their exact distribution," Hill says. Frequencies of following digits can also be predicted ("0" is the most likely second digit, showing up about 12 percent of the time),

however, digits become increasingly more uniform deeper into the number.

The phenomenon was first noticed in 1881 when astronomer and mathematician Simon Newcomb observed that logarithm books displayed more wear and tear in the opening pages, indicating that people were looking up more numbers that began with 1 than 2, and more that began with 2 than 3. Newcomb proposed a formula to express the phenomenon: Probability (first significant digit = d) = log (1 + 1/d).

Newcomb published an article about his discovery, but it attracted little attention. Then in 1938, General Electric physicist Frank Benford independently made the same observation. Yet Benford went further. Drawing upon 20,229 observations, he found the significant digit rule holds in mixtures of many different sets of data: drainage areas of rivers, atomic weights of elements, American baseball statistics – even numbers pulled from newspaper pages.

Though Benford's paper sparked considerable interest – causing him to become the law's namesake – there was no real proof. "It was treated like a gimmick," Hill says. "No one could explain why it happened or predict when it would happen, so people didn't take it seriously."

Hill, who specializes in mathematical probability, became interested in Benford's Law in the early 1990s, when preparing for a speech on surprises in probability. What began as a recreational experiment quickly turned into a full-fledged academic pursuit.

Many mathematicians had tackled Benford's Law over the years, but a solid probability proof remained elusive. In 1961, Rutgers University Professor Roger Pinkham observed that the law is scale-invariant – it doesn't matter if stock market prices are changed from dollars to pesos, the distribution pattern of significant digits remains the same.

In 1994, Hill discovered Benford's Law is also independent of base – the law holds true for base 2 or base 7. Yet scale- and base-invariance still didn't explain why the rule manifested itself in real life. Hill went back to the drawing board. After poring through Benford's research again, it clicked: The mixture of data was the key. Random samples from randomly selected different distributions will always converge to Benford's Law. For example, stock prices may seem to be a single distribution, but their value actually stems from many measurements – CEO salaries, the cost of raw materials and labor, even advertising campaigns – so they follow Benford's Law in the long run.

Hill constructed a rigorous mathematical proof in 1996 that finally gave Benford's Law the credibility it needed.

As a result, the nearly forgotten rule is winning new exposure. Benford's Law is being put

to work in a number of areas, such as mathematical modeling and computer design.

Perhaps its most intriguing application is fraud detection, an idea introduced by Southern Methodist University accounting Professor Mark Nigrini. The U.S. Institute of Internal Auditors is conducting classes on how to apply Benford's Law. Hill has done preliminary consulting for both the IRS and the International Institute for Drug Development in Brussels, which is interested in using the law to reveal fabricated data in clinical trials.

In the past, certain "red flags" were used to detect fraud, but few statistical tests like Benford's Law existed to ferret out fakers. "When people fabricate data – either for fraudulent purposes or just to fill in the blanks – their conception of random numbers doesn't match reality," Hill explains.

Case in point: Hill asks his students to either (1) flip a coin 200 times and record the pattern of "heads" or "tails", or (2) simply make up results. The next day he stuns the class by separating the faked data from true trials at a glance. No psychic feat, just a little probability theory at work. A sequence of 200 random coin tosses has a high probability of containing a run of six heads or tails. When people try to fake results, they rarely include such long runs.

Hill travels extensively, talking about Benford's Law and probability theory to groups that range from university professors to senior citizens to Boy Scouts. This outreach program is part of a $500,000 grant from the National Science Foundation (NSF). Through a separate NSF grant, Hill is also continuing research on a number of probability topics including Benford's Law. "One of the beauties of NSF is that it takes chances on individuals and ideas that are not always part of the mainstream," Hill says.

Although a solid scientific explanation now exists for Benford's Law, there are still some loose ends to tie up, such as:

1) Determining how much information (how many different types of distributions and samplings from each) is needed for the law to kick in.

2) Picking a probability measure at random: Finding a good model will give indications of the speed of convergence to Benford's Law and the deviations one might expect.

3) Trying to understand why certain dynamical systems follow Benford's Law. A number of physicists have contacted Hill, finding their data often follows the rule; an oceanographer studying plankton found two families conformed to the law, while one did not.

Despite the flurry of attention resulting from his proof, Hill deems it "a relatively small

idea – it's not at all my deepest theorem or one I'm most proud of." Still, as a theoretical mathematician, it's rare to have a real-life application, he points out. "It's thrilling to make a small contribution to society."

A West Point graduate and former U.S. Army Ranger captain, Hill holds a master's degree in operation research from Stanford and a Ph.D. in mathematics from the University of California at Berkeley. A dedicated adventurer, Hill says: "If I'm working on a math problem, it has to be as interesting as diving in the Yucatan."

And in probability theory, there's never a dull moment. "Math is extremely exciting right now," says Hill, noting that computer technology allows exchange of ideas and research to accelerate exponentially. "Science is just bursting.... We are entering an unprecedented age of discovery."

> **For more information,** contact Dr. Ted Hill, School of Mathematics, Georgia Tech, Atlanta, GA, 30332-0160. (Telephone: 404-894-4408) (Email: theodore.hill@math.gatech.edu)

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ResearchHorizons

Twister Technology

The Severe Storms Research Center is developing new technologies to increase tornado warning time for Georgia citizens.

By Jane M. Sanders

Though this year's tornado season in Georgia was not as active as the past few years, researchers at Georgia Tech are busy analyzing the weather data they collected from several twisters that hit the state this past spring. They hope this information will help them improve current storm detection technology, while they also create new methods to increase warning time.

Researchers at the Severe Storms Research Center (SSRC) at Georgia Tech completed their first tornado season since installing three state-of-the-art Warning Decision Support Systems (WDSS) in metro Atlanta early this year – two at Georgia Tech and one at the National Weather Service office in Peachtree City, Ga. Researchers are using these systems to determine if the WDSS tornado recognition logic can be better "tuned" to the tornadoes of the Southeast.

National Oceanic & Atmospheric Administration

"Tornadoes in Georgia and elsewhere in the Southeast are often short-lived events," says Gene Greneker, director of the

SSRC. "Here, tornadoes can come and go in 10 minutes, as opposed to an hour in Kansas."

The National Severe Storms Laboratory developed the Warning Decision Support System technology for early detection of tornadoes. Researchers at Georgia Tech are tweaking it to account for differences in tornadoes in the Plains, such as the one shown here, and in the South. Tornadoes in the South are shorter-lived.

WDSS technology – which includes advanced image processing, artificial intelligence, neural networks and other algorithms that use Doppler radar data – was developed at the National Severe Storms Laboratory in Norman, Okla. There, studies showed a 50 percent increase in warning time for tornadoes, severe thunderstorms and flash floods in Great Plains states.

"Another goal of the SSRC is to fund the development of new technologies that may be able to detect the early formation of tornadoes," Greneker says. "If we are successful, these technologies could complement the Doppler radars operated by the National Weather Service."

Complementary technologies being developed by Georgia Tech researchers are:

- early detection of tornadoes based on the "acoustic signatures" they produce and on the correlation between tornado occurrence and pre-storm thunder activity. Dr. Krishan Ahuja, a professor of aerospace engineering and a Regents Researcher at Georgia Tech Research Institute (GTRI), is trying to determine whether there is a correlation between tornado sound and the rotational speed of tornadoes as they materialize. If so, researchers could determine an "acoustic signature" that would predict tornadoes before they actually form.

- early detection of tornadoes based on a pattern of increasing electrical discharges produced by cloud-to-cloud lightning strikes. Dr. Tom Pratt, a senior research engineer at GTRI, has developed a first-generation lightning detection system that provides range, direction and radio frequency signatures associated with lightning activity in severe thunderstorms. He plans to fine tune the system by integrating additional sensors, including acoustic devices, into the system, and by developing advanced processing and analysis capabilities to improve total lightning detection and discrimination.

- a more meaningful 3-D severe thunderstorm display that is designed with human perception capabilities in mind. GTRI principal research scientist Nick Faust has created an integrated visualization of 3-D Doppler radar and global, high-resolution terrain – representing the first time such data have been displayed together in real time. This system also provides integrated browsing and analysis, and integration of relevant data, such as buildings and maps. The latter capability will grow in importance as researchers develop sophisticated models of storm development that yield rules for how storms behave in the

presence of hills or mountains and other features, Faust reports.

