

## COVER STORY

### DECADES of DISCOVERY and DESIGN . . .

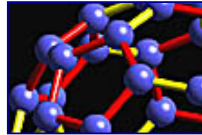
*Research Horizons* recounts  
Georgia Tech research success stories

By Jane M. Sanders and  
Gary Goettling

*Perspective* — Jane M. Sanders

#### Basic Discoveries:

[Ozone Pollution](#)  
[Fractal Geometry](#)  
[Chaos Theory & Nonlinear Dynamics](#)  
[Molecular Dynamics Simulation](#)  
[Fluid Dynamics](#)  
[OH Radical Measurement](#)  
[Self-Organized Criticality](#)  
[Nanotubes](#)  
[Rotational Dynamics Theory](#)  
[A New Bacterium](#)  
[Molecular & Electron Collision Scattering](#)



#### Technological Achievements:

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)  
[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)



- [Other Significant 20th Century Research at Georgia Tech](#)
- [The Next Century of Research at Georgia Tech](#)

## FEATURES

### Harnessing Brain Power

Georgia Tech research assists direct  
brain-computer interaction

By Gary Goettling



### Reducing VOC

A new polymer coating process  
combines a high degree of  
flexibility with improved  
environmental properties.

By John Toon



## DEPARTMENTS

### Research Notes

- [Sounds of Silence](#)
- [Industrial Modernization](#)
- [Awards and Honors](#)



### Research Links

- [Weighing the Very Small](#)
- [Tracking Real Estate](#)
- [Measuring Scientific Research](#)

**Research Horizons**  
**Volume 17, Number 1**  
**Fall 1999**

A publication of the  
[Georgia Institute of Technology](http://www.gatech.edu)

**Editor**

Jane M. Sanders  
[jane.sanders@edi.gatech.edu](mailto:jane.sanders@edi.gatech.edu)  
404/894-2214

**Contributing Writers**

T.J. Becker  
Gary Goettling  
Jane M. Sanders  
John Toon  
Jan Youtie

**Photography**

Defense Visualization

Information Service  
Georgia Department of Industry,  
Trade and Tourism  
Stanley Leary  
Gary Meek  
Oak Ridge National Laboratory

**Photography (cont.)**

Boris Pevzner  
PhotoDisc

**Graphic Design**

Everett Hullum  
Nao Yamashita

**Illustration**

Mac Evans

**Administration**

Dr. Edward Reedy  
*Director, GTRI, and Vice  
President, Georgia Tech*  
Dr. Charles Liotta  
*Vice Provost for Research and  
Dean of Graduate Studies,  
Georgia Tech*

Research Horizons is a member of  
the University Research Magazine  
Association. For more information,  
point your browser to [www.urma.org](http://www.urma.org).

**Research News & Publications Office**

Georgia Institute of Technology  
430 Tenth Street, N.W.  
Suite N-116  
Atlanta, Georgia 30318  
(Telephone: 404/894-6986)

The information released herein does not necessarily reflect the position or the policy of research sponsors, and no official endorsements should be inferred. Address correspondence to the editor. Articles may be reprinted in full or in part, or freely quoted, if source is acknowledged.

Copyright © 1999 Georgia Tech Research Corporation. All rights reserved. ISSN #1060-6696

Research Horizons readers may subscribe to the electronic version of the magazine by sending an email message to [listproc@gtri.gatech.edu](mailto:listproc@gtri.gatech.edu). The body of the email message should read "Subscribe rh.subscribers." Subscribing to this distribution list will alert you to new issues of the magazine as they are posted on our Web site. If you wish to stop receiving these reminder messages, you may send an email message to [listproc@gtri.gatech.edu](mailto:listproc@gtri.gatech.edu). The body of the email should read "Unsubscribe rh.subscribers."

[Research Horizons](#) | [GT Research News](#) | [GT Research News & Publications](#) | [GTRI](#) | [Georgia Tech](#)

Questions or comments? Please [send us e-mail](#).

Last updated: October 26, 1999

Notwithstanding any language to the contrary, nothing contained herein constitutes nor is intended to constitute an offer, inducement, promise, or contract of any kind. The data contained herein is for informational purposes only and is not represented to be error free. Any links to non-Georgia Tech information are provided as a courtesy. They are not intended to nor do they constitute an endorsement by the Georgia Institute of Technology of the linked materials.

## Perspective

By Jane M. Sanders

---

"The horizon leans forward, offering you space to place new steps of change," wrote American poet Maya Angelou.

At Georgia Tech, the 20th century has offered a broad horizon with plenty of space for change — both in the realm of basic scientific discovery and in technological innovation. Many scientists and engineers have filled that space with revealing and relevant research. Change has resulted, much of it advancing a modern society that now depends heavily upon its scientists and engineers for betterment.

As the century ends, Research Horizons pauses in this issue to examine the horizon — the accomplishments found on the one we are passing and the hopes of the frontier that is now before us.

In the spring of this year, we solicited suggestions from faculty and administrators via our campus email distribution system. They responded with lists highlighting some of the best research done at Georgia Tech in the 20th century — most of it in the past four decades because of the university's young, yet significant history in research.

From faculty and administration responses, we chose 26 projects to write about in this issue of Research Horizons. Some are basic scientific discoveries, such as those in chaos theory, and others are technological innovations, such as a structural design software program that is used worldwide.

Survey respondents also provided the magazine with lists of research projects that hold great promise for the 21st century. We have covered many of those in recent issues. Here, we list these projects and, where available, provide links to Web sites with more information on them.

As exhaustive as all this information may sound, there are many more noteworthy research projects not mentioned in this issue. Memories fail. Space is limited. Time is

tight. Perhaps future issues of Research Horizons can give these projects their due.

Now, leaning forward on the 21st century's horizon, patches of blue dot the Georgia Tech sky. Those patches pierce the clouds that try to obstruct our view. We are beginning to see the vast space where our feet must step to bring change.

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## *Basic Discoveries:*

### BASIC DISCOVERIES

[Ozone Pollution](#)

[Fractal Geometry](#)

[Chaos Theory & Nonlinear Dynamics](#)

[Molecular Dynamics Simulation](#)

[Molecular & Electron Scattering](#)

[OH Radical Measurement](#)

[Fluid Dynamics](#)

[Self-Organized Criticality](#)

[Rotational Dynamics](#)

[Nanotubes](#)

[A New Bacterium](#)

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## [Basic Discoveries:](#)

### **Ozone Pollution**

In 1988, researchers in the School of Geophysical Sciences (now [Earth & Atmospheric Sciences](#)) reported in *Science* that natural hydrocarbons from trees play a larger role than originally believed in creating the ozone pollution that plagues many U.S. cities.

Because ozone pollution is created from chemical reactions involving hydrocarbons and nitrogen oxides in the presence of sunlight, the scientists suggested that control strategies aimed at reducing nitrogen oxide emissions should be implemented. At the time, the nation's ozone abatement strategies focused almost exclusively on limiting hydrocarbon emissions.

In the intervening years since the 1988 Georgia Tech study, there has been an increasing awareness of the importance of natural hydrocarbons and the need for nitrogen oxide emission controls. Today, control of nitrogen oxide emissions from automobiles and power plants has become a key component in the nation's efforts to reduce ozone pollution.

Many people criticized the natural hydrocarbon theory. Some said the Georgia Tech study claimed that trees were causing pollution. But it actually meant that human-induced emissions of nitrogen oxides, instead of hydrocarbons, cause the pollution. Others argued that if the theory were correct, urban areas could control ozone problems by cutting down trees.

But a follow-up study published in the *Journal of Geophysical Research* in 1990 found that reducing the number of trees in urban areas may raise temperatures, promoting an increase in the production of natural hydrocarbons and worsening the pollution.

Trees and other plants actually moderate air temperature through the evaporation of water from their leaves, a natural air conditioning effect known as evapo-transpiration. Replacing trees with human-made materials that retain heat reduces evapo-transpiration, creating what is called an "urban heat island." Thus this follow-up study suggested that trees and green spaces may help alleviate urban pollution, instead of exacerbate it.

Dr. William Chameides and his colleagues R.W. Lindsay, J.L. Richardson, Chia S. Kiang and Carlos Cardelino conducted the research.

For more information, contact Dr. William Chameides, School of Earth and Atmospheric Sciences, Georgia Tech, Atlanta, GA 30332-0340. (Telephone: 404- 894-1749) (E-mail: [william.chameides@eas.gatech.edu](mailto:william.chameides@eas.gatech.edu))

Georgia Tech file photo



A 1990 Georgia Tech study of ozone pollution showed that reducing the number of trees in urban areas may raise temperatures, promoting an increase in the production of natural hydrocarbons and worsening air quality. Here, a researchers checks an air chemistry monitor.

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## Basic Discoveries:

### Fractal Geometry

In 1984, researchers in the School of Mathematics made a breakthrough in fractal geometry, which can represent shapes that are irregular and broken. That breakthrough has since led to a patented image compression technology that is changing the field of computer graphics. The mathematicians solved "the inverse problem" — how the geometry of an actual scene can be used to generate the right algorithm or set of rules to represent that scene.

Using fractal geometry, the researchers were able to determine a natural scene's redundancies, one form of which is self-similarity (shapes of objects remaining the same at different levels of magnification). They then designed a system to automatically analyze the geometry of a given object and regenerate it fractally. Fractals allow objects to be represented more efficiently (that is, with fewer numbers) than other methods, such as pixels. Therefore, fractals effectively increase a computer's capacity to store and access image data.

In 1987, lead researcher and mathematics professor Dr. Michael Barnsley and associate math professor Dr. Alan Sloan co-founded Iterated Systems Inc., an Atlanta company that specializes in digital image science. The next year, the researchers took a leave of absence from Tech to devote their full-time efforts to Iterated Systems. They later resigned from Tech, but Barnsley recently rejoined the faculty as an adjunct professor in the Georgia Tech Center for Dynamical Systems and Nonlinear Studies. He is also a professorial fellow at the University of Melbourne in Australia.

The popularity of Iterated Systems' fractal method of storing and regenerating images grew enormously from 1992 to 1997, when Microsoft used it in the top-selling CD-ROM encyclopedia "Encarta." A more recent technology developed by the company is called StiNG<sup>tm</sup>. It is a family of core image-handling technologies that includes lossless encoding, patented fractal scaling and automated quality management that translates pixel-based images into resolution-independent images.

Iterated Systems still has a significant Georgia Tech connection among its employees. Two of Barnsley and Sloan's Georgia Tech collaborators, Drs. Stephen Demko and John Elton, are both now employed by Iterated Systems. Other Tech researchers involved in the project were Jeffrey Geronimo and Douglas Hardin.

For more information, contact Dr. Michael Barnsley at [barnsley@aol.com](mailto:barnsley@aol.com).

Courtesy Iterated Systems Inc.



Georgia Tech researchers designed a system to automatically analyze the geometry of a given object and regenerate it fractally (such as this image). Fractals allow objects to be represented more efficiently, effectively increasing a computer's capacity to store and access image data.





# Research Horizons

## BASIC DISCOVERIES:

[Ozone Pollution](#)

[Fractal Geometry](#)

[Chaos Theory & Nonlinear Dynamics](#)

[Molecular Dynamics Simulation](#)

[Molecular & Electron Scattering](#)

[OH Radical Measurement](#)

[Fluid Dynamics](#)

[Self-Organized Criticality](#)

[Rotational Dynamics](#)

[Nanotubes](#)

[A New Bacterium](#)

[TECHNOLOGICAL ACHIEVEMENTS](#)

[TABLE of CONTENTS](#)

## Basic Discoveries:

### Chaos Theory and Nonlinear Dynamics

In the latter 1950s, the late Georgia Tech physicist Joseph Ford began investigating the scientific phenomena of chaos, described by him as "deterministic randomness." Ford, the self-avowed "Evangelist of Chaos," was a pioneer in this relatively new field of science. During his decades of research in the area, he moved from an evolutionary to a revolutionary view of chaos, ultimately declaring it the key to the future of all science.

In the 1960s, Ford conducted computer experiments that verified and extended the results of work in chaos published in the 1950s. Ford said he demonstrated that many systems exhibited such completely unexpected, wildly erratic behavior that intuition suggested scientists were observing the long-anticipated deterministic randomness in Newtonian dynamics. There was little argument against his assertions.

By the late 1970s, Ford and an Italian colleague had unified disciplines ranging from astronomy to zoology in their findings related to chaos. They started a new journal of nonlinear science called *Physica D*.