• high-resolution documentation of tornado tracks based on storm path and duration information gathered at the scene. Research scientist Dr. Jim St. John, of the School of Earth and Atmospheric Sciences, is creating a detailed database called the Tornado Track Survey. The database contains tornado start and end points, as well as detailed descriptions of damage caused by the storm. St. John uses global positioning system receivers to pinpoint locations along the storm track, and he shoots digital images to record damage at each point. This information is then available to other researchers for comparison to radar or other data to investigate characteristics and evolution of tornadoes.

• more effective tornado detection algorithms than are currently part of WDSS. Principal research engineer Dr. Mark Richards and senior research engineer Vince Sylvester, both of GTRI, want to make radar smarter using advanced signal processing techniques. These will clarify the system's often-indistinct display of a tornado's rotating wind pattern. The researchers are also applying new target recognition methods to detect tornadoes and their precursors. In addition, they are studying potential sites for an experimental radar station in north Georgia, parts of which are underserved by existing stations, the researchers say.

"While these technologies are experimental, they are promising," Greneker says. "They will continue to be tested."

After the WDSS technology has been tested in north Georgia, it will be exported to south Georgia as funding permits, Greneker says.

The SSRC's research is being funded by the Georgia Emergency Management Agency, the Federal Emergency Management Agency, the Georgia General Assembly and a grant from BellSouth Business Systems.

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Research Horizons

Out of Time

Researchers recreate 1665 clock experiment to gain insights into modern synchronized oscillators.

By John Toon

While recovering from an illness in 1665, Dutch astronomer and physicist Christiaan Huygens noticed something very odd. Two of the large pendulum clocks in his room were beating in unison, and would return to this synchronized pattern regardless of how they were started, stopped or otherwise disturbed.

An inventor who had patented the pendulum clock only eight years earlier, Huygens was understandably intrigued. He set out to investigate this phenomena, and the records of his experiments were preserved in a letter to his father. Written in Latin, the letter provides what is believed to be the first recorded example of synchronized oscillators – a physical phenomenon that has become increasingly important to physicists and engineers in modern times.

photo by Gary Meek

More than 300 years after Huygens' letter, physicists at the Georgia Institute of Technology have recreated his original experiment. Beyond the historical curiosity, the researchers hope this straightforward mechanical system of gears, springs, weights and levers may help them gain insights into more modern and complex synchronized oscillators.

"Having a system available that lends itself to an intuitive and physical understanding could be quite useful," says Dr. Kurt Wiesenfeld, a Georgia Tech physics professor. "We might be able to learn how this system is like laser systems or superconducting electronic systems. If there are general mechanisms affecting coupled oscillators, then perhaps we can learn about these mechanisms by using the clocks as mechanical analogs for electronic systems."

Dr. Kurt Wiesenfeld and Dr. Michael Schatz are reflected in the pendulum bob of one clock they are using to recreate the 1665 experiment done by Dutch astronomer and physicist Christiaan Huygens. (300-dpi JPEG version - 356k)

In particular, Wiesenfeld says the clocks may offer a new way to look at a type of electronic device known as a Josephson Junction.

"It's a very old-fashioned idea, not the way people who study coupled oscillators have been thinking about nonlinear dynamics over the past decade or so," he adds. "Classical physics still has things to teach us."

The system under study consists of two spring-powered pendulum clocks attached to a wooden platform with metal weights added. The platform is set on wheels, free to move along a level metal track. Though the clocks are much smaller than those built by Huygens, the relationship between the masses of the pendulum bobs and that of the overall platform is similar. The clocks' period – time between ticks – is also approximately the same.

The modern clock system includes a feature not available to Huygens: laser monitoring that records the pendulum swings for computer analysis.

So far, the clocks have shown an ability to synchronize only in anti-phase – that is, with their pendulums swinging in opposite directions. This is true even when the pendulums are started in-phase – swinging in the same direction. The 1665 letter recounts that Huygens also observed only anti-phase synchronization, helping confirm that the Georgia Tech researchers have successfully duplicated his experimental conditions.

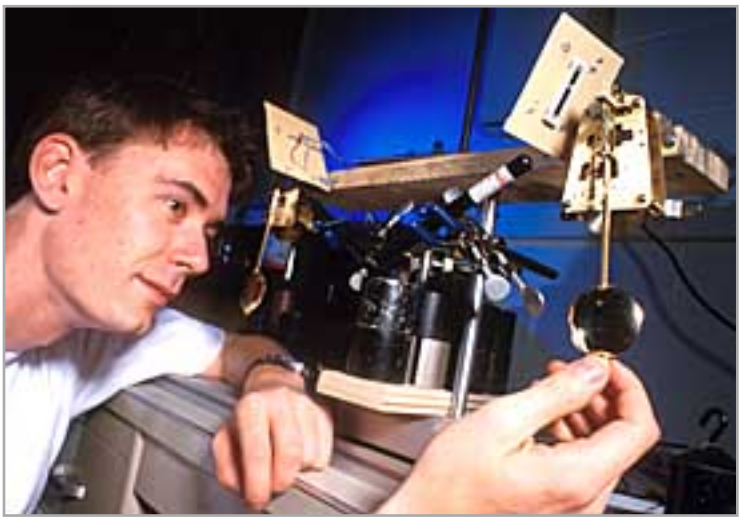
But the Georgia Tech clocks also display behavior Huygens did not describe: what the researchers call "amplitude death." Instead of synchronizing, one or both pendulums ultimately stop moving altogether. This becomes more likely as weight is removed from the platform carrying the clocks.

Working 20 years before Sir Isaac Newton formulated the now-familiar laws of mechanics, Huygens was hampered in his ability to explain what he saw. Because the clocks are attached to a platform able to move, Huygens suggested that the swinging of the pendulums somehow caused the platform to move "imperceptibly." He also ruled out

other theories, including the possibility that air currents caused the synchronization.

Unlike Huygens, Wiesenfield and collaborators Dr. Michael Schatz and undergraduate student Matthew Bennett do have theories to explain what they see.

photo by Gary Meek



Matthew Bennett restarts the pendulum of one clock in the experiment being used to study synchronized oscillators. These clocks – like those of Christiaan Huygens 335 years ago — synchronize in an anti-phase state, with their pendulums swinging in opposite direction. (300-dpi JPEG version - 356k)

"In modern terms, the general motion of pendulums can be roughly described as a combination of in-phase and anti-phase synchronized motions, which are 'normal modes,'" explains Schatz, an assistant professor of physics. "A key feature of our understanding of Huygens' clocks is that the in-phase motion doesn't couple to the platform in the same way as the anti-phase motion. In-phase motion can drive the very small platform movement, which drains energy out of the system through friction between the platform and the surface on which it rests."

But when the clocks are synchronized in anti phase, the swinging pendulums balance each other, generating no movement in the platform. This conserves their energy, thus, providing a mechanism for favoring anti-phase motion by the system, he suggests.

"The heavier the platform, the smaller the coupling between the two clocks," Schatz says. "If it's really heavy, the platform doesn't move at all, and there is no coupling and no synchronization. But on the other hand, if the platform is too light, and there is too much motion, it will damp out the clocks' energy and create 'amplitude death.' "

Despite the differences introduced by improved clock-making, the fact that both systems display stable anti-phase synchronization shows the robustness of that feature, Wiesenfeld points out.

Recreating the system required considerable research that spanned not only 335 years, but also two languages. Dr. Heidi Rockwood, chairwoman of Georgia Tech's Department of Modern Languages, worked with Wiesenfeld to decipher the original Latin – which was not as scientifically clear as the researchers had hoped.

"Only with Kurt's help did some of the passages make sense," Rockwood says. "Since he understood the physics, he could ask questions like, 'could this mean such-and-such?' And then things often fell into place." From Rockwood, Wiesenfeld learned that the Huygens letter actually described two different experiments.

But questions remain. "There's a lot of detective work in this," Wiesenfeld says. "You can get some pieces of it, but you're not sure what to fill in. The more you think about it, the more you can imagine other possibilities."

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ResearchHorizons

Better Buildings, Stronger Structures

Structural design and analysis software adapted at Tech benefits engineers and the public.

By Jane M. Sanders

Ten thousand pounds of bells are safely swinging in the belfry of St. Luke's Episcopal Church in downtown Atlanta. Down the street, business people go about their work in the high-rise offices of One Peachtree Plaza. Across the globe, cars and trains travel from Denmark to Sweden across the world's longest cable-stayed bridge. And in China, citizens light their homes with power generated by the Three Gorges hydroelectric project.

These structures have all been made better, in large part, because the engineers who designed them used GT STRUDL™ software, a structural analysis and design computer program. GT STRUDL, which stands for Georgia Tech Structural Design Language, has been under continuous development for the past 25 years at the Georgia Institute of Technology.

The original STRUDL program was created in the late 1960s at the Massachusetts Institute of Technology (MIT) to operate on an IBM mainframe computer. Subsequently, GT STRUDL (based on MIT STRUDL) was written for Control Data Corporation's mainframe – and subsequently other platforms – by Georgia Tech civil engineers beginning in 1975. Today, GT STRUDL is used by thousands of engineers daily in about 900 firms and 39 countries. It takes engineers' initial ideas, performs mathematical calculations and rapidly predicts how a structure would behave under a variety of loads and stresses.

photo by Gary Meek

GT STRUDL co-developers Drs. Leroy Emkin and Kenneth Will have devoted the past 25 years of their careers to the structural design and analysis software, which is used by engineers worldwide. One Peachtree Plaza in Atlanta, shown here, is among the many structures designed with the assistance of GT STRUDL. (300-dpi JPEG version - 347k)

"We transfer cutting-edge technology in civil/structural engineering into the practicing engineering profession to the direct benefit of society," says Dr. Leroy Emkin, one of GT STRUDL's initial developers and a professor of civil engineering. "Our primary goal is improving the quality of life through structures designed with the assistance of GT STRUDL."

Though the general public doesn't always associate its quality of life with the safety and durability of its civil structures, Emkin sees a clear connection. "High quality engineering, aided by a powerful computer program, creates a winning combination," he says.

In its quarter-of-a-century history, GT STRUDL has had a successful career and a broad impact. It is the largest gross revenue-producing technology ever licensed by Georgia Tech, generating more than $25 million since 1978.

The program has been used throughout the world to analyze and design a variety of structures. "I am constantly

photo by Gary Meek

GT STRUDL contains a graphical user interface to create models and display results, including some in 3-D and others with animation. (300-dpi JPEG version - 167k)

amazed at the types of structures – both traditional and non-traditional – for which GT-STRUDL is used," says GT STRUDL co-developer Dr. Kenneth "Mac" Will. "They include everything from buildings to bridges to nuclear power plants." Other examples include towers, flood control dams, offshore platforms, highways and even an F-22 missile launcher.

One GT STRUDL user cites his rather simple, yet unusual, use for the program. Craig Bennett, a Georgia Tech graduate and engineer with Cummings & McGrady Inc. in Charleston, S.C., recently used GT STRUDL to determine the structural response of St. Luke's Episcopal Church's nearly 100-year-old bell tower to the swinging of 10,000 pounds of new bells. The program allowed Bennett to redesign the structure to meet the needs of good bell control, i.e. with movement at the belfry level limited to about one thirty-second of an inch.

"This project would have been very difficult to do only by hand," Bennett says. "I always do hand checks on everything to see if the numbers are realistic. In this case, I developed my analyses in rough form using hand checks, then put them in a simple GT STRUDL model that led to a series of finer and finer models until I had confidence in the final model."

Bennett has used GT STRUDL in numerous other historic renovation projects. GT STRUDL has always delivered superb results, he says.

Engineers can conduct a variety of analyses with GT STRUDL; these include static, dynamic, linear, non-linear, frame and finite element analyses. On the design side, GT STRUDL is used for creation of steel frame and reinforced concrete structures. The program contains a graphical user interface to create models and display results, including some in 3-D and others with animation. And GT STRUDL has a powerful menu system that enables the user to describe problem-solving requirements.

"GT STRUDL is recognized worldwide as the leading civil/structural engineering software," Emkin says, "measured in terms of functionality, depth of technology, breadth of technology, quality related to the accuracy of its computations, and performance. In fact, GT STRUDL is among a very few such programs in the world whose quality of software development and operation fully conform to the stringent requirements of the applicable provisions of the United States Nuclear Regulatory Commission's 10CFR21 and 10CFR50 quality standards. And we believe that we are also the leader in technical support services, such as education and training in the effective uses of computers for civil and structural engineering applications."

In fact, a 1998 article in Modern Steel Construction Magazine compared GT STRUDL to two other similar software programs. The magazine rated GT STRUDL highest in ease of learning, documentation, ease of data input, expectations, accuracy and productivity. The Tech program also received the magazine's highest overall rating.

Users also give high marks to GT STRUDL. John Bryson, a civil engineer at Parsons,

Technology Dependence

Software developer warns structural engineers of computer misuse.

Structural engineers, beware of depending too heavily on computers and software to perform structural analyses and design, says a Georgia Tech civil engineering professor and software creator. The results of misusing computers and software could threaten the public's safety.

Dr. Leroy Emkin, co-developer of GT STRUDL, a popular structural analysis and design program, is so concerned about the issue that he delivers written warnings to GT STRUDL users.

"You can't simply focus on the benefits of technology without also paying careful attention to the dangers associated with the misuse of that technology. We give equal weight to both," Emkin says in regard to the irony of the warning he issues.

The Georgia Tech Computer Aided Structural

Brinckerhoff, Quade and Douglas Inc., a large engineering firm headquartered in New York City, frequently uses GT STRUDL for static and dynamic analyses, most recently with a 1,550-foot suspension bridge project in Canada. The Lions Gate Bridge in northern Vancouver is being restored in 52 sections, with workers making the repairs at night and drivers continuing to use the bridge during the day.

"GT STRUDL is a good program," Bryson says. "It's one of the three better programs for this type of work. I am using it for analysis of very complicated structures."

Meanwhile, at John Portman & Associates Inc. in Atlanta, Housh Rahimzadeh uses GT STRUDL for 3-D frame analysis of complicated buildings. "We design many buildings with sophisticated geometry," Rahimzadeh says. "GT STRUDL is one of the best ways to cope with this geometry, and it gives us an accurate result.... The program can model the building like it is actually designed."

Rahimzadeh points out two other benefits of GT STRUDL. One, its analyses often result in savings on framing. And two, it was the first program, and the only one for many years, that could perform analyses based on a sequence of construction. This is an important factor in many of the high-rise building projects designed by Portman, he explains.

photo by Oresundsbro Konsortiet

The recently completed Oresund Link Bridge, which crosses the main channel of a 10-mile span of water and small islands between Denmark and Sweden, was designed with the assistance of GT STRUDL. It is the world's longest cable-stayed bridge that carries both rail and vehicle traffic. (300-dpi JPEG version - 663k)

Another example of GT STRUDL's value to complicated projects is its use in designing and analyzing the recently completed Oresund Link Bridge, which crosses the main channel of a 10-mile span of water and small islands between Denmark and Sweden. Designed by a group of European firms, the Oresund is the world's longest cable-stayed bridge that carries both rail and vehicle traffic.

"This project involved an incredibly complex analytical process – both linear and non-linear and static and dynamic analyses, as well as a simulation of the sequence of construction," Emkin explains. "There are very few structural engineering and design programs in the world capable of this type of work."

Another GT STRUDL user likes the program's capabilities and technical support. "GT STRUDL is a better quality program than others that are available," says Henry Fix, a senior engineer for Frederic R. Harris Inc. in Philadelphia. "It is stable in performance.... I have very high praise for GT STRUDL's user support. If I have an analysis problem that I can't get my hands around, the tech support people usually have ideas on how I can get the model to do what I want to achieve. The program has broad capability from basic to

Engineering (CASE) Center, which manages the technical aspects of GT STRUDL, distributes an introductory packet that includes Emkin's lengthy article on the misuse of computers by structural engineers. The warning was prompted by a "disturbing trend" in engineering practice that CASE Center researchers have observed over the past 25 years, Emkin says.

"Engineers appear to be depending more and more on computers to perform engineering computations and then using those solutions from the computer without proper validation," he says. "... Solving engineering problems does not require a computer. Humans were solving engineering problems for hundreds of years before we had computers."