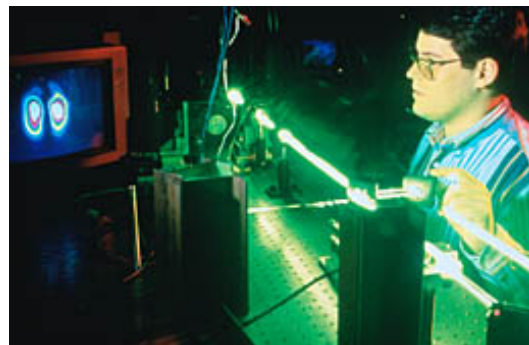
Later in the decade, Ford embraced a Soviet colleague's new algorithmic complexity theory, which provides both qualitative and quantitative measures of nature's complexity. From this time on, Ford referred to a revolutionary view of chaos and encountered many arguments against his theories. He believed the theory of chaos indicates the universe is completely random.

In the 1980s, Ford and Georgia Tech physicist Ronald Fox worked individually to define chaos at the quantum mechanical level and to use those definitions to determine if quantum systems exhibit chaos. At that time, no quantum models had exhibited true chaos over the long term, like their classical model counterparts did. Ford showed the quantum description of chaos is actually only quasiperiodic. On the basis of algorithmic complexity theory, he believed errors existed in the foundations of quantum mechanical theory, and that quantum models could not exhibit chaos.

Fox, on the other hand, believed quantum mechanics would yield a quantum signature of classical chaos that paralleled the classical definition. By the mid-1990s, Fox had approached the chaos and quantum-classical correspondence problems from a general perspective, rather than from the behavior of any particular model system.

His studies showed strong quantitative correspondence between the evolution of initial sharply localized wave packets and evolution of associated classical ensembles. By measuring the initial growth rate of the quantum variances, the local classical Lyapunov exponent (the universal hallmark of classical chaos) could be determined. Fox concluded that quantum-

Georgia Tech file photo



In 1994, Georgia Tech researchers, including Dr. Scott Thornburg (above), showed for the first time that two chaotic lasers could be synchronized. He and Dr. Rajarshi Roy, former chair of the [School of Physics](#), suggested potential communications-related applications for the work. ([300-dpi JPEG version - 205k](#))

classical correspondence for chaotic dynamics does not require notions involving infinite time and that the local Lyapunov exponent is a quantum signature of classical chaos.

Following on Ford and Fox's groundbreaking work in chaos, Dr. Rajarshi Roy, former chair of the [School of Physics](#), and his colleagues learned to control the chaotic fluctuations in light intensity produced by certain laser systems. In 1994, Roy and Dr. K. Scott Thornburg of Georgia Tech showed for the first time that two chaotic lasers could be synchronized. At that time, they suggested potential communications-related applications for the work.

Subsequently, Roy and Dr. Quinton Williams, a former Georgia Tech Ph.D. student, studied erbium-doped fiber lasers and amplifiers with the goal of using them for chaotic communications. Then in 1998, Roy and Georgia Tech graduate student Gregory Van Wiggeren used chaotic fluctuations in light intensity to encode information being transmitted from one laser to another through fiber optic cable. This research opens the possibility of using chaotic carrier signals to hide "private" messages transmitted across existing optical fiber networks.

For more information, contact Dr. Ronald Fox, School of Physics, Georgia Tech, Atlanta, GA 30332-0430.  
(Telephone: 404-894-5260) (E-mail: [ronald.fox@physics.gatech.edu](mailto:ronald.fox@physics.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## [Basic Discoveries:](#)

### **Molecular Dynamics Simulation**

Since the late 1970s, researchers in the [School of Physics](#) have developed and used novel theoretical and computer-based modeling and simulation methods to investigate the microscopic origins of complex physical and chemical materials phenomena.

These methods, known as molecular dynamics simulations, yield insights into the microscopic nature of structure and dynamics in various materials systems. These systems range from atomic processes underlying friction, lubrication and wear, and the size-dependent evolution of the properties of materials clusters, to the formation mechanisms of nanometer-scale wires and quantum dots, and the quantized electronic conductance in such miniaturized structures.

In a 1990 report in *Science*, the researchers predicted the formation and properties of metallic nanowires, generated through elongation of the contact between the tip of a scanning tunneling probe and a gold surface. This study showed that mechanical and electrical properties of such wires vary significantly as their width narrows to the nanoscale — less than a few atoms.

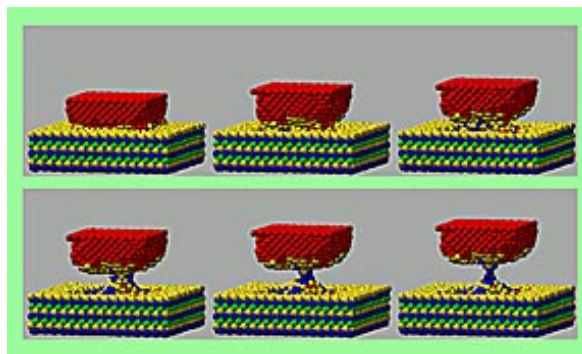
The information is relevant to the fabrication of novel miniaturized electronic devices, and it led to a joint study between Georgia Tech researchers and an experimental group in Madrid. The researchers reported in a 1995 *Science* article that they produced such wires in the laboratory, and measured room-temperature, quantized electronic transport through them. The study verified the scientists' early theoretical predictions.

Also in 1995, the Georgia Tech researchers reported in *Science* that under extreme conditions, lubricants in systems such as computer disk drives may behave in unexpected ways that can harm the systems they are intended to protect. Molecular dynamics simulations predicted that ultra-thin films of organic lubricants used in nanometer-scale devices may act more like solids than liquids when subjected to high pressures.

In 1998, they reported in the *Journal of Physical Chemistry* that rapidly oscillating the width of the lubricant-filled gap separating two sliding surfaces can significantly reduce friction between them. The technique keeps the lubricant in a state of dynamic disorder, preventing the formation of molecular layering that can increase friction. Based on molecular dynamics simulations, the findings would be of particular interest to designers of micro-scale machines.

The research program is headed by Dr. Uzi Landman, director of the Center for Computational Materials Science, and a

Courtesy of Dr. Uzi Landman



This molecular dynamics simulation represents the formation of a metallic nanowire, generated as a slightly indented nickel tip (with atoms depicted as red spheres), as it is pulled away from a gold surface (with the top atomic layer of the gold substrate depicted by yellow spheres, the second layer down by blue spheres, and so on). ([300-dpi JPEG version - 530k](#))

Regents' and Callaway Chair professor of physics. His Georgia Tech collaborators include R.N. Barnett, E.N. Bogachek, C. L. Cleveland, J. Gao, W.D. Luedtke, A.G. Scherbakov and C. Yannouleas.

For more information, contact Dr. Uzi Landman, School of Physics, Georgia Tech, Atlanta, GA 30332-0430.  
(Telephone: 404-894-3368) (Email: [uzi.landman@physics.gatech.edu](mailto:uzi.landman@physics.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## *Basic Discoveries:*

### **Molecular and Electron Collision Scattering**

When atoms, molecules, ions and electrons collide at relatively high energies, electrons can be transferred from one particle to another, removed to make ions or excited to eventually result in the emission of light. Very low-energy collisions between such species result in chemical changes and the combination of the colliding species.

During the 1960s, Georgia Tech was well-known for development of unique and innovative experimental systems in atomic collisions, initiated by the late Dr. Earl W. McDaniel of the Engineering Experiment Station (now [Georgia Tech Research Institute](#), GTRI). McDaniel later became a professor in electrical engineering and physics.

Among the notable projects was the first development of the drift tube mass spectrometer used to study low-energy chemical reaction with defined species. Another highlight was the first series of U.S.-based experiments to study collisions between beams of electrons and ions. In the late 1960s, the program added a theoretical component to provide prediction and fundamental understanding of atomic collisions.

Much of the early work was to provide data for support of the Controlled Thermonuclear Reactor at Oak Ridge, Tenn. High-energy beam studies performed by Drs. David Martin and Ed Thomas of the School of Physics fostered development of neutral beam injectors to heat and fuel such reactors.

The electron-ion collision experiments by Dr. John Hooper of the School of Electrical and Computer Engineering and theoretical predictions by Dr. Ray Flannery of the School of Physics helped provide an understanding of the cooling processes in such devices.

Also, McDaniel's data on low-energy chemical reaction processes furthered the understanding of atmospheric chemistry, in particular the creation and destruction of ozone. And Flannery's theoretical calculations were used to model atmospheres of stars, such as our sun.

The researchers at Tech are well known for the production of scholarly reviews and data tabulations, which are widely used in technological fields and basic research programs. The programs initiated by McDaniel continue with several research groups at Tech.

Courtesy of Oak Ridge National Laboratory



In the 1960s, Georgia Tech researchers developed a series of innovative experimental systems in atomic collisions. The early work supported the mission of the Controlled Thermonuclear Reactor at Oak Ridge, Tenn. High-energy beam studies fostered development of Oak Ridge neutral beam injectors (shown here in a 1961 photo) to heat and fuel such reactors.

(Telephone: 404-894-5263) (E-mail: [ray.flannery@physics.gatech.edu](mailto:ray.flannery@physics.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## Basic Discoveries:

### OH Radical Measurement

One way of fighting air pollution is to learn more about the Earth's natural anti-pollution defenses. A step in that direction occurred unexpectedly in the early 1980s, when former Engineering Experiment Station scientist Dr. Fred Eisele was developing a sensitive atmospheric ion-measurement technique. In the process, he discovered the technique could be adapted to measure the elusive hydroxyl (OH) radical.

Considered the single most important cleansing agent in the atmosphere, the OH radical acts as an oxidizing agent and removes several greenhouse gases and other pollutants from the atmosphere.

Continuously replenished during the daytime, but highly reactive — the molecule lasts only a fraction of a second before it combines with other chemicals — and tiny even by molecular standards, the OH radical defied in situ measurement for 20 years until Eisele.

In early 1989, Eisele modified his ion-sampling apparatus to support the physical chemistry needed to detect the OH radical. His measurement technique combines the highly reactive nature of the OH radical with the extreme sensitivity offered by a mass spectrometer.

Air drawn through a sampling tube is subjected to a rapid succession of chemical reactions initiated by the addition of isotopically labeled sulfur dioxide, which converts all of the naturally occurring OH into isotopically labeled sulfuric acid. To prevent the formation of new OH by certain elements in the air sample, Eisele injects propane shortly after the initial OH is titrated away.

The acid is ionized to form an isotopically labeled bisulfate ion, which is then measured with a selected ion chemical ionization mass spectrometer. Because the OH was converted into the acid in a one-to-one ratio, the amount of sulfuric acid reveals the ambient OH concentration.

This technique also provides the unique ability to measure ambient sulfuric acid, which plays a central role in aerosol nucleation and growth — in this case by detecting the non-isotopically labeled bisulfate ion. Researchers calibrate both of these measurements by photo-dissociating a known amount of water vapor with a known flux of 184.9 nanometer UV photons. Together, they form known OH and sulfuric acid concentrations in the instrument's sample inlet.

Georgia Tech file photo



Working at a field experiment site, GTRI scientist Dr. Fred Eisele uses a sensitive atmospheric ion-measurement technique he adapted to measure the elusive hydroxyl (OH) radical. The OH radical is considered the single most important cleansing agent in the atmosphere.



[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## [Basic Discoveries:](#)

### **Fluid Dynamics**

In the 1980s, Georgia Tech biomedical engineering researchers and collaborators at The University of Chicago studied fluid mechanics as applied to understanding the origins, detection and treatment of cardiovascular disease.

Their subsequent investigations with laser Doppler velocimetry and pulsed Doppler ultrasound showed the potential importance of blood flow disturbances in the early detection of carotid artery atherosclerotic plaques, an arterial disease that often leads to stroke. This work was adopted by clinicians and is now used in vascular diagnostics around the world.

Because atherosclerotic plaques tend to be localized at sites of branching and artery curvature and because researchers expected these locations to harbor complex flow patterns, the scientists hypothesized that fluid dynamics might play an initiating role in atherosclerosis.

They considered several fluid dynamic variables as possible initiating factors. Then they conducted fluid dynamic model experiments and used physiologic conditions to simulate arterial flows. Researchers also examined the thickness of atherosclerotic plaques in human arteries.