Emkin defines misuse as: excessive dependence on the computer to deliver solutions to engineering problems; use of the software by people without enough experience in structural engineering practice; and expectations that the software will deliver a solution without validating it by some means independent of the computer.

He advocates "the brute force method of direct, intimate and intensive involvement of competent human engineers in the details of computation" before engineers turn to a computer software program for perhaps a better solution to a structural problem.

"Computers can be a significant benefit in helping

advanced analysis."

an experienced engineer find a better solution, but engineers must first have the skills to solve engineering problems without a computer," Emkin says. "Then they can use a computer to get an even better solution – one that has improved safety, is more cost-effective, performs better and provides more functionality."

— Jane M. Sanders

Emkin and Will, who manage GT STRUDL development activities in the School of Civil and Environmental Engineering's Computer Aided Structural Engineering (CASE) Center, attribute GT STRUDL's success to one primary factor. Since its inception, it has been developed and technically supported in house, rather than relinquishing control to a commercial third party. It is the only academically based program of its kind.

photo by Pierre Mens

Engineers work on the Oresund Link Bridge. It was one of the most complicated structures ever designed using GT STRUDL. (300-dpi JPEG version - 856k)

Emkin and Will believe having this control maximizes the benefit to the educational process at Georgia Tech. "It maximizes our opportunity to do fundamental research into numerical methods," Emkin says. "Then we implement the results of that research into a technology that can be transferred into practice and provide a direct benefit to the profession and to society."

Will adds: "CASE control of GT STRUDL is the most effective and timely way of disseminating relevant research results to practicing civil engineers. Technology transer through GT STRUDL software eliminates the delays that occur with traditional technical publications."

"Software is one of the best ways to deliver knowledge," Emkin says. "There is a great benefit to society and the quality of life when that knowledge is delivered in a timely fashion and is properly used."

For more information, contact Drs. Leroy Emkin and Kenneth Will, School of Civil and Environmental Engineering, Georgia Tech, Atlanta, GA 30332-0355 (Telephone: 404-894-2260) (E-mail: leroy.emkin@ce.gatech.edu or kenneth.will@ce.gatech.edu)

ResearchHorizons

Virtual History

City planning professor recreates the action of Civil War battlefields using computer mapping technology and the Internet.

By Maria Lameiras

Confederate Pvt. Fleet Johnson fought in many of the Civil War's major battles – Fredericksburg, Chancellorsville, Gettysburg, Wilderness, Spotsylvania, Cold Harbor – but it was a chance encounter with a famous general that led to his death on an obscure battlefield in Virginia.

Johnson was with the battle-tested 7th North Carolina Infantry unit at Gravel Hill, Va., when the unit attacked a column of Union Cavalry, expecting the unit to fall back, as most cavalry units would not engage in ground fighting. But the commander of this particular cavalry unit was Gen. George Custer. A fierce fighter who expected the same from his men, Custer and his unit counterattacked and drove the Confederate infantry unit back. Johnson was killed in the skirmish at First Deep Bottom.

photo by Alan David

This arcane bit of Civil War history might have been lost to

modern knowledge if not for the persistence of Dr. Bill Drummond, an associate professor of city planning in the Georgia Institute of Technology's College of Architecture.

Civil War photographer George Barnard's battlefield (top) – taken during Sherman's Atlanta campaign – is now part of the Georgia Tech campus (bottom). (TOP - 300-dpi JPEG version - 555k) (BOTTOM - 300-dpi JPEG version - 605k)

Drummond, his wife Laura and their son Jonathan, now 7, were touring Civil War battlefields in 1996 when they decided to find where Laura's great-great-grandfather, Fleet Johnson, had fallen in battle.

"Well, I have a Ph.D., and my wife has a master's in library and information science, and yet between the two of us, we could not locate where Fleet Johnson had died until we went to the actual park where it happened. There, the person at the desk knew who the Deep Bottom expert was. They pulled that park ranger out of a staff meeting to talk to us," Drummond recalls. "He pulled out his own, hand-drawn map to show us where the spot was."

Drummond was amazed at the combination of tenacity and luck it took to make the discovery, so he pondered how to make it easier for others to trace the paths of their ancestors who fought in the Civil War.

"There is an incredible amount of expertise in the heads of the rangers and historians at these parks, but unless they happen to write a book, that expertise stays in their heads," Drummond says. "... I was interested in finding a way to codify this informal knowledge so it can be passed on from person to person and generation to generation."

So Drummond is now working to preserve battlefields in the Fredericksburg and Spotsylvania National Military parks using geographic information systems (GIS) to map and codify the battlefields for posting on the Internet. He believes his work could help save Civil War battlefields that are in danger of development.

"GIS will not only make it easier for people to find where their relatives marched and fought and died, but it also may preserve Civil War landscapes by making the connection between people today and what happened there 135 years ago. That connection between past and present makes people want to preserve these areas," he says.

Drummond – whose own great-grandfather, Inslee Deaderick, was a Confederate cavalry trooper who survived the war – was dismayed at the thought that encroaching development might prevent his son from showing his descendants where their ancestors had fought. That is when Drummond's personal interests and professional life juxtaposed, and he began working on GIS software that would accomplish the task.

"Geographic information systems are well-suited to some applications, like mapping parcels and doing environmental analysis," Drummond says. "But they are not particularly well-suited for applications such as showing troop movements in the Battle of Chancellorsville because GIS doesn't deal with changes over time particularly effectively. What I had to do was develop new approaches and GIS methodologies to accommodate some of the unique historical challenges of mapping a battlefield."

After a year of work, Drummond developed prototype systems and aspects of systems for Civil War sites in Georgia at Kennesaw Mountain, Chickamauga, Resaca and Ringgold. That led to his current site work in Virginia, which uses the same technology on an expanded scale, integrating multimedia applications.

Drummond is collecting primary- and secondary-source information in the form of written histories, officers' and soldiers' accounts, and photos from each battle, then linking them to the maps for each battlefield.

"The fascinating thing about the Civil War is that for almost any unit you trace, you will find facts that would add life and color and interest to the maps," Drummond says. "Right now, you can discover these things if you know where and how to look for them and are persistent, but what interests me is thinking that a junior high or elementary school student, using this system, could discover these things as well."

At Fredericksburg and Chancellorsville, Drummond is compiling a detailed account of the battles that took place there, researching what troops fought and mapping their positions during the battles. Using GIS, Drummond then creates maps that not only show static troop positions, but also recreate a battle by showing troop movements across the landscape over time. "Once you do the initial database that has troop locations and times, you play it as an animation and compare what you see to what is in the sources. Then you make changes or add additional routes if it is obvious that two units should have been together or should fight," he explains. "You go through several cycles of that before the results seem reasonable and likely."

The work is a blend of traditional GIS applications, planning and history, a combination uniquely suited to Drummond's credentials. He earned his undergraduate degree in history from Duke University, then earned master's degrees in divinity and theology from Duke. After serving as a Presbyterian minister for two years in Pittsboro, N.C., he became

interested in city planning after befriending the county planner, who attended his church. Drummond returned to school and earned his doctorate in city and regional planning from the University of North Carolina at Chapel Hill.

"I had to read a lot of Civil War historical narratives and primary-source materials, as well as historical methodology on how to reconstruct battles from bits and pieces from letters and officers' after-battle reports," Drummond recalls.

The educational potential of the project surpasses any printed material, Drummond says. Using information already available, as well as a roster being developed by the National Park Service of all 4 million Civil War soldiers and their units, it will someday be possible for someone on the Internet to type in the name of a soldier, then jump to a battlefield to see where that unit marched and fought.

courtesy of Dr. Bill Drummond

This Geographic Information System image plots Civil War troop movements on the first day of the battles of Chancellorsville, May 1, 1863. (300-dpi JPEG version - 356k)

"When you do traditional history, there are space limitations, and color maps are incredibly expensive. Through the Internet, however, every piece of primary-source information ultimately will be in the database, and people whose ancestors may have fought in the 12th Virginia Infantry will be able to see where they fought," he explains.

To give the battle maps modern relevance – particularly in an area like Atlanta, where the battlefields have been wholly developed – Drummond uses GIS to lay the historical maps over modern parcel, road and topographical maps.

For instance, a map of 1864 Atlanta at Drummond's Civil War mapping site (http://www.civilwar.gatech.edu) shows where fortifications were located and sieges took place. It also features buttons linked to Civil War era and modern photographs at certain map coordinates.

Several of these photos show areas that are now part of the Tech campus, including a famous photo by George Bernard of a battlefield where the Ivan Allen College now

stands, and a Confederate fort on the site of the Tech library.

"In overlaying the fortification map of Atlanta, you can see where the line went from around the Fox Theater to the Tech Tower to library hill to the Habersham Building," Drummond says. "The Union troops went along 10th Street, and in overlaying the map, it looks like there was a Federal fort on the hill on the Turner property on the other side of 10th Street from Alexander Coliseum."

Drummond is also interested in developing a three-dimensional aspect to the maps, including an interactive function that would allow users to go "into" the maps to pan and zoom into and out of the battlefields.

"I have done some 3-D images of Resaca while running the software live, and I've viewed different commercial GIS 3-D packages to get a feel for what it looks like. There might be some nice visuals we could develop," he says.

Drummond's work is being funded jointly by the National Park Service, the Spotsylvania County government and the Georgia Tech Foundation. It will be available through the Internet.

Similar work could be done on battlefields that have already been compromised. "You can do it for lost battlefields like Peachtree Creek or the Battle of Atlanta, where the areas have already been wholly developed," Drummond says. "Ultimately, I think you could image every battlefield. Every battlefield should have one."

Drummond has already begun thinking of practical uses for the type of GIS he has developed.

"I'm thinking about a general area called heritage tourism and how we might design a system that incorporates this material. Its object is to make it as easy as possible for people to discover ancestral information, whether they are in Ohio or Alaska or Indiana or Oregon. We would have links to accommodations in the area to encourage them to see these sites for themselves," he says. "Ultimately it could be an economic development tool, especially for rural communities."

For more information, contact Dr. Bill Drummond, College of Architecture, Georgia Tech, Atlanta, GA 30332-0155. (Telephone: 404-894-9840) (E-mail: bill.drummond@arch.gatech.edu)

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Send questions and comments regarding these pages to Webmaster@gtri.gatech.edu

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ResearchHorizons

Making a Difference in the Real World

Catherine Ross brings theory and practice together at transportation agency.

By Gary Goettling

When it comes to taking the measure of our lives, it doesn't matter if you're rich or poor, famous or unknown, says Dr. Catherine Ross.

"In the end, all that really matters, the only legacy any of us can leave, is whether or not we made a positive difference in the world, something linked to the public good," says Ross, a former professor of city planning at the Georgia Institute of Technology.

photo by Gary Meek

Dr. Catherine Ross, a former professor of city planning, is executive director of the Georgia Regional Transportation Authority.

That kind of big picture viewpoint is perfect for her job now as executive director of the Georgia Regional Transportation Authority (GRTA). A Georgia Tech professor for more than 20 years, Ross assumed the GRTA post in October 1999. Now, she runs a powerful state agency charged with overseeing transportation projects and major Atlanta-area developments. The agency's goal is to reduce traffic congestion and improve air quality.

Initiated by Georgia Gov. Roy Barnes, approved by the state legislature in 1999, and with backing by both business leaders and environmentalists, GRTA is supposed to reconcile local interests with the transportation needs of the region as a whole. The agency is empowered to build roads, sidewalks and rail lines, and wields veto power over major road and development

projects.

GRTA's 15-member board of directors, which decides upon the recommendations of Ross and her staff, also doubles as the Governor's Development Council with oversight for land use planning statewide.

"Almost everything I did at Tech has prepared me for this job," says Ross, whose resume includes positions as vice provost for academic affairs, associate vice president for academic affairs, co-director of the Transportation Research and Education Center, and director of the College of Architecture's Ph.D. program.

"I've had the opportunity to operate in a number of environments with varied levels of responsibility, all of which required the ability to set goals, meet deadlines, manage and chart a course," adds Ross, who spent a year as a senior policy advisor to the Transportation Research Board of the National Academy of Sciences in Washington, D.C. She was also founder and a principal of CRA Consulting until disassociating herself from the practice when she accepted the GRTA post.

"Catherine is a very talented person who has a warm and winning personality," says Georgia Tech President Dr. Wayne Clough. "She is a successful university faculty member who excels at teaching and research, a successful university administrator and a great family person. The only downside to her taking the top job at GRTA was that Georgia Tech lost the services of one of its best people."

Dr. Larry Frank, an assistant professor of city planning at Tech, says Ross is ideally suited to her task. "Catherine possesses both a strong sense of the political process and the critical relationship between good information and credible decision making."

Frank's observation is also characteristic of the more than two dozen major funded research projects that have earned Ross a national reputation in land development and transportation planning expertise. Her work has included inquiries into the interaction between land use and transportation in both urban and rural settings. She has also studied the environmental impacts of growth and conducted air-quality modeling for urban environments.

The mental discipline associated with research and teaching at Tech imparts an analytical way of looking at things, she says.

"I believe in the unity of theory and practice," she says. "At Georgia Tech, I was able to concentrate on the theory side. This new job allows me to put theory and practice together to develop a higher-level, more fundamental understanding of what the issues are relative to transportation planning, engineering air quality, regional planning – all of the issues

that are clearly on GRTA's mandate."

SmartTraq – Strategies for Metro Atlanta's Regional Transportation and Air Quality – is a project providing Ross with an interesting connection between academics and practice. Developed at Georgia Tech's College of Architecture and its School of Civil and Environmental Engineering, SmarTraq is a multi-faceted, holistic research project designed to integrate data on land use, transportation, air quality and even household physical activity. As a decision-making tool, SmarTraq will develop indicators that track land development and transportation investment patterns at the local government level with the ultimate aim of providing a solid knowledge base to back GRTA recommendations.

"You develop a tendency to look for a better way, a new way, a more efficient way in everything you do, which comes from the academic experience at Tech," she explains.

photo by Stanley Leary

Atlanta's congested downtown connector interstate highway is jammed with morning rush-hour commuters every weekday. The Georgia Regional Transportation Authority is developing plans to alleviate some traffic congestion in metro Atlanta.

The stickiest challenges facing Ross will likely be getting disparate interests to go along with the regional transportation plans GRTA promulgates. The 13 counties comprising the metro Atlanta region represent different constituencies, agendas and directions. Indeed, the fact that local governments have had difficulty working together is the reason GRTA was created in the first place. But Ross is optimistic.

"I think the level of debate is operating at a higher level than it was 12 months ago," she says. "We're talking about the right issues – not just in this office, but in the public arena. People are beginning to have a sense of what congestion really means in terms of its impact on their quality of life, health and the future economic viability of the region.

"Atlanta is full of pragmatists. If a particular transportation plan is good for business, good for our health, good for our mobility, ultimately we'll get there. We're making uneven progress, but Atlanta is further along than any other city in coming up with a strategy for mitigating congestion and improving air quality. We have a mechanism in place – GRTA. Now we have to make it work."

While mass transit weighs heavily in GRTA's list of transportation possibilities, Ross knows from her research that effective solutions have many components.

"The congestion issue is simply something we have to provide options for – we have no choice," she says. "And it can't possibly be done in one mode. We need a multi-modal, balanced transportation system. Sometimes that means roads; not every place in the metro area has adequate roads."

Ross emphasizes that all stakeholders must be included in the decision-making. For any group to be estranged from the process undermines the effort's credibility and potential for success, she notes. It's a lesson in politics she learned first hand as an undergraduate at Kent State University in 1970. On May 4 of that year, National Guardsmen fired into a crowd of anti-war demonstrators, killing four and wounding nine.

Looking back at the Kent State shooting and the contentious period it symbolized, she realized that much of the unrest occurred because "people felt like they were on the outside, that they were not involved in decisions that clearly affected their lives."

That outlook will serve her well at GRTA as it did at Tech, where decisions are invariably politically loaded, and making headway hinges on "inclusiveness and encouraging participation by all sides of an issue, even as you make decisions they don't always support.

"Each of us has to rise above our own experiences and our own subjectivity, and that's not easy to do," says Ross, describing critical qualities common to both a researcher and a consensus builder. "We operate from our own narrow interest, typically, and our own subjectivity. And most people don't even know they're subjective – they don't understand that the view they're putting on the table is perhaps not a broad or inclusive view. If you can rise above that subjectivity – and you have to work at it - to bring diverse interests to coalesce around a common issue, then you can move people along."