Correlations between fluid dynamic variables and plaque thickness revealed that atherosclerotic plaques tended to occur at sites of low and oscillating artery wall shear stress. These observations were reinforced by studies in animal models of atherosclerosis. The findings set the stage for many subsequent investigations on the importance of fluid dynamics in affecting cellular function, a field of research that is very active today.

The researchers were led by Dr. Don P. Giddens, who now heads the Georgia Tech-Emory University [School of Biomedical Engineering](#). His collaborators included Dr. David Ku, now a professor of mechanical engineering at Tech and a professor of surgery at Emory. Key medical collaborators included Drs. C. K. Zarins and S. Glagov of The University of Chicago.

For more information, contact Dr. Don Giddens, School of Biomedical Engineering, Georgia Tech, Atlanta, GA 30332-0535. (Telephone: 404-894-6825) (E-mail: [don.giddens@bme.gatech.edu](mailto:don.giddens@bme.gatech.edu))

Copyright PhotoDisc Inc., 1999



Georgia Tech scientists studied fluid mechanics as it applied to understanding the origins, detection and treatment of cardiovascular disease. Their subsequent diagnostic research was adopted by clinicians and is now used in vascular diagnostics around the world.

## Basic Discoveries:

### Self-Organized Criticality

In 1991, a researcher in the [School of Physics](#) expanded the theory of self-organized criticality, which he and his colleagues originated in 1987 while at Brookhaven National Laboratory.

The theory asserts that complex systems far from equilibrium spontaneously evolve toward a critical state without external tuning. The best-known example involves sandpiles that gradually reach a critical state — leading to avalanches of varying sizes — as grains of sand are slowly added. The work and its implications remain controversial in the physics community.

Proponents of self-organized criticality believe it may explain many extraordinary or unstable phenomena, including earthquakes, stock prices, electrical flow, fluctuating river levels, traffic jams, quasar signals and even the presence of fractal shapes in nature.

The 1991 research on self-organized criticality was published in *Physical Review Letters* by Georgia Tech physicist Dr. Kurt Wiesenfeld, Dr. James Theiler of MIT's Lincoln Laboratory and Dr. Bruce McNamara of Reed College. The original theory was described by Wiesenfeld, Per Bak and Chao Tang of Brookhaven.

In 1997, Dr. Peter Jung, a visiting physicist at Georgia Tech, and Dr. Ann Cornell-Bell of Connecticut-based Viatch Imaging found the first evidence that chemical activity within networks of brain cells displays behavior characteristic of self-organized criticality. While the implications of the work remain unclear, the researchers believe further study could lead to new insights into disease processes, improved techniques for diagnosing diseases of the brain, and perhaps even new treatment options.

Also, one of Wiesenfeld's former Ph.D. students, Jeff Hasty (now at Boston University) did his dissertation on a new theory of self-organized criticality using an idea known as "the Renormalization Group." It aims to explain the origin of self-organized critical behavior from first principles, which are fundamental tenets that do not invoke (as most theories do) unproven hypotheses.

That work was published in *Physical Review Letters* in 1998. Meanwhile, Wiesenfeld's work on self-organized criticality is continuing, now with a focus on magnetic avalanches in superconductors.

Georgia Tech file photo



The theory of self-organized criticality, developed in part by physics professor Dr. Kurt Wiesenfeld, finds its best-known example in sandpiles, which gradually reach a critical state — leading to avalanches of varying sizes — as grains of sand are slowly added.

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## Basic Discoveries:

### Rotational Dynamics Theory

In the mid-1980s, former Georgia Tech physics professor Dr. William G. Harter and colleague Dr. Chris Patterson of Los Alamos National Laboratory advanced their theory of the rotational dynamics of molecules. The "semi-classical" theory incorporates certain classical features into the quantum description of the behavior of matter.

Harter and Patterson asserted that molecular motion uses a rotational energy surface, which is a way of generalizing to rotations the potential energy surface commonly used to describe vibrations. The rotational energy surface allows scientists to define the rotational-vibrational quantum state of a molecule more clearly and to identify the values or range of values for each of the relevant physical quantities.

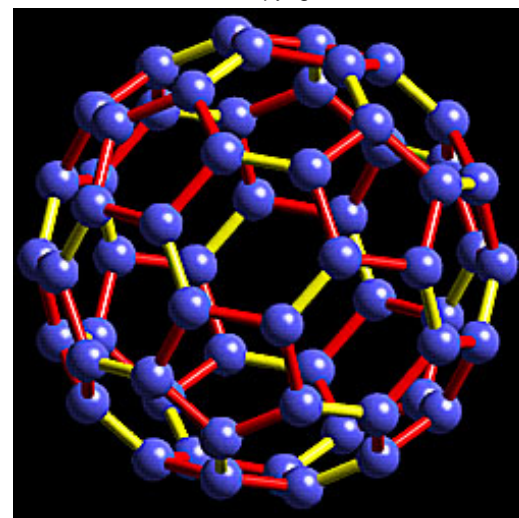
By 1985, Harter and Patterson had examined molecular data obtained with a tunable laser and discovered that molecular rotation resembles just what its name implies — the rotation of a planet on its axis. As molecules spin around their center of gravity, they wobble in a conical pattern or "precess" as they rotate around a multitude of axes. Also, molecules execute a generally slower "tunneling" or tumbling motion that would be forbidden in a world governed by classical mechanics. This rotational form of so-called "quantum tunneling" is seen in nuclear decay and electron flow in semiconductors.

Crucial to the model is that as the molecule rotates, precesses and tunnels, centrifugal force is exerted on its nuclei. This "stretches out" the electronic bonds of the molecule, affecting the vibrational motion of the molecule — which in turn affects its rotation and precession, as well as the dynamics of electronic and nuclear spin moments. The net result is an extremely complex series of interacting movements, which the researchers portrayed in a relatively simple way using the rotational energy surface described in their theory.

In 1987, Harter and former Georgia Tech graduate student David Weeks used Harter's theory to do the first predictions on the rotational-vibrational spectra of the soccer ball-shaped molecule Buckminsterfullerene (C<sub>60</sub>), nicknamed "buckyball." This structure had been proposed in 1985 by a group of Rice University researchers, who had seen a mass-spectra peak of atomic mass 720.

Subsequently, researchers from the University of Arizona and the Max Planck Institute used Harter and Weeks' findings and their Macintosh software program to further analyze C<sub>60</sub>. In 1989, those researchers realized from Harter and Weeks'

Copyright Boris Pevzner, 1995



Former Georgia Tech physics professor Dr. William Harter proposed a molecular rotational dynamics theory he used to make the first predictions on the rotational-vibrational spectra of the soccer ball-shaped molecule Buckminsterfullerene (C<sub>60</sub>), nicknamed "buckyball."

vibrational spectral predictions that they had been making C60 since the early 1970s.

Other experts were skeptical, but IBM labs at San Jose, Calif., verified the University of Arizona's results in 1990. Just two years later, Science named C60 "Molecule of the Year," and the Rice University-led research team received a Nobel prize in chemistry in 1996 for its work with the molecule.

Harter is now a professor of physics at the University of Arkansas, where he studies optimal control theory for quantum systems. In 1995, he was elected a fellow of the American Physical Society. Weeks is a professor at the U.S. Air Force Postgraduate School near Wright Patterson AFB in Dayton, Ohio.

For more information, contact Dr. William Harter at [wharter@comp.uark.edu](mailto:wharter@comp.uark.edu)

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## Basic Discoveries:

### Nanotubes

In 1996, researchers carried out a chemical reaction in what may be the world's smallest set of test tubes: carbon nanotubes with inside diameters of less than 10 nanometers and lengths of just one micron. (A micron is a millionth of a meter.)

The ongoing research, now based at Georgia Tech, was reported in the journal *Science*. Ultimately, it could have important applications in microelectronics and other fields in which extremely small conductors and other structures would allow production of new types of nanoscale devices.

In related research in 1998, the same scientists moved one step closer to a practical application for electron wave effects in extremely small-scale circuits. In laboratory experiments, they observed ballistic conductance — a phenomenon in which electrons pass through a conductor without heating it — at room temperature in multi-walled carbon nanotubes up to five microns long. Again, the results were published in *Science*.

This was the first time that ballistic conductance had been seen at any temperature in a three-dimensional system of this scale. The ability of micron-sized structures to conduct relatively large currents without harmful resistance heating would allow use of the very small conductors.

Earlier this year, the researchers discovered new electronic and micromechanical properties of the nanotubes and proposed one application for them. In *Science*, they suggested a "nanobalance" small enough to weigh viruses and other sub-micron scale particles.

Researchers used electrical voltage to induce electrostatic deflection and vibrational resonance in individual carbon nanotubes. The ability to selectively deflect or induce resonance in individual nanotubes opens new potential micromechanical applications for the tiny structures.

Dr. Walt de Heer, a professor in the [School of Physics](#), and Dr. Z.L. Wang, a professor in the [School of Materials Science and Engineering](#), made the discoveries.

For more information, contact Dr. Walt de Heer, School of Physics, Georgia Tech, Atlanta, GA 30332-0430. (Telephone: 404-894-7880) (E-mail: [deheer@electra.physics.gatech.edu](mailto:deheer@electra.physics.gatech.edu)); or Dr. Z.L. Wang, School of Materials Science and Engineering, Georgia Tech, Atlanta, GA 30332-0245. (Telephone: 404-894-8008) (E-mail: [zhong.wang@mse.gatech.edu](mailto:zhong.wang@mse.gatech.edu))

Courtesy Drs. Walt de Heer & Z.L. Wang



The images above show a bundle of carbon nanotubes (left), and the same bundle to which an oscillating current has been applied (right), causing resonance in one tube.

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999



## Basic Discoveries:

### A New Bacterium

In 1986, a Georgia Tech biology professor in collaboration with scientists at the Centers for Disease Control (CDC) confirmed and reported the first cases of human gastrointestinal illness associated with a bacterium they had first identified only two years earlier in pigs with gastrointestinal illness.

The bacterium, *Campylobacter hyointestinalis*, is a distinct species in the genus *Campylobacter*. One other species in this genus (*C. jejuni*) is responsible for an estimated two million cases of diarrheal illness in people in the United States every year. *C. hyointestinalis* is one of the least common species of the genus, but it caused severe illness in the four patients in which it was reported in the *Journal of Clinical Microbiology* in 1987.

Researchers, led by Georgia Tech's Dr. Paul Edmonds, isolated the bacterium from the patients' stool specimens. They used the DNA-DNA hybridization technique to genetically confirm the identification of the strains. The technique, developed at the CDC, continues to be a state-of-the-art method for identifying unknown strains of bacteria based on a high degree of matching gene sequences in the DNA from samples examined.

The authors also reported that, like patients with illnesses caused by other species in the *Campylobacter* genus, patients with *C. hyointestinalis* infections responded well to treatment with the antibiotic erythromycin.

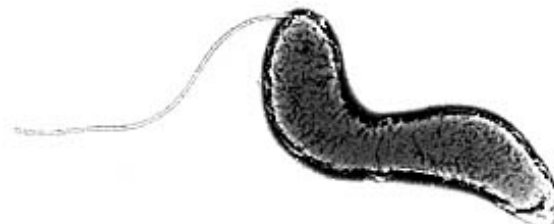
The researchers noted that all four patients in this study could be considered as having compromised health: One was an elderly woman who had recently traveled in Egypt; two were homosexual men; and the fourth was an infant who had been drinking raw milk and untreated well water.

Shortly after the study ended, the researchers received two additional stool specimens containing *C. hyointestinalis*. These were from an elderly man and a 3-year-old boy. Researchers suggested that further research needed to confirm whether the bacterium is restricted to presumably compromised patients or whether it can infect otherwise healthy people.

The researchers' findings were published in the April 1987 issue of the *Journal of Clinical Microbiology*. Edmonds was the lead author. Since the publication of the article, other researchers have reported at least six more cases of human gastrointestinal disease associated with *C. hyointestinalis*. At least one of those cases was in a patient whose immune system was compromised by leukemia. The CDC does not compile statistics on disease related to this bacterium.

Also, since publication of the Edmonds, et al. article, *C. hyointestinalis* has been reported in cattle, sheep, mussels, oysters,

Courtesy of Dr. Paul Edmonds



The bacterium, *Campylobacter hyointestinalis*, was first identified in humans in 1986 by Georgia Tech biology professor Dr. Paul Edmonds. Though rare, it causes severe intestinal illness in humans. ([266-dpi JPEG version - 205k](#))

Macaca nemestrina monkeys and Moluccan rusa deer. A new subspecies has been identified in pigs.