Growing up in Cleveland, the oldest of six children, Ross didn't know exactly what she wanted to do with her life, except that she didn't plan on doing it in Ohio.

"I wanted to see the world, to move around and live in different places. I wanted to have a broader perspective than I had," she recalls, adding that the security of an advanced education was also important as a means to whatever end she ultimately selected. "I wanted to make a contribution to my society, my neighborhood, my family. And I wanted to be independent. I've always been fiercely independent."

After finishing at Kent State with an undergraduate degree in social sciences, Ross enrolled at Cornell. There she earned a master's in regional planning and a doctorate in

city and regional planning. In 1976, she moved to Atlanta because her new husband, Georgia Tech economics Professor Dr. Thomas D. Boston, wanted to live in the South near his native Florida – at least for a year or two.

Twenty-four years and two children later, she's still here. In Georgia, Ross has found not only a home, but a calling.

"I think everyone ought to try and leave the world a little better than they found it, and that's why this work with GRTA is so important to me. If I can make even a small contribution, that's a lot to do."

> **For more information,** contact Dr. Catherine Ross, Georgia Regional Transportation Authority, 245 Peachtree Center Ave. NE, Suite 900, Atlanta, GA 30303. (Telephone: 404-463-3000) (E-mail: ross@grta.org)

Gary Goettling is an Atlanta-based freelance writer.

Research Horizons

Research Notes

Powering the Future

Fuel cell research center to contribute knowledge and innovations for sustainable energy sources.

The energy source that powered the Space Shuttle, Apollo, Skylab and Gemini spacecraft might one day operate your portable phone, your car and your neighborhood's electric plant.

This source – the fuel cell – is a primary focus of a new research center at the Georgia Institute of Technology. The Center for Innovative Fuel Cell and Battery Technologies will take a multidisciplinary approach to fuel cell and battery-related research, says center director Dr. David Parekh.

photo by Sue Clites

"At Georgia Tech, we have a broad range of expertise in this field. The center will serve as a catalyst for revolutionary advances through world-class research integrated across disciplines and spanning from fundamental discovery to application-specific prototypes," Parekh says.

Groundbreaking research in these areas will move the world toward more sustainable energy sources. Additionally, recent research at Georgia Tech on fuel cells and related electrochemical devices has led to the invention of several processes that enable waste streams from commercial chemical manufacturing to be profitably recycled to provide fresh feed to the manufacturing plants.

A fuel cell is an electrochemical device that operates much like a battery. It combines hydrogen fuel with oxygen to produce electricity and heat, releasing water as a byproduct. Fuel cells are a clean, environmentally friendly, versatile, reliable and efficient power source.

Student researcher Jessica Johnson in Dr. Jack Winnick's lab in the School of Chemical Engineering examines a fuel cell, which is an electrochemical device that operates much like a battery. Fuel cells are a clean, environmentally friendly, versatile, reliable and efficient power source. (300-dpi JPEG version - 549k)

Batteries, of course, are familiar to most of us, as are their advantages as compact, portable and self-contained power sources. But this recognized technology also can benefit from research advancements in rapid charging, measuring the charge a battery contains at any given time, and development of new types, sizes and configurations of batteries to run cars and other devices.

Georgia Tech's center will focus on fuel cell and battery technology for wireless telecommunications, ultra-low-emission vehicles and distributed stationary power supplies. The new center is developing new integrated facilities for development and testing – such as a power cell testing laboratory unveiled in March – and also will hold workshops on fuel cell technology.

Engineers and scientists from the Georgia Tech Research Institute, Georgia Tech's School of Materials Science and Engineering, School of Mechanical Engineering, School of Chemical Engineering, School of Electrical and Computer Engineering, and the National Electric Energy Testing, Research and Applications Center based at Georgia Tech will participate in the center. Key industry partners also will be invited to join the center to share their technology needs and collaborate on open and proprietary research projects.

The expertise Georgia Tech brings to its fuel cell and battery research includes basic and applied work in electrochemistry, materials science, nanostructures, micro-electro-mechanical systems fabrication, fluid dynamics, acoustics and controls, modeling and simulation, power transmission and distribution, and systems-level integration.

Georgia Tech's research contributions to fuel cell and battery technologies include:

- development of thin-film electrolytes and mixed-conducting electrodes for fuel cells;
- modeling of molten carbonate and solid oxide fuel cells;
- extending fuel cell technology for use with electrochemical membrane devices that clean fuel, gases and other substances;

- enabling technologies for compact, small-scale or micro proton exchange membrane fuel cells;
- development of an advanced room-temperature, sodium-based battery for high power and energy density;
- development of new electrode alloys and polymer electrolytes for lithium batteries;
- development of new methods for faster, more efficient battery charging;
- and modeling of battery power sources for electric and hybrid-electric vehicle designers and users.

Georgia Tech researchers hold numerous patents in fuel cell and battery technology areas.

– ***Lea A. McLees***

For more information, contact David Parekh, Aerospace, Transportation and Advanced Systems Laboratory, Georgia Tech Research Institute, Atlanta, GA 30332-0860 (Telephone: 770-528-7826) (E-mail: david.parekh@gtri.gatech.edu); or center co-director, Dr. Jack Winnick, School of Chemical Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0100 (Telephone: 404-894-2839) (E-mail: jack.winnick@che.gatech.edu).

Understanding How Load Affects Bone Health

Study on the mechanics of bone may benefit osteoporosis patients.

Scientists studying human bone health have long known that weight-bearing exercise makes bones stronger. But how such mechanical load actually creates this effect remains unclear and hampers treatment for osteoporosis patients.

Now in a comprehensive study on the mechanics of bone, a Georgia Institute of Technology researcher and her Emory University collaborator are seeking insight on exactly how mechanical loads affect bone remodeling – a natural process of bone resorption and reformation. Their study may lead to better

biomaterial design for bone implants in patients with osteoporosis and other bone diseases.

photo by Gary Meek

In a comprehensive study of bone mechanics, mechanical engineering Associate Professor Dr. Iwona Jasiuk and recently graduated master's degree student Frederic Bouyge are seeking insight on exactly how mechanical loads affect bone remodeling – a natural process of bone absorption and reformation. Their study may lead to better biomaterial design for bone implants in patients with osteoporosis and other bone diseases. (300-dpi JPEG version - 246k)

In patients with osteoporosis, bone formation does not keep pace with resorption. The result is structural changes, including increased porosity, that make bone fragile. About 10 million Americans, mostly women, suffer from osteoporosis; 18 million more are at risk. Osteoporosis is responsible for more than 1.5 million fractures a year, and treatment costs top $13.8 billion annually.

"With scanning electron microscopy (SEM), we have observed significant differences between microstructures of healthy and osteoporotic bone at multiple scales (macro to micro)," says Dr. Iwona Jasiuk, a Georgia Tech associate professor of mechanical engineering. "... For example, SEM images show differences in the trabecular structure of bone (the inner, sponge-like component of bone) and a dramatically different alignment of collagen fibers."

Recently graduated master's degree student Frederic Bouyge contributed heavily to the SEM studies and initial theoretical modeling investigation.

"Now we are beginning to study localized stress and strain fields at the cellular level where bone remodeling takes place," Jasiuk says. "... We are comparing healthy bone to osteoporotic samples using both an experimental and a theoretical modeling approach."

Eventually, Jasiuk and Dr. Janet Rubin, an Emory associate professor of medicine with expertise in bone cell growth, hope to predict how mechanical loads in normal versus osteoporotic bones might differentially affect bone remodeling. Their work is funded by the National Science Foundation and the Georgia Tech-Emory University Bioengineering/ Bioscience Seed Grant Program.

There are several applications for Jasiuk's multiscale studies on the mechanics of bone. They are:

- Understanding the microstructure of bone helps other researchers choose the right materials for bone implants.

- Local stress analysis provides insight on the optimal shape for bone implants.

- Jasiuk's plan to develop fracture criteria based on micromechanical theory will help drug designers focus their efforts on the microstructure of bone.

- Understanding the effects of osteoporosis at multiple scales could bring insight into the underlying causes of osteoporosis.

The researchers face some hurdles in their mechanical analyses.