Another more recently developed hybridization technique for identifying bacterial strains is based on 16S rRNA sequence analysis. But the technique called polymerase chain reaction (PCR) is now the most efficient method of detecting the presence of *C. hyointestinalis* in clinical specimens.

For more information, contact Dr. Paul Edmonds, [School of Biology](#), Georgia Tech, Atlanta, GA 30332-0230.  
(Telephone: 404-894-3737) (E-mail: [paul.edmonds@biology.gatech.edu](mailto:paul.edmonds@biology.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## Technological Achievements:

### TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)

[Virtual Therapy](#)

[Near-Field Antenna Measurements](#)

[Near-Field Sampling](#)

[Three-Dimensional Vision](#)

[Fused Silica Radomes](#)

[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)

[Artificial Vision](#)

[FalconView](#)

[Millimeter Wave Radar](#)

[Applied Chaos](#)

[Solar Energy](#)

[Pulse Combustion](#)

[Digital Signal Processing](#)

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

## TABLE of CONTENTS

## Technological Achievements:

### Computer-Aided Structural Design Software

In 1975, researchers in the Georgia Tech [School of Civil Engineering](#) initiated development of a sophisticated structural information processing system capable of performing finite element analysis and structural design.

Led by civil engineering professors Drs. Leroy Emkin and Kenneth Will, the group produced a software product called GT STRUDL®, which represents Georgia Tech Structural Design Language. Since 1979, it has become the largest revenue-producing technology ever licensed by Georgia Tech, and it is used daily by thousands of engineers in about 30 countries worldwide.

Today, with a staff of 15, the Georgia Tech Computer-Aided Structural Engineering Center (CASE), continues to research and develop GT STRUDL. It serves as a "technological pipeline" through which research results and development flow quickly and efficiently to industry, government and educational institutions. The result is a software product that is frequently updated and provides users with state-of-the-art structural analysis and design technology.

GT STRUDL takes engineers' initial ideas, performs mathematical calculations and rapidly predicts how a structure would behave under a variety of loads and stresses. The most recent version of the software operates on PCs and workstations with a powerful Windows-based, menu-driven graphical user interface.

GT STRUDL is now used by more than 800 companies in the fields of construction, heavy industry, plant design, civil works projects, commercial buildings, governmental agencies and educational institutions for the structural design of thousands of projects annually.

Among the organizations using GT STRUDL are the Tennessee Valley Authority, the Southern Company, Bechtel Corp., Mitsubishi, Samsung and the California Department of Transportation. Structure types designed by GT STRUDL include high-rise buildings, large towers, cable-stayed bridges, power plants, flood control dams, offshore platforms,

Courtesy of Dr. Leroy Emkin



First Interstate World Center in Los Angeles is one of many structures worldwide designed with the help of GT-STRUDL, a Georgia Tech- developed structural information processing system. ([300-dpi JPEG version - 395k](#))

boiler buildings and general industrial structures.

Examples of structures designed with the aid of GT STRUDL are Atlanta's Marriott Marquis, the First Interstate World Center in Los Angeles, Two Prudential Plaza in Chicago, the Oeresund Link bridge between Denmark and Sweden and the Three Gorges hydro- electric project in China.

For more information, contact Dr. Leroy Emkin, School of Civil and Environmental Engineering, Georgia Tech, Atlanta, GA 30332-0355. (Telephone: 404-894-2260) (E-mail: [leroy.emkin@ce.gatech.edu](mailto:leroy.emkin@ce.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)

[Virtual Therapy](#)

[Near-Field Antenna Measurements](#)

[Near-Field Sampling](#)

[Three-Dimensional Vision](#)

[Fused Silica Radomes](#)

[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)

[Artificial Vision](#)

[FalconView](#)

[Millimeter Wave Radar](#)

[Applied Chaos](#)

[Solar Energy](#)

[Pulse Combustion](#)

[Digital Signal Processing](#)

[BASIC DISCOVERIES](#)

[TABLE of CONTENTS](#)

## Technological Achievements:

### Virtual Therapy

In the early 1990s, a virtual reality (VR) computing researcher from Georgia Tech partnered with an Emory University psychiatry professor and other specialists in the development of a VR "graded exposure" program to treat people with a fear of heights (acrophobia). The program gradually exposes acrophobics to virtual reality height situations, increasing their exposure in small steps as they are ready.

The researchers published results documenting their success with virtual reality graded exposure in the April 1995 issue of the *American Journal of Psychiatry*. It was believed to be the first controlled study on the use of VR for treating a behavioral disorder. They reported that after two months of treatment, patients undergoing virtual therapy showed significant improvement compared to a control group. In addition, they suggested that virtual therapy may be more time- and cost-effective than traditional exposure therapy.

Research continued to explore other psychiatric applications for the technology, including the use of VR therapy for fear of flying and post-traumatic stress disorder. In 1996, researchers Dr. Larry F. Hodges, a professor in the Georgia Tech [College of Computing](#), and Dr. Barbara O. Rothbaum, a psychiatry professor in Emory University's School of Medicine, founded a company to market their VR therapy programs to qualified therapists.

In 1997, the company, Virtually Better, received a business assistance grant from the state-funded Faculty Research Commercialization Program. Today, the company — in which both Georgia Tech and Emory hold equity positions — is flourishing.

The fear of flying VR therapy program is one with a potentially large impact. Millions of people suffer from a fear of flying. Realizing this need, the researchers designed a virtual reality airplane and are conducting a National Institutes of Mental Health-funded study on treating the fear of flying with VR therapy.

Georgia Tech file photo



A therapeutic program developed at Georgia Tech and Emory University gradually exposes acrophobics to virtual reality height situations, increasing their exposure in small steps as they are ready. One scenario puts patients in a hotel's glass

elevator. [\(300-dpi JPEG version - 314k\)](#)

Traditional exposure therapy has been an effective technique for fear of flying, but exposure therapy is also expensive, logistically difficult to arrange, and presents significant problems of patient confidentiality and potential embarrassment. Using the virtual airplane for exposure therapy is a potential solution to many of the current problems of fear of flying exposure therapy.

Another application of VR therapy is for post-traumatic stress disorder, particularly that experienced by Vietnam War veterans. The researchers have designed a virtual reality simulation of Vietnam War combat. It is being evaluated by psychotherapists at the Atlanta Veterans Administration Hospital and the National Center for Post-Traumatic Stress Disorder in Boston.

For more information, contact Dr. Larry Hodges, College of Computing, Georgia Tech, Atlanta, GA 30332-0280.  
(Telephone: 404-894-8787) (E-mail: [larry.hodges@cc.gatech.edu](mailto:larry.hodges@cc.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

## TABLE of CONTENTS

## Technological Achievements:

### Near-Field Antenna Measurements

An antenna's placement has a substantial bearing on its performance, which can vary across different frequencies and depends upon the shape of the object on which it is mounted.

To determine the best antenna location for a particular situation, Dr. R.C. Johnson of the Engineering Experiment Stations (now [Georgia Tech Research Institute](#), GTRI) invented the compact radar range in the late 1960s. The technique simulates a plane wave over the entire antenna under testing and involves two main elements: a parabolic reflector and a mechanical device that lifts and rotates the target antenna.

Although the compact range operates in a relatively small space — most are indoors — it can measure the radiation patterns of antennas as they would occur over long distances. Advantages of indoor compact ranges are security and the ability to operate regardless of weather conditions.

The characteristics of the compact radar range, now offered commercially by Scientific-Atlanta, are typical: Useful measurement area approximates a 4-foot cylindrical region — large enough for a 4-foot reflector — although actual useful area varies with frequency band and accuracy required. Antennas up to eight feet can be handled by the facility, which includes controlled access for security and a dedicated air-handling system for temperature stability.

Without the compact range, the alternative would have been a far-field range test site, which consists of two towers whose separation depends on the target size and frequencies studied. One tower holds the antenna under test while the other receives the signals. Given the size of vehicles and the high frequencies involved, far-field towers would have to be stationed several miles apart.

At Fort Huachuca, Ariz., GTRI designed an outdoor compact radar range, thought to be the world's largest, for the U.S. Army. The facility, which includes a 75-foot parabolic reflector and a lift capable of positioning objects up to 50 feet long and weighing as much as 70 tons, was built to measure antenna performance from 6 to 40 GHz on vehicles and helicopters.

Georgia Tech file photo



At Fort Huachuca, Ariz., the U.S. Army constructed a compact radar range thought to be the world's largest. GTRI scientist Dr. R.C. Johnson invented the compact range in the late 1960s.



For more information, contact Dr. Bob Trebits, Sensors and Electromagnetic Applications Laboratory, GTRI, Georgia Tech, Atlanta, GA 30332-0859. (Telephone: 770-528-7915) (E-mail: [bob.trebits@gtri.gatech.edu](mailto:bob.trebits@gtri.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)

[Virtual Therapy](#)

[Near-Field Antenna Measurements](#)

[Near-Field Sampling](#)

[Three-Dimensional Vision](#)

[Fused Silica Radomes](#)

[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)

[Artificial Vision](#)

[FalconView](#)

[Millimeter Wave Radar](#)

[Applied Chaos](#)

[Solar Energy](#)

[Pulse Combustion](#)

[Digital Signal Processing](#)

[BASIC DISCOVERIES](#)

[TABLE of CONTENTS](#)

## Technological Achievements:

### Near-Field Sampling

In the early 1970s, the extensive antenna-testing research performed at Georgia Tech included development of techniques to measure antenna radiation patterns without need for building a large far-field test range.

One such technique was near-field sampling. Researchers measured the near field of an antenna, then calculated the far-field pattern from the measurements, while simultaneously correcting for the directional effects of the measuring probe.

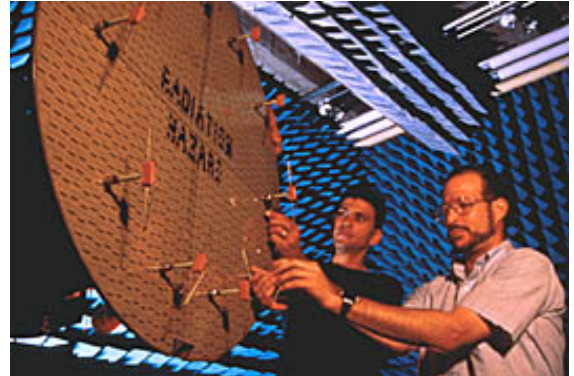
Researchers investigated plane and cylinder sampling surfaces. For the plane, the near field was measured in front of the test stationary antenna by moving the measuring probe both vertically and horizontally in front of the antenna. For the cylinder, the antenna was mounted on a rotating turntable in front of a probe that could be moved on a vertical line.

Near-field measurements can also be use to calculate other aspects of antenna performance, including gain and polarization ratio.

Electrical engineering professors Drs. Ed Joy and Marshall Leach conducted the research under the guidance of the late Dr. Demetrius Paris, who served as their thesis advisor and mentor.

For more information, contact Dr. Ed Joy (retired) or Dr. Marshall Leach, [School of Electrical and Computer Engineering](#), Georgia Tech, Atlanta, GA 30332-0250. (Joy's Telephone: 303-776-5389) (Leach's Telephone: 404-894-2963) (Joy's E-mail: [ed.joy@ee.gatech.edu](mailto:ed.joy@ee.gatech.edu)) (Leach's E-mail: [marshall.leach@ee.gatech.edu](mailto:marshall.leach@ee.gatech.edu))

Georgia Tech file photo



In the 1970s, Georgia Tech researchers used near-field sampling to measure antenna radiation patterns, such as this one for the F-15, without need for building a large far-field test range.

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

## [TABLE of CONTENTS](#)

## *Technological Achievements:*

### **Three-Dimensional Vision**

In the late 1970s and early 1980s, former Engineering Experiment Station research engineer Richard Steenblik worked tenaciously to develop a three-dimensional vision technique that has today provided the basis for a successful and popular commercial optical film product used in certain 3-D glasses.

The Chromatek Inc. product, called ChromaDepth 3-D, uses pieces of microptic film to selectively shift the points at which different colors of light are focused. Known as chromostereoscopy, the technique makes objects of different colors appear to be at varying distances from the viewer.

The technique developed after Steenblik noticed slight 3-D effects produced by a video game. The effect was caused by an imperfection called chromatic aberration in the lenses of the eye. Also, Steenblik knew the brain expects that red color often comes from objects close to the viewer, while blue tends to come from objects far away.

Steenblik worked to enhance the effect and concluded that passing light through two different liquids would provide the necessary shifting, known as refraction. In his first prototype model, he used two liquids of Chinese cinnamon oil and glycerin, which provided the opposing refraction needed to produce right-eye and left-eye views from the same two-dimensional image.

Steenblik patented the technique in 1983 and soon thereafter founded Atlanta-based Chromatek Inc. with New York businessman Frederick Lauter. The company owners then developed 3-D glasses based on double prisms, rather than liquids, but they did not work as well as Steenblik hoped.

Early collaboration with binary optics scientists at the Massachusetts Institute of Technology allowed for the inexpensive manufacture of the complex prism patterns needed to produce the 3-D effect. The new product debuted in 1992.

Georgia Tech licensed the 3-D vision technique to Chromatek, while MIT licensed the binary optics technology to the company.

Georgia Tech file photo



A three-dimensional vision technique patented in 1983 by a former GTRI researcher is used today in the production of a commercial optical film product used in 3-D glasses. Inventor Richard Steenblik (shown here) founded Chromatek Inc. in Alpharetta, Ga., to manufacture and market the product.

Today, Chromatek markets the low-cost, easy-to-implement stereoscopic 3-D ChromaDepth process for all color display media. ChromaDepth 3-D images look normal until viewed with the patented ChromaDepth 3-D optics. Then they jump into dramatic 3-D. More than 100 million pair of ChromaDepth 3-D glasses have been purchased since 1992 for various marketing and promotional uses.

For more information, contact Richard Steenblik, Chromatek Inc., 11450-F North Fulton Industrial Boulevard, Alpharetta, GA 30201. (Telephone: 404-772-9852) (E-mail: [nowuc3d@mindspring.com](mailto:nowuc3d@mindspring.com))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)

[Virtual Therapy](#)

[Near-Field Antenna Measurements](#)

[Near-Field Sampling](#)

[Three-Dimensional Vision](#)

[Fused Silica Radomes](#)

[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)

[Artificial Vision](#)

[FalconView](#)

[Millimeter Wave Radar](#)

[Applied Chaos](#)

[Solar Energy](#)

[Pulse Combustion](#)

[Digital Signal Processing](#)

[BASIC DISCOVERIES](#)

[TABLE of CONTENTS](#)

## Technological Achievements:

### Fused-Silica Radomes

Radomes — the structures that shield a missile's sensors — must withstand rapid high heating and harsh weather while maintaining a special quality that allows radio signals to pass through them.

That was part of the challenge of a research project first presented to the Engineering Experiment Station (now [Georgia Tech Research Institute](#)) in the late 1950s.

Highly regarded for their work in high-temperature ceramic materials, Tech researchers developed a slip-cast fused silica technique for forming refractories of massive size and complex shapes — structures such as radomes and missile nose cones, and rocket engine components.

Researchers developed several improvements to the fused-silica process over the years. In 1970, researchers discovered that manipulating the rate of heating, temperature and the time at temperature affect the development of the ceramic's mechanical strength in a phenomenon called sintering. The result was 50 percent stronger than previous efforts, yet maintained the requisite electromagnetic properties.

By the end of the 1980s, Tech researchers learned that adding aluminoborosilicate fibers to the mix strengthened the material. A further refinement was made when they found that short fibers - - meaning lengths 20 or 30 times their diameter versus fibers measuring 100 times their diameter — doubled radome strength with only a minimal loss of density.

The shorter fibers also prevented clumping during slip casting, a condition that results in lower density and strength, and large flaws.

Fibers increase the amount of energy needed to break the fused silica material. And should a crack develop, it would run into a fiber and follow the fiber along a tortuous path.

Courtesy Defense Visualization Information Service



GTRI scientists developed an improved technique for producing radomes, the structures that shield a missile's sensors, that are now widely used for intelligent missile systems such as the Patriot shown here.

The radomes developed at Tech are widely used for intelligent missile systems such as the Patriot.

For more information, contact retired GTRI employees Joe Harris at 770-279-7291 or Jesse D. Walton at 404-634-2033.

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

## TABLE of CONTENTS

## Technological Achievements:

### Monodisperse Aerosol Generation Interface

Technological "magic" developed at Georgia Tech in the late 1970s opened the door for the first time to mass spectrometric analysis of a wide range of organic compounds using liquid chromatography.

Mass spectrometry allows precise identification of complex chemical compounds by breaking them into small fragments and identifying the fragments in unique patterns according to molecular weight. Mass spectrometry has been useful for characterizing a wide range of volatile organic compounds, but only a small number of involatile or thermally unstable ones.

Because mass spectrometers can analyze only one compound at a time, researchers use chromatographs to separate compounds in chemical mixtures. Gas chromatographs have limited effectiveness with organic compounds. The alternative, liquid chromatography, was of limited value because there was no way to separate a compound from the stream of fluid in a liquid chromatograph.

In 1978, the [School of Chemistry and Biochemistry's](#) Dr. Richard Browner began work on the use of aerosols to remove the liquid solvents in a chromatograph. The result was Monodisperse Aerosol Generation Interface Combining Liquid Chromatography with Mass Spectrometry, abbreviated as MAGIC. This device allows for the development of the new "hyphenated" technique, LC/MS, or "liquid chromatography with mass spectrometry."

With the MAGIC interface, the flow of liquids carrying the separated compounds in the chromatograph is sprayed with an aerosol involving a helium-gas jet that removes the liquid solvents by evaporation.

MAGIC's potential, especially in the fast-growing biotechnology industry, was recognized by Hewlett-Packard. The company purchased exclusive rights to commercialize the product, which it sells under the name Particle Beam. Today, more than 400 of the instruments are in use in university, government and industrial laboratories worldwide.

In 1989, Browner followed up on MAGIC's initial success by perfecting technology for interfacing a liquid

Georgia Tech file photo



An analytical chemistry device developed by Georgia Tech professor Dr. Richard Browner in the 1970s has been commercialized by Hewlett-Packard, which it sells under the name Particle Beam. The patented name is Monodisperse Aerosol Generation Interface Combining Liquid Chromatography with Mass Spectrometry, abbreviated as MAGIC.

chromatograph with a Fourier transform infrared spectrometer. Co-invented with the University of Georgia's Dr. Jim deHaseth, the Fourier device links two complementary, but previously incompatible, methods of chemical analysis.

The instrument facilitates separation of mixtures containing many chemical compounds into separate components by a chromatographic or other separation process. The species derived from the chromatographic column are identified by their infrared spectra.

The system allows on-line, continuous flow analysis to be carried out with a wide range of solvent types typically used for chromatographic separations. These include normal phase solvents, such as water, aqueous buffers, acetonitrile, methanol and various combinations of the solvents.

The Fourier instrument extends the reach of mass spectrometry even further and can analyze about 95 percent of all chemicals.

Also marketed by Hewlett-Packard, the device can be used for analyzing pharmaceuticals, food products and environmental pollutants, as well as conducting basic research into the nature of particular substances.

For more information, contact Dr. Richard Browner, School of Chemistry, Georgia Tech, Atlanta, GA 30332-0400. (Telephone: 404-894-4020) (E-mail: [rick.browner@chemistry.gatech.edu](mailto:rick.browner@chemistry.gatech.edu))

---

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999



## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

## TABLE of CONTENTS

## Technological Achievements:

### Photonic Sensors

In the late 1980s, [GTRI](#) researcher Nile Hartman developed an optical sensing apparatus and sensing method that provided improved stability and lower cost than what was then available. In 1990, that invention was patented, but Hartman had already taken his research to the next level. He was developing an integrated optic interferometric sensor that would quickly detect even smaller amounts of various contaminants in air, soil, groundwater and food. In 1997, the work reached a major milestone when it was patented by Hartman and the Georgia Tech Research Corporation.

Subsequently, the sensor was licensed commercially by the Atlanta-based company Photonic Sensor. The company is a recent graduate of Georgia Tech's Advanced Technology Development Center, a business incubator for high-tech firms.

Hartman's sensor was developed from laser-based technology originally conceived for optical communication applications. That technology allows a multichannel microsensors fitted with the proper chemical coatings to simultaneously detect multiple contaminants. It works like this: The speed of light increases or decreases when passing through materials of differing optical properties. Detection of contaminants becomes possible by measuring a contaminant's influence on the optical properties of the sensor. Then researchers observe the effects on these properties through changes in the transmitted laser light.

The sensors have been integrated into an environmental monitoring system called E-SMART, which can detect and analyze various chemical contaminants, including heavy metals, solvents, and petroleum oil and lubricants. E-SMART operates in real time and measures very small amounts of contaminants. In addition, researchers say it will reduce health and safety risks and help ensure environmental compliance.

An ongoing series of E-SMART field tests at U.S. Department of Defense facilities will precede the product's availability on the national and international commercial markets. When it does become available, the E-SMART system and also the sensor as a stand-alone environmental monitor will have numerous applications in the private sector, from manufacturing operations to water treatment facilities.

Photo by Gary Meek



An integrated optic interferometric sensor, developed by GTRI scientist Nile Hartman, quickly detects even the smallest amounts of various contaminants in air, soil, groundwater and food. ([300-dpi JPEG version - 323k](#))

An additional application of the photonic sensor technology is a rapid-response biosensor for detecting microbial contamination in food, particularly poultry. The biosensor incorporates integrated optics, immunoassay techniques and surface chemistry skills. Hartman developed it in collaboration with Dr. Paul Edmonds, an associate professor of biology at Georgia Tech, and Dr. Dan Campbell, a research scientist in GTRI. A field test in a north Georgia poultry plant is expected to begin later this fall.

For more information, contact Nile Hartman, Electro-Optics, Environment and Materials Laboratory, [Georgia Tech Research Institute](#), Georgia Tech, Atlanta, GA 30332-0825. (Telephone: 404/894-3503) (E-mail: [nile.hartman@gtri.gatech.edu](mailto:nile.hartman@gtri.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)

[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

[TABLE of CONTENTS](#)

## Technological Achievements:

### Artificial Vision

A machine vision device developed at Georgia Tech in the late 1980s is helping manufacturers improve productivity and quality by imparting greater accuracy and speed to their automated inspection capability.

Marketed as the SmartImage Sensor, the device integrates optics, image-acquisition electronics and a microprocessor. The system can, for example, provide quality control inspection results and statistical process-control data and coordinate information for motion controllers.

The technology, invented by Drs. Steve Dickerson and Kok-Meng Lee of Georgia Tech's [School of Mechanical Engineering](#), differs from traditional machine vision by eliminating TV signal-conversion electronics, fixed-frame rates and fixed field of view (image size and location).

SmartImage Sensor allows dynamic access of the charge-coupled device (CCD) with none of the horizontal image jitter associated with conventional frame-grabber-based systems. Horizontal jitter can result in image movement of more than 10 times the desired inspection accuracy. It also can lead to distorted geometric shapes and poor repeatability of performance, especially when performing measurement of components or other high-accuracy inspections.

The sensor also differs from traditional systems by providing a variable inspection rate of 40 to 70 parts a second; traditional systems have a fixed rate of 60 frames a second. SmartImage can be customized for specific manufacturing environments. Also, its embedded microprocessor can perform partial image acquisitions, increasing image-acquisition rates to more than 4,000 inspections a minute.

In 1991, Atlanta-based DVT Inc. was awarded exclusive licensing rights to the technology, and has continually upgraded the sensor's speed and image-resolution capabilities.

More than 4,000 SmartImage sensors are at work in nearly every manufacturing sector, including automotive, metal

Photo by Gary Meek



Manufacturers inspecting their products on the assembly line got increased speed and accuracy with Georgia Tech's development of an artificial machine vision system. Mechanical engineering professors Drs. Steve Dickerson and Kok-Meng Lee (pictured here) co-invented the device called SmartImage Sensor.

stamping, injection moulding, semiconductors, pharmaceuticals and electronics.