"Direct experimental measurement of local strain fields is very complex because of the small scales involved," Jasiuk says. "So we are using an experimental/numerical approach for local strain prediction."

The researchers' techniques include: measuring microstructural features of bone with SEM; measuring the material response of bone samples using a mechanical load testing machine; nanoindentation to measure bone properties at much lower scales; and innovative multiscale computational modeling to account for the hierarchical nature of bone microstructure.

The experimental measurements will be used as a check in the researchers' analytical studies and numerical simulations. Knowing the microstructural details of bone at different scales will allow researchers to predict numerically, and verify experimentally when possible, the local material properties of bone. Knowing such properties will help researchers determine local strains from local stresses (load per unit area). These can then be used in simulations of bone remodeling.

Jasiuk's other collaborators on the project to date have been Dr. William Hutton of the Emory University Spine Center, Dr. Tim Ganey of Georgia Baptist Hospital and Dr. Robert Apkarian of the Emory University School of Chemistry.

– ***Jane M. Sanders***

For more information, contact Dr. Iwona Jasiuk, School of Mechanical Engineering, Georgia Tech, Atlanta, GA 30332-0405. (Telephone: 404-894-6597) (E-mail: iwona.jasiuk@me.gatech.edu)

Also see *Research Links* news stories.

Send questions and comments regarding these pages to Webmaster@gtri.gatech.edu

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Research Horizons

Research Links...

A Computerized T-Shirt

Healthcare monitoring to benefit from Tech research commercialization.

Healthcare providers soon will have a new tool for monitoring vital signs, thanks to a licensing agreement between the Georgia Tech Research Corporation and SensaTex Inc., a start-up company funded by New York-based Seed One Ventures, LLC. SensaTex will work with Georgia Institute of Technology researchers to further develop, manufacture and market the "Smart Shirt," a T-shirt that functions like a computer, with optical and conductive fibers integrated into the garment.

When incorporated into the design of clothing, the technology could quietly monitor the wearer's heart rate, EKG, respiration, temperature and a host of other vital functions, alerting the wearer or physician if there is a problem. The Smart Shirt also can be used to monitor the vital signs of law enforcement officers, firefighters, astronauts, military personnel, chronically ill patients, elderly persons living alone, athletes and infants. The U.S. Navy provided initial funding for the Smart Shirt project in October 1996.

photo by Stanley Leary

"The Smart Shirt represents a quantum leap in healthcare monitoring, producing accurate, real-time results," says Jeffrey Wolf, chief executive officer of SensaTex. "The potential applications for the technology are enormous ... and SensaTex is well-poised to pursue them all."

SensaTex will seek FDA approval for the Smart Shirt after conducting human testing of the garment in a clinical setting. SensaTex expects the Smart Shirt will be less costly than current monitoring systems, and predicts the shirt will be available to consumers in the first quarter of 2001.

"It is extremely gratifying to know that the results of our research will indeed make a positive impact on the quality of life for individuals in the real world," says Dr. Sundaresan Jayaraman, a professor in Georgia Tech's School of Textile and Fiber Engineering and the lead researcher of the Smart Shirt project.

Textile and Fiber Engineering Professor Dr. Sundaresan Jayaraman is working with start-up company SensaTex Inc. to further develop, manufacture and market the "Smart Shirt," a T-shirt that functions like a computer and will help in monitoring the wearer's vital signs.

"Judging from the number of inquiries we have received from parents, physicians and caregivers from all over the world, there is a critical need for the Smart Shirt, and I am happy that this need will be met in the near future," he adds.

The Georgia Tech Research Corporation received an equity stake in SensaTex Inc., and a portion of the revenue generated by sales of the Smart Shirt will support other research endeavors at Georgia Tech.

SensaTex's founders, Wolf and Dr. Jeff Himawan, vice president and chief science officer, have a successful track record in marketing healthcare technologies. One of their recent ventures, Elusys Therapeutics, is developing novel pharmaceutical products to clear the blood of a wide range of invading pathogens.

Georgia Tech's School of Textile and Fiber Engineering has played a leading role in textile technology for more than a century. The school's Textile Information Systems Research Laboratory, headed by Jayaraman, is a leader in exploring the synergy between textile engineering and computing.

– *Victor Rogers,* Institute Communications

> **For more information,** contact Dr. Sundaresan Jayaraman, School of Textile and Fiber Engineering, Georgia Tech, Atlanta, GA 30332-0295. (Telephone: 404-894-2490) (E-mail: sundaresan.jayaraman@textiles.gatech.edu). Also, see http://vishwa.tfe.gatech.edu/gtwm/gtwm.html

Go With the Flow

Acclaimed Altamaha River in south Georgia studied for feasibility of nature-based tourism.

Undammed and rich in natural history, southeast Georgia's Altamaha River has been called one of the "75 last great places in the world" by The Nature Conservancy. Officials

in 11 counties along the river wanted to know if the Altamaha can support tourism as well as scores of rare plants and animals, and asked researchers at the Georgia Institute of Technology to research that possibility.

Given the popularity of nature-based tourism and the region's array of attractions and activities, researchers found that potential does exist, but considerable work, and cooperation, will be necessary for success.

"For years, the Altamaha system has been the locals' secret," says Ann O'Neill, a senior researcher at the Georgia Tech Economic Development Institute and chief researcher on the project. "If they're willing to share it with us, it could become one of Georgia's leading wilderness experiences."

Ga. Dept. of Industry, Trade & Tourism

South Georgia's undammed Altamaha River has been called one of the "75 last great places in the world."

As part of the effort, researchers conducted more than 50 interviews with local businesses, elected officials and state agencies, and they spent three days along the river taking inventory of the river's assets and evaluating its access points.

The 12-month project: (1) examined the environmental and cultural issues surrounding tourism development; (2) analyzed the most promising market segments for tourism in the area; (3) selected and profiled the best segment; (4) took inventory of and analyzed the region's tourism assets; and (5) recommended how to prepare for and attract visitors.

Because of population growth along the coast, researchers noted that visitation will increase in any event and suggested that communities should determine how much change is acceptable and consider impacts on the quality of life. Preservation of the asset is crucial for economic, as well as environmental, reasons.

The study found that nature-based tourism offers the greatest potential. This market segment is growing at 10 to 30 percent annually, and as many as 77 percent of all pleasure travelers reportedly have participated in nature-based activities – for example, bird-watching, hiking, kayaking and camping – while on vacation.

The 137-mile Altamaha corridor offers diverse attractions, from manatees and alligators to cypress and orchids to a colonial-era fort and a slave-dug canal. The river is known for

fishing and canoeing, and its tributaries boast their own sights and sites, such as the Ohoopee River's white sand and black water. In addition, the lower part of the river is close to the Okefenokee Swamp, Cumberland Island National Seashore and a new wild animal park planned for the coast. And the Georgia Department of Natural Resources is considering a new state park in Appling County, the northern border of which is formed by the Altamaha River.

Successfully developing river-based tourism, the study observed, is a large and complex task, one too great for one or a few counties. Researchers recommended that officials first establish a formal organization whose goal is sustainable tourism development of the river system, and the group's committees would address environmental issues, infrastructure, community relations, business development, funding and other issues.

As an economic development strategy, this sort of tourism could boost existing businesses such as outfitters, restaurants, lodgings and retailers, as well as foster creation of river tour operators and outdoor recreation equipment suppliers.

Any such effort wouldn't happen overnight. The time frame will be years, O'Neill says, although the region could see some increase in visitation within a few months.

Also participating in the project were representatives of Georgia Southern University, the Heart of Georgia Altamaha Regional Development Center, and the state departments of Industry, Trade and Tourism, Community Affairs, and Natural Resources.

– Lincoln Bates

> **For more information,** contact Ann O'Neill, Economic Development Institute, Georgia Institute of Technology, Atlanta, GA 30332-0640. (Telephone: 404-894-3113) (E-mail: ann.oneill@edi.gatech.edu)

A Bumper Crop at ATDC

A record 19 companies graduate from Georgia Tech's business incubator, attracting more than $300 million in investment.