For more information, contact Dr. Steve Dickerson, School of Mechanical Engineering, Georgia Tech, Atlanta, GA 30332-0405. (Telephone: 404-894-3255) (E-mail: [steve.dickerson@me.gatech.edu](mailto:steve.dickerson@me.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)

[Virtual Therapy](#)

[Near-Field Antenna Measurements](#)

[Near-Field Sampling](#)

[Three-Dimensional Vision](#)

[Fused Silica Radomes](#)

[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)

[Artificial Vision](#)

[FalconView](#)

[Millimeter Wave Radar](#)

[Applied Chaos](#)

[Solar Energy](#)

[Pulse Combustion](#)

[Digital Signal Processing](#)

## BASIC DISCOVERIES

## TABLE of CONTENTS

## Technological Achievements:

### FalconView

Military pilots can prepare their flight charts faster and with greater accuracy, thanks to a laptop computer-based system developed at the [Georgia Tech Research Institute](#) (GTRI) beginning in 1992.

FalconView — developed for the U.S. Air Force by GTRI, the U.S. Air Force Reserve and the Air National Guard — replaces hand-drawn mission maps with high-resolution graphics displayed on a laptop computer screen carried onboard an aircraft. The system displays data, such as the locations of no-fly zones, buildings and other structures. Its maps also note objects that produce electronic emissions within certain bands, including friendly aircraft and ships.

Connected to a modem or network, FalconView can receive the latest information concerning troop movements, weather and detailed threat information. The system takes into account topography, flight elevation and the range of a threat's radar system to let pilots know whether their planes are detectable.

In addition, pilots can set up maps and give different symbols to various features. Each symbol can be clicked on for more information in the form of a text document, sound file, photograph or even a Web page — each related and geo-referenced to sites on the map.

Originally designed for use in fighter airplanes, FalconView has been customized for a range of military aircraft, such as helicopters and cargo transports.

FalconView was one of five finalists in the Sixth Annual Windows World Open Competition, which recognizes developers for creating breakthrough problem-solving, custom Microsoft Windows applications.

An estimated 13,000 air crew members worldwide use FalconView. Among them are members of the 89th Airlift Wing at Andrews Air Force Base, Md., which provides executive support missions for the president, vice president and other high-ranking U.S. government officials.

Photo by Stanley Leary



Military personnel test a laptop computer system called FalconView on a U.S. Air Force C-130. FalconView, developed at GTRI, helps pilots prepare flight plans faster and with greater accuracy. ([300-dpi JPEG version - 733k](#))

Principal researchers for FalconView included John Pyles, Vinnie Sollicito, Rob Gue and Jim Rhodes.

For more information, contact Terry N. Hilderbrand, Information Technology and Telecommunications Laboratory, Georgia Tech Research Institute, Georgia Tech, Atlanta, GA 30332-0832. (Telephone: 404-894-3523)  
(E-mail: [falconview@gtri.gatech.edu](mailto:falconview@gtri.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)

[Virtual Therapy](#)

[Near-Field Antenna Measurements](#)

[Near-Field Sampling](#)

[Three-Dimensional Vision](#)

[Fused Silica Radomes](#)

[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)

[Artificial Vision](#)

[FalconView](#)

[Millimeter Wave Radar](#)

[Applied Chaos](#)

[Solar Energy](#)

[Pulse Combustion](#)

[Digital Signal Processing](#)

[BASIC DISCOVERIES](#)

[TABLE of CONTENTS](#)

## Technological Achievements:

### Millimeter Wave Radar

In the 1950s, expanding upon the radar work started at the end of World War II, scientists at the Engineering Experiment Station (now [Georgia Tech Research Institute](#), GTRI) began investigating use of the millimeter portion of the electromagnetic spectrum. That work represents significant contributions to the national technology base and established Georgia Tech's international reputation in radar research and development.

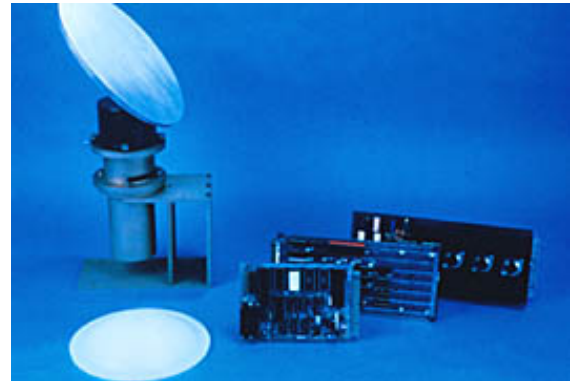
The advantages of millimeter waves include their ability to provide accurate, excellent image identification and resolution. They also provide remote measurements while operating through smoke, dust, fog or rain. At the same time, millimeter waves can be vulnerable to absorption by certain atmospheric and meteorological activity. GTRI scientists learned which frequencies work best for a particular task and better identified and refined windows of attenuation — the frequencies that mitigate atmospheric interference with the signals.

Millimeter wave research at GTRI has been an ongoing process of discovering the appearance of objects — from tanks to raindrops — when viewed by high-frequency waves. Researchers have also determined the types of data — specifically the absorption and reflection characteristics — they can derive from the interaction of those objects with the waves. In the process, they have pioneered the fundamental science of the millimeter wave environment, while inventing the hardware — antennas, receivers and transmitters — to use that end of the spectrum.

GTRI built the first military-designation millimeter wave radar in the late 1950s, followed by a succession of increasingly advanced models. By the 1980s, ongoing research to build a radar with a wavelength as near to 1 millimeter as possible culminated in development of the world's highest-frequency microwave radar, operating at 225 GHz. The device can provide useful imaging with an antenna less than 30 centimeters in diameter and is coherent, meaning it can detect Doppler returns from moving targets.

Research by the late Jim Gallagher in millimeter spectroscopy paved the way for exploiting millimeter waves for measurements in radio astronomy, satellite-based studies of the upper atmosphere, climate, rainfall and vegetation

Georgia Tech file photo



GTRI scientists have used a millimeter wave radar direction finding system (shown here) to discover the appearance of objects — from tanks to raindrops — when viewed by high-frequency waves.

patterns, and a host of other environmental concerns.

Tech scientists have also achieved a number of firsts in millimeter characterization of clutter and targets — essential data for reliable millimeter radar systems. Since the 1960s, more than a dozen projects have provided millimeter measurements of the ocean, rain, snow-covered ground, desert, foliage and foreign military vehicles. In the 1980s, GTRI researchers conducted a comprehensive study of the image-quality effects of atmospheric turbulence and precipitation on millimeter wave propagation.

The versatility of millimeter wave technology is illustrated by the radar flashlight developed at GTRI. It is a device that detects respiration at a distance. Originally developed to locate wounded soldiers on a battlefield, it may prove useful in situations where access is difficult, such as a collapsed building following an earthquake.

In their ongoing search for more applications of millimeter wave technology, GTRI scientists are examining its potential for an automatic target-recognition system, as well as in various electronic countermeasures and counter-countermeasures. These include decoy beacons, threat assessment, reconnaissance and signal disruption.

While innumerable researchers are responsible for GTRI's national leadership in millimeter wave research and development, particular recognition belongs to Harold Bassett, Don Bodnar, Ron Bohlander, Charlie Brown, Clark Butterworth, John M. Cotton, Nick Currie, Jim Echard, Ron Forsythe, J.J. Gallagher, Bill Holm, Ted Lane, Robert W. McMillan, Guy Morris, Sam Piper, Ed Reedy, James Scheer, Bob Trebits and Jim Wiltse.

For more information, contact Dr. Ed Reedy, Director, Georgia Tech Research Institute, Georgia Tech, Atlanta, GA 30332-0801. (Telephone: 404-894-3400) (E-mail: [ed.reedy@gtri.gatech.edu](mailto:ed.reedy@gtri.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999



# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)

[Virtual Therapy](#)

[Near-Field Antenna Measurements](#)

[Near-Field Sampling](#)

[Three-Dimensional Vision](#)

[Fused Silica Radomes](#)

[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)

[Artificial Vision](#)

[FalconView](#)

[Millimeter Wave Radar](#)

[Applied Chaos](#)

[Solar Energy](#)

[Pulse Combustion](#)

[Digital Signal Processing](#)

[BASIC DISCOVERIES](#)

[TABLE of CONTENTS](#)

## Technological Achievements:

### Applied Chaos

The Georgia Tech Applied Chaos Laboratory has made some significant strides toward harnessing the scientific phenomena of chaos to improve medical devices and computing in the past several years.

In the medical realm, research published in *Nature* in March 1998 revealed the chaotic patterns of an often-fatal condition called ventricular fibrillation. The findings put scientists a step closer to developing a new defibrillator or improving existing ones. Dr. William Ditto, head of the Applied Chaos Laboratory, was among the international team of researchers that conducted the study.

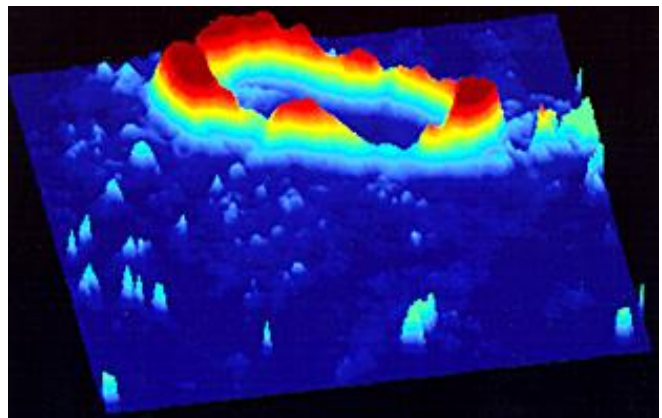
In the study, a remarkable series of high-resolution movies clearly showed how ventricular fibrillation disrupts the electrical signals that normally govern the heart. The movies reveal a series of unusual spiral waves that originate with "rotors" near the surface of the heart.

Because the spiral waves seem chaotic in their behavior, researchers hope they can apply newly discovered chaos control techniques to restore normal heartbeat. Instead of the massive jolt of electricity that current defibrillators provide, the chaos control technique might bring the heart back into normal rhythm using carefully applied electrical signals of much less energy.

In 1995, Ditto and colleagues Steven Schiff of the Children's National Medical Center and Mark Spano of the Naval Surface Warfare Center reported early success at altering chaotic patterns of brain activity similar to those associated with certain types of epileptic seizures. That work may provide a new option for severe cases of epilepsy now remedied only with brain surgery.

More recently, in September 1998, Ditto and collaborator Sudeshna Sinha of the Institute of Mathematical Sciences in Madras, India, reported in *Physical Review Letters* a revolutionary new computing technique that uses a network of chaotic elements to "evolve" its answers. The technique could provide an alternative to the digital computing systems widely used today. This "dynamics-based computation" may be well suited for optical computing using ultra-fast

Courtesy of Dr. William Ditto



Applications of the scientific phenomena of chaos include future development of better ways of controlling ventricular fibrillation in the human heart. [Bioengineering](#) professor Dr. William Ditto examined high-resolution movies (shown here) of a heart in v-fib. They revealed a series of spiral waves that originate with "rotors" near the surface of the heart. ([200-dpi JPEG version - 280k](#))

chaotic lasers and computing with silicon/neural tissue hybrid circuitry.

For more information, contact Dr. William Ditto, [School of Biomedical Engineering](#), Georgia Tech, Atlanta, GA 30332-0535. (Telephone: 404-894-5216) (E-mail: [wditto@acl.gatech.edu](mailto:wditto@acl.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

## TABLE of CONTENTS

## Technological Achievements:

### Solar Energy

In the mid-1970s, the Engineering Experiment Station, now the Georgia Tech Research Institute (GTRI), got in on the ground floor of solar energy with programs in high temperature solar thermal energy conversion, and liquidification and gasification of biomass using solar thermal energy. A decade later, as research funding interests changed, the focus of solar energy studies at Georgia Tech moved to photovoltaic devices, which convert sunlight directly into electricity.

Led by the U.S. Department of Energy-funded Solar Thermal Test Facility managed by GTRI's Dr. Tom Brown, early studies at GTRI demonstrated the ability to store solar energy for nearly an hour. The next advancement was a method for creating high-grade synthetic fuels with solar thermal energy.

In 1980, Brown and researchers from Princeton University announced a breakthrough in pyrolysis, an established process for producing liquid and gaseous fuels from biomass materials, such as wood and corn cobs. Highly concentrated solar energy, rather than burning of biomass, provided the heat necessary for pyrolysis reactions. The method's advantages were conserving the biomass feedstock and producing a higher quality fuel.

Subsequently, GTRI senior research engineer Jim Walsh and others were instrumental in developing standards for several different types of biomass fuels through the American Society for Testing and Materials (ASTM). The organization named Walsh a fellow in 1995 for his work on the project.

Two years later, researcher Doug Neale and other GTRI engineers at the Solar Thermal Test Facility produced directly usable electricity with a Swedish-built external combustion engine whose pistons were driven by helium heated by intense sunlight. At the time, the engine was three times more energy efficient than photovoltaic panels. The engine's manufacturer later marketed it to supply the power needs for irrigation and desalination in Third World countries.

By the mid-1980s, utility companies shifted their interest to photovoltaics (PV), as the efficiency of PV devices increased and the cost of making solar cells decreased. A research program led by electrical engineering professor Dr.

Photo by Stanley Leary



Electrical engineering professor Dr. Ajeet Rohatgi (front) fabricates cheaper, more efficient solar cells in Georgia Tech's University Center of Excellence for Photovoltaics Research and Education. ([300-dpi JPEG version - 570k](#))

Ajeet Rohatgi studied new semiconductor materials and designed innovative devices.

In 1992, Rohatgi's work garnered Georgia Tech a Department of Energy contract to operate the [University Center of Excellence for Photovoltaics Research and Education](#) (UCEP). Its goal is to help make photovoltaics a leading contender in the search for clean, renewable energy sources.

One of its working research laboratories is the 340-kilowatt PV system installed in the Georgia Tech Aquatic Center, which was built for the 1996 Olympics. At the time, this was the world's largest rooftop grid-connected PV system. The system produces about 400 megawatt hours of electrical energy per year and has already produced close to 1,000 megawatt hours of energy. It is providing significant, long-term data on how to build and maintain large-scale PV structures.

In 1997, Rohatgi's research team reported on a process called rapid thermal processing (RTP), through which they cut in half the time it takes to make a silicon solar cell without diminishing its performance. They produced a solar cell with the same efficiency rating — 18 percent — as one made by conventional furnace processing. They created the cells in 8-1/2 hours, compared with the 17 hours needed for a furnace-processed cell.

More recently, researchers have combined RTP with screen-printed (SP) contact technology to reduce the cell processing time to less than two hours. This RTP-SP rapid technology has produced silicon solar cells with greater than 17 percent efficiency, and further improvements are expected with process optimization.

As their research continues, Georgia Tech's UCEP scientists are compiling an impressive list of achievements. They hold patents for seven production techniques and have applied for several others. They've published more than 150 papers in peer-reviewed journals and both refereed and non-refereed conference proceedings.

For more information, contact Tom Brown, Georgia Tech Research Institute, Georgia Tech, Atlanta, GA 30332-0816. (Telephone: 404-894-0834) (E-mail: [tom.brown@gtri.gatech.edu](mailto:tom.brown@gtri.gatech.edu)); or Dr. Ajeet Rohatgi, School of Electrical and Computer Engineering, Georgia Tech, Atlanta, GA 30332-0250. (Telephone: 404-894-7692) (E-mail: [ajeet.rohatgi@ee.gatech.edu](mailto:ajeet.rohatgi@ee.gatech.edu))

Photo by Gary Meek



Georgia Tech scientists continue to collect data from the solar energy system atop the Tech Aquatic Center, built for the 1996 Atlanta Olympic Games. ([300-dpi JPEG version - 290k](#))

---

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

## TABLE of CONTENTS

## Technological Achievements:

### Pulse Combustion

The vibrations caused by combustion instabilities that can destroy a rocket motor can also make industrial furnaces more efficient and productive, says Dr. Ben Zinn. For more than 30 years, Zinn, of Georgia Tech's [School of Aerospace Engineering](#) and [School of Mechanical Engineering](#), has studied the causes and control of combustion instabilities that generate intense sound inside a variety of combustion systems, particularly in rocket motors and gas turbines. Unless controlled, these large-amplitude sound waves will cause engine or mission failure.

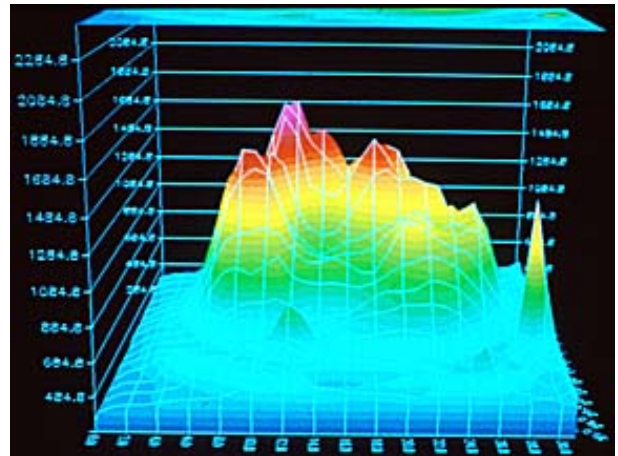
Dr. Zinn's team, one of the world's premier research groups in this field, is developing a novel approach for preventing the occurrence of detrimental combustion instabilities. Their approach employs a control system that rapidly detects the presence of sound waves and then modifies the fuel-injection scheme in a manner that instantaneously dampens the instability.

To date, the effectiveness of this approach has been demonstrated on an experimental rocket motor at Georgia Tech and on a full-scale, power-generating, low-emissions gas turbine at Westinghouse.

Zinn's studies have also found that the intense sound waves that occur in rockets and gas turbines can improve domestic and industrial combustion systems. Zinn's group, with the support of the Gas Research Institute, U.S. Department of Energy and the Environmental Protection Agency, has demonstrated that pulse combustion — an oscillatory combustion process that generates sound waves — can increase the efficiency and productivity of unpulverized coal combustors, full-scale rotary cement kilns, steel ladle preheaters, incinerators and dryers.

The pulse combustion process also increases the combustion efficiency and lowers the emissions of nitrogen oxides, carbon monoxide and soot in systems that burn such fuels as coal, wood, propane and natural gas.

Courtesy of Dr. Ben Zinn



Pulse combustion — an oscillatory combustion process that generates sound waves — can increase the efficiency and productivity of unpulverized coal combustors, full-scale rotary cement kilns, steel ladle preheaters, incinerators and dryers, according to research led by aerospace engineering professor Dr. Ben Zinn.

Zinn and his colleagues are working, under Department of Defense support, on the development of novel micro-combustion and power generation systems that could power remote sensors and unmanned aircraft and vehicles. Further into the future, these micro-power generators could replace batteries. The sound waves reverberating inside these systems may be beautiful music to the environment and economy.

For more information, contact Dr. Ben Zinn, School of Aerospace Engineering, Georgia Tech, Atlanta, GA 30332-0150. (Telephone: 404-894-3033) (E-mail: [ben.zinn@aerospace.gatech.edu](mailto:ben.zinn@aerospace.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

# Research Horizons

## TECHNOLOGICAL ACHIEVEMENTS

[Computer-Aided Structural Design](#)  
[Virtual Therapy](#)  
[Near-Field Antenna Measurements](#)  
[Near-Field Sampling](#)  
[Three-Dimensional Vision](#)  
[Fused Silica Radomes](#)  
[Monodisperse Aerosol Generation](#)

[Photonic Sensors](#)  
[Artificial Vision](#)  
[FalconView](#)  
[Millimeter Wave Radar](#)  
[Applied Chaos](#)  
[Solar Energy](#)  
[Pulse Combustion](#)  
[Digital Signal Processing](#)

## BASIC DISCOVERIES

## TABLE of CONTENTS

## Technological Achievements:

### Digital Signal Processing

Work at Georgia Tech to improve the technology for digital transmission and storage of speech signals led to a new national standard in digital speech compression. The U.S. Department of Defense's Digital Voice Processors Consortium awarded the designation in May 1996 following a three-year, federally sponsored competition among a host of highly respected research labs.

The digital speech standard follows years of research at Georgia Tech in general speech and audio processing. The work includes three-dimensional modeling of speech production, low-rate speech coding, speech analysis and synthesis, speaker characterization, speech quality measurement, automatic speech recognition and digital audio coding at high quality.

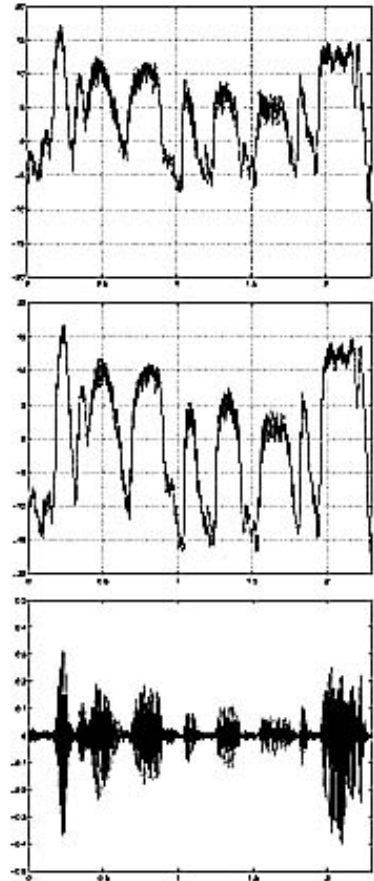
This new standard is improving telecommunications technology and reverberating throughout the cellular, Internet, telephone and wireless communications industries.

The standard resulted from research started in the late 1980s by graduate student Alan McCree and Dr. Thomas Barnwell III, a professor in the School of Electrical and Computer Engineering. In essence, the work involves development of processing algorithms that incorporate knowledge of speech production processes and the intrinsic redundancies of human speech.

With those algorithms, the computer-sampled voice signal can be stripped down in the laboratory and then reconstituted without the listener perceiving any great difference.

Researchers have developed a voice coder or "vocoder" that systematically constructs high-quality synthetic speech by "remembering" and "using" voice redundancies. Key to the vocoder's performance is a filter through which the excitation source passes.

Courtesy ASP Inc.



Georgia Tech research by Drs. Ronald Schafer and Thomas Barnwell III has improved the technology for digital transmission and storage of speech signals and led to a new national standard in digital speech compression. [Click here to see larger 70k version.](#)

Ten parameters in the filter interact with the source in such a way that the natural voice signal it was derived from can be defined, then reproduced.

Barnwell is co-founder and president of Atlanta Signal Processors Inc., which sells hardware and software tools for digital signal-processing algorithm development and multimedia on high-speed microprocessors.

For more information, contact Dr. Thomas Barnwell III, [School of Electrical and Computer Engineering](#), Georgia Tech, Atlanta, GA 30332-0250. (Telephone: 404-894-2914) (E-mail: [tom.barnwell@ee.gatech.edu](mailto:tom.barnwell@ee.gatech.edu))

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999



## Harnessing Brain Power

**Georgia Tech research assists direct brain-computer interaction.**

By Gary Goettling

F-I-V-E.

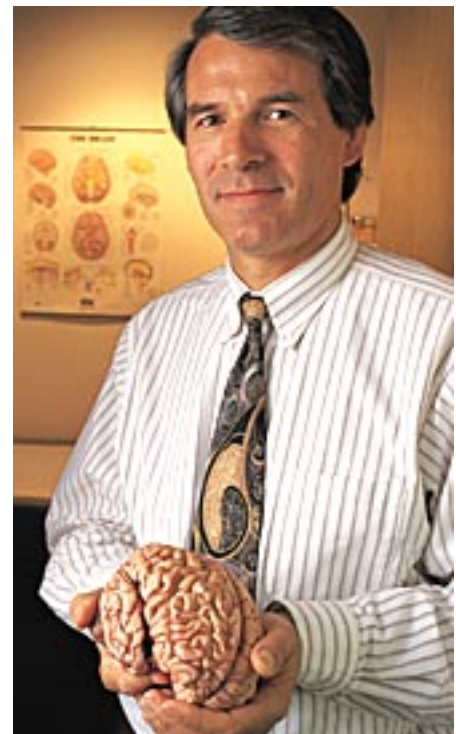
At the Veteran's Administration Hospital in Decatur, Ga., 53-year-old Johnny Ray focuses his thoughts to move a cursor across a keyboard displayed on a computer screen near his bed. Slowly and deliberately he selects the letters to correctly answer the question: How many children do you have?

A device developed at Georgia Tech is helping Ray, the victim of a massive stroke that left him mute and almost completely paralyzed, communicate through a computer using the tiny electrical impulses generated by his brain.