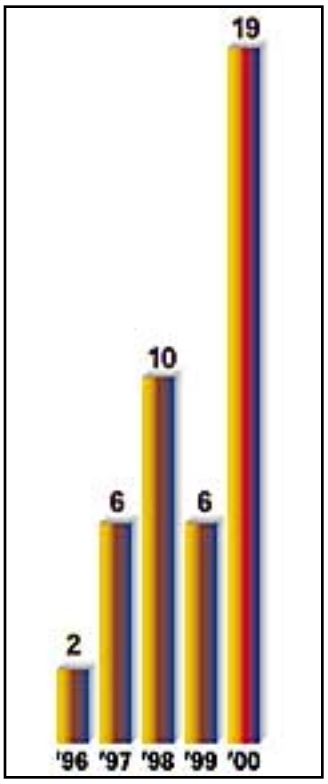
The Advanced Technology Development Center (ATDC), Georgia Tech's incubator for technology start-ups, graduated a record number of new companies this past spring. Nineteen companies were recognized for their success, nearly twice the previous record of 10 graduates set in 1998.

"We're operating on Internet time now," says Wayne Hodges, director of ATDC. "The speed at which companies get to market is more important now than ever before."

The 19 graduate companies together have attracted more than $300 million in investment from venture capital, mergers and acquisitions.

ATDC nurtures young technology firms by providing business management advice, contacts with venture capital sources and other business community support, flexible leases for office space, educational opportunities and technical support. Companies graduate when they achieve specific benchmarks, including sustained revenues, number of employees or acquisition by another firm.

Over the past several years, compression of the market cycle in many business areas has accelerated the maturing process for start-up companies. Some ATDC firms now graduate less than a year after entering the incubator.



ATDC Graduate Companies, 1996-2000 (higher resolution JPEG version - 31k)

The flow of graduates is having a significant impact on the area around the Georgia Tech campus. More and more graduates – including Idapta and NoticeNow – are planting roots in the Midtown area.

"Their proximity allows for greater synergy between Georgia Tech and the business community," Hodges says. "The net effect is creating a hotbed of technology companies."

ATDC's screening process assures investors that ATDC companies are worth investigating.

"The quality of ATDC's companies just keeps getting better," says Stephen Fleming, general partner in Atlanta venture capital firm Alliance Technology Ventures. "The screening mechanisms have been tightened to the point where almost every company there sounds like a good investment candidate. We're proud to have two of our portfolio companies graduating this year, and we look forward to bringing more companies through the process in years to come."

ATDC screens applicant companies against several criteria.

"If a company makes it into ATDC, it means they have a truly unique technology," says Tony Antonaides, ATDC venture catalyst. "We've kicked all the tires and checked under

the hood, and there's really something there. And these companies have more than just 'gee-whiz' technology going for them. They have real-world market applications."

And that's something financiers look for. "Today's companies come in with such hot technologies that investors want to snatch them up," Antonaides adds. Though the bulk of venture capital once flowed primarily from regional investors, ATDC companies are now capturing the attention of national firms such as J.P. Morgan.

– *T.J. Becker,* Freelance Writer

> **For more information,** contact Wayne Hodges, ATDC, 430 10th St., Suite N-112, Atlanta, GA 30318. (Telephone: 404-894-5217) (E-mail: wayne.hodges@edi.gatech.edu). Also, the full text news release version of this article, which includes descriptions of each graduate ATDC company, can be found at http://atdc.org/companies/may42000.html.

Safety Net

EDI helps start-up company gain steadier footing.

When Anita Hill launched her disposable baby bib company, she had plenty of marketing savvy, but lacked manufacturing expertise. So Georgia Tech's Economic Development Institute (EDI) extended a helping hand in a variety of ways, causing the entrepreneur to view EDI as a "safety net."

photo by Gary Meek

Hill, who launched KDI Inc. in 1996, outsourced her production initially, but always wanted to bring it in-house. In 1997, after an opportunity to sell her bibs to Wal-Mart, Hill was on the brink of purchasing die-cutting machinery and leasing a larger facility when she contacted an EDI field office for assistance with a plant layout.

"Once we got out there, we realized she needed more than a plant layout," says former EDI field office manager John Laszcz. That's pretty typical, he adds: "When people call us, what they think is a problem often turns out to be a symptom of something else."

In Hill's case, Laszcz thought the entrepreneur was

moving a little too fast. "We got her to slow down and catch her breath a little," he says.

The investment in equipment would have been a huge capital expense, and Laszcz advised Hill to continue outsourcing and slowly phase-in manufacturing under one roof as her customer base matured. Laszcz also recommended that Hill pass on the facility she was about to lease. Though it met many of her needs, there was no loading dock, which would have caused problems as shipments increased.

EDI usually works with more established manufacturers. But Laszcz was impressed by Hill's potential and recruited other EDI staff members to lend their expertise. They included Lawanna Burgess, Mark Heflin, Charles France, Harris Johnson, Vicki Leighton, Lydia Lyons and Andy Johnson. Laszcz also involved Darrel Hulsey from the Norcross Small Business Development Center to help Hill with financial and sales analysis.

Georgia entrepreneur Anita Hill received business advice from the Georgia Tech Economic Development Institute as she made plans to expand her disposable baby bib company.

Some of the team's contributions are:

- **Fine-tuning production:** Hill's company had received fabric and plastic laminate separately, then bonded the layers together before printing and cutting. EDI suggested obtaining prelaminated fabric. "That may not sound crucial, but it was key," says Hill, noting the adjustment reduced production time and also cut down on wrinkles and stretch in her final product.

- **Software selection:** Wanting to automate her accounting and materials requirement planning process, Hill had been considering a software system that cost $11,000. Instead, EDI found a system that answered her needs for $300 – saving more than $10,000.

- **Research:** Hill had an opportunity to produce disposable aprons for a large meat cutting company, but needed to learn more about the antibacterial process. EDI assisted with marketing research, and Hill is moving ahead on the project.

- **Continuing education:** Last fall, Hill attended EDI's manufacturing conference, which provided insight into new technologies and confidence that her company was on the right track with planned EDI and e-commerce initiatives. The

conference also caused Hill to shift her focus from sales volume to profits.

"When you first start out, you're thrilled just to have product on the shelf. Well, that thrill is gone," says Hill, who is now concentrating sales efforts on larger retailers that can offer better margins.

– *T.J. Becker,* Freelance Writer

> **For more information,** contact Anita Hill, KDI Inc., 1798 Montreal Circle, Suite 100, Tucker, GA 30084. (Telephone: 770-938-1739 or 678-938-8887) (E-mail: ajhill@kdi.org) (Web address: www.kdi.org).

Faculty Awards and Honors

Professor Emeritus **Dr. Aubrey Bush** of the School of Electrical and Computer Engineering was named division director for the National Science Foundation's Division of Advanced Networking Infrastructure and Research Directorate of Computer and Information Science and Engineering.

Dr. Mary Frank Fox, a professor of sociology in the School of History, Technology and Society, was an invited speaker at the Berlin-Brandenburg Academy of Sciences' international conference on "The Work of Science" in celebration of the Academy's 300th anniversary in June 2000.

The **Georgia Geographic Information Systems (GIS) Data Clearinghouse** was selected by the Urban and Regional Information Systems Association to receive the 2000 Exemplary Systems in Government (ESIG) Award in the Single Process System Category. Research scientist **Thomas D. Mettille** of the College of Architecture is the clearinghouse manager.

Dr. Rita Gregory, an assistant professor in the College of Architecture and the School of Civil and Environmental Engineering, received the prestigious 1999 Tasker H. Bliss Medal by The Society for American Military Engineers.

Assistant Professor **Dr. Andrew Lyon** of the School of Chemistry and Biochemistry received a Beckman Young Investigator Award. It is one of the most prestigious awards a young scientist can earn.

Dr. Edward W. Price, a Regents' Professor Emeritus in the School of Aerospace Engineering, was selected for membership in the National Academy of Engineering, one

of the highest professional distinctions accorded an engineer.

Assistant Professor **Dr. Emmanouil M. Tentzeris** of the School of Electrical and Computer Engineering received a 2000 National Science Foundation CAREER Award "for novel multi-resolution, time-domain schemes for the adaptive analysis and design of high-frequency circuits and packaging structures."

Dr. C.P. Wong, a Regents Professor in the School of Materials Science and Engineering and research director of the Packaging Research Center, was selected for membership in the National Academy of Engineering, one of the highest professional distinctions accorded an engineer.

Also see *Research Notes* news stories.

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