Dr. Philip R. Kennedy, a clinical assistant professor of neurology at [Emory University](#) in Atlanta, developed and patented the "neurotrophic electrode" in the mid-1980s while working as a neural prosthetics researcher at Tech. His work capitalizes on the basic fact that the act of thinking prompts physical activity in the brain in the form of electrical impulses. Implanted into a patient's brain, the electrode detects and captures those electrical signals, which are processed by customized microelectronics and software applications to move a cursor and select icons on the screen. In effect, the brain's neural signals become a computer mouse.

A Carrollton, Ga., drywall contractor, Ray received

Photo by Gary Meek



Dr. Philip R. Kennedy, a clinical assistant professor of neurology at Emory University in Atlanta,

the implant in the spring of 1998. By the end of the year he learned to select icons representing phrases such as "I am too cold." After a few more months of practice, he mastered the keyboard and began forming his own words — even holding short conversations with his doctors.

developed a device that helps disabled patients communicate through a computer. ([300-dpi JPEG version - 455k](#))

"It works, and I knew it would work," says Kennedy of the neural implant. "Fourteen months after implantation we're still getting strong signals, and that's incredible — very hopeful."

### *Years of Research*

The success with Johnny Ray follows 13 years of research, testing and animal trials for the electrode and other components of the system collectively called a "cortical control device." Kennedy received U.S. Food and Drug Administration approval to conduct human trials and an enabling grant from the National Institutes of Health.

"It basically began at Tech and it's very much a Tech project, but everyone's essential," says Kennedy, a naturalized U.S. citizen originally from County Limerick, Ireland. "I call the project a child of the Atlanta Village — we've got people from Georgia State, as well as from Tech and Emory working on it. It's a big, combined effort."

Kennedy earned a medical degree at the National University of Ireland and trained as a surgeon in Dublin. In 1976 he immigrated to Canada to study neurosurgery, then moved to Chicago and earned a Ph.D. at Northwestern University studying neurophysiology and neuroanatomy. Kennedy joined Georgia Tech in 1986 as a research scientist, when he also started developing his neurotrophic electrode. From 1990 to 1997, he served as director of Tech's Neuroscience Laboratory. For the past two years Kennedy has divided his time among a private neurology practice and his research, the latter facilitated by an affiliation with Emory's School of Medicine.

The key component of Kennedy's cortical control device is the hollow glass, cone-shaped neurotrophic electrode. About the size of a ballpoint pen tip, the device contains a pair of microscopic gold wires and is coated with a biocompatible substance. That coating encourages neurites — tentacle-like structures extending from neurons — to migrate into the electrode, thereby ensuring a solid electrical connection and also holding the device firmly in place. In fact, the ability to remain stationary distinguishes Kennedy's electrode from similar efforts. It's a critical attribute if a patient is to achieve control with consistent results.

The low-amplitude signals traveling across the local neurons pass through the electrode, which relays the impulses to a tiny power induction

amplifier and FM transmitter inserted just under the scalp. Those signals, amplified about 1,000 times, are broadcast to a computer where signal-recognition software translates them into cursor movement.

Two electrodes are employed because basic computer operation is a two-step process. The first requires moving a cursor among a number of options; the second involves selecting one of those options.

If the electrode is implanted in the motor cortex in an area associated with, say, finger movement, the patient can generate electrical signals to move the cursor by concentrating on moving a finger. Another electrode, implanted in an area associated with a different kind of movement, can facilitate the computer's "select" function.

Because the location of movement-specific cells varies from person to person, a magnetic resonance imaging scan performed before implantation helps identify the best location for the electrodes.

"It's actually not very high-tech," Kennedy says. "One thing that has made it possible is that small computers can do so much. It's amazing what they can do."

### ***Human Trials***

Ray is the second person to receive the electrode. The first patient, a woman in the final stages of amyotrophic lateral sclerosis (ALS) — also known as Lou Gehrig's disease — died from the disease 77 days after surgery and before she could master the computer-control technique. A third patient identified only by his initials, T.T., has been selected for implantation.

Kennedy and his co-researchers must be very selective for the human trials.

"This will not help people in a coma," Kennedy explains. "People have to be cognitively intact and know what's going on, but be unable to communicate." The best candidates at this stage of the experiment are individuals with ALS or those with high brain stem or high spinal cord injuries, or patients with advanced degenerative muscle disease, he says.

Photo by Gary Meek



Dr. Kennedy patented the "neurotrophic electrode" in the mid-1980s while working as a neural prosthetics researcher at Tech. ([266-dpi JPEG version - 505k](#))

The latest patient has been bedridden for the past four years and in a severely weakened state for the past 10. The metabolic muscle disease afflicting T.T. has left him with only slight eye movement left and right, and slight head movement, Kennedy says.

"His brain is not affected," Kennedy adds, "and that makes him a good candidate for the procedure."

### ***Human/Computer Interaction***

While computers have been helping paralysis victims for years through various kinds of adaptive interfaces, Kennedy's project is the first to establish a direct connection between the brain and a computer.

The collaborative, multidisciplinary effort's short-term goal is to devise new and more efficient means of human-computer interaction, thereby opening a communications window to the outside world for severely paralyzed individuals. Eventually the technology could enable many other interactive functions as well.

For victims of paralysis, the ability to manipulate a computer holds implications far greater than the simple ability to communicate wants and needs, Kennedy says.

"You can run businesses off the Internet," he says. "So why couldn't these people do that? All they have to do is run the computer. The technology opens up that possibility."

Kennedy is also convinced that his neurotrophic electrode portends many possibilities of its own, including operating complex robotic prosthetics or muscle stimulators.

### ***Easier Communication***

Exploring possibilities for the cortical control technology is the job of Dr. Melody Moore, a former graduate student and faculty member at Georgia Tech's College of Computing.

Now an assistant professor in the Computer Information Systems Department at [Georgia State University](#), Moore also teaches software engineering to Tech students and involves them in her part of the research.

Photo by Gary Meek

"My students wrote a communications program that allows him to choose an icon that stands for critical phrases like, 'I'm too cold' or 'I need the nurse,' " Moore says. "By selecting one button, he can communicate a whole phrase instead of having to

spell everything out."

As Ray's proficiency has increased, so has the sophistication of the communication, Moore says.

"We're actually having conversations with him," she explains. "Instead of asking him to spell Phil or Mel, we're asking things like, 'What's the best book you've read? What's your favorite movie?' He moves the cursor around and selects the letters to go into a writing program, and then he's able to speak them because we added a voice synthesizer.

"He's definitely improving. It's such a thrill for all of us, and it has improved his motivation, too."

Ray may soon begin navigating the Web with a browser built for him by Moore and her students. The group is also perfecting a virtual "dart game" to help future patients learn to control the cursor, and analysis software to track the learning curves of patients.

"We're trying everything we can think of," Moore says. "Nobody's ever done this before — this is a totally new area. It's definitely cutting-edge, very futuristic technology, but the neatest thing about it is that it works."

Ray's recent progress is all the more gratifying because it follows a long period of health troubles.

"Anybody with a complete paralysis has health problems, but they are exacerbated by things like skin problems, bed sores and infections," Moore explains. "Sometimes it's hard to work with him because he's on so many painkillers, the brain signals don't happen. But lately he's been feeling better, he's off the ventilator, and he is really doing well."

### ***Collaborative Effort***

In addition to Moore and Kennedy, the cortical control device owes its success to the work of many other Tech scientists.

Andy Hopper and Barry Sudduth, research engineers at the Biomedical Interactive Technology Center, built the electronics that interface with the electrode.



Former Georgia Tech computing professor Dr. Melody Moore, now at Georgia State University, led her students in writing a communications program that allows patients to choose an icon that stands for critical phrases like, "I'm too cold" or "I need the nurse." ([266-dpi JPEG version - 300k](#))

"We have recently changed the design of the electronics from surface-mount components that were soldered to each other to a more robust PC board-based design using surface-mount components," Hopper says.

At the Georgia Tech Center for Rehabilitation Technology, graduate student Kim Adams and research scientist John Goldthwaite have provided valuable, though unofficial, assistance.

"We're trying to help with the rehab engineering part — technical equipment, assisted technology, recommending software and things like that," Goldthwaite says, adding that he hopes the center can take a more active role in the future.

"We're trying to stay in it, but we don't have the funding to participate as much as we'd like to," he explains. "At some point, we would like to work with the patients and help them use computer-based augmented communications."

Also, Dr. Steven Sharpe and Neal Hollenbeck of the Georgia Tech Research Institute were deeply involved in the early work to develop a telemetry device for transmitting brain signals to a receiver.

Now, a research team including Emory University professor Dr. Roy A.E. Bakay is leading the way in implanting cone electrodes in human trial patients.

### ***Determined and Dedicated***

But even with all its promise, Kennedy's research has been beset with frustrating funding problems throughout its history. At one point several years ago, when Kennedy was making the transition from basic research to application of his electrode, there were fears the work may have to be put on hold for lack of money. With typical determination, he decided to raise research money by obtaining dollar pledges for each mile he ran in the Atlanta Track Club's Thanksgiving Day Marathon. The Georgia Tech Research Corporation matched the pledges.

The National Institutes of Health provided a grant for his first three human trials, but that support does not extend beyond T.T.'s implantation.

Various grant proposals are in the hopper, and while there's nothing concrete to report yet, Kennedy remains determined.

"I'm never going to give up."

**For more information, contact Dr. Philip Kennedy at his private practice office at 770-622-2230. Or, you may contact him at Emory University at 404-727-3818.**

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: November 16, 1999

## Reducing VOC

**New polymer coating process combines high degree of flexibility with improved environmental properties.**

By John Toon

A new coating material that emits virtually no volatile organic compounds (VOC) during application could replace conventional solvent-based paints and anti-corrosion coatings in a wide range of uses. Based on a durable polyester material, the new coating can be tailored to provide the specific properties required by different applications.

Developed by a research team at the Georgia Institute of Technology, the patented ultra-low VOC coating would meet new environmental regulations expected to severely limit VOC emission from paints and other coatings.

"The potential applications are enormous," says Dr. Robert E. Schwerzel, a principal research scientist at the [Georgia Tech Research Institute](#) (GTRI). "These coatings could, in principle, replace many of the solvent-based paints, enamels and varnishes that are currently used to coat everything from stoves and refrigerators to aircraft."

Photo by Stanley Leary



Georgia Tech researchers have high expectations for a new coating material that has both environmental benefits and flexibility for customization. Researchers are using gas chromatographs with a mass spectrometer to analyze precursors for an ultra-low volatile organic compound coating. ([300-dpi JPEG version - 320k](#))



In addition to the coating's environmental attractiveness, the novel process used to produce it also offers formulators a high degree of flexibility in selecting the resulting properties of the coating. The work was described at a meeting of the American Chemical Society earlier this year.

"We have developed a system for applying coatings that can be tuned for a whole group of different properties," says Dr. Charles Eckert, a professor in Georgia Tech's [School of Chemical Engineering](#) and director of the Specialty Separations Center. "We believe we will be able to adapt this to a variety of applications each with different needs and different constraints."

Conventional polyester coatings are cross-linked and cured in a process that involves removing a small volatile molecule and evaporating an organic solvent. The small molecule and solvent usually evaporate into the atmosphere, becoming pollutants. But the new Georgia Tech process removes and captures that small molecule during the manufacturing process — and does not require a solvent.

"Our coating molecules are applied to a surface, and with light or heat and a suitable catalyst, rearranged to form a strong, durable coating without any need for solvents or any need for removal of the small molecules," Eckert explains. "This leaves us with a virtually zero VOC paint."

Using novel chemical processes, the researchers produce cyclic polyester oligomer molecules that are polymerized using an organo-tin or organo-titanate catalyst to form a material that can be either a powder or liquid at room temperature. Once applied to a surface, the coating is cured using heat or ultraviolet light to rearrange the cyclic polymer to a linear and cross-linked structure.

"The properties of these molecules can be changed by altering not only the backbone of the polymer, but also the side groups of the polymer," Eckert adds. "We have been able to make structural changes and get virtually any melting point we would like."

The research team has worked with the U.S. Air Force and Atlanta-based Delta Air Lines on potential aerospace applications.

By altering the surface properties, the researchers believe they could produce a coating that would make aircraft less susceptible to icing. In addition to improving flight safety, such a coating could also reduce the amount of environmentally undesirable ethylene glycol used for aircraft de-icing.

Eliminating the hazardous solvent from the coatings could also make them easier to use and reduce the amount of equipment and ventilation now required to protect workers,

Eckert notes. This could produce cost savings for aircraft operators and others using large quantities of coatings.

A solvent-less coating also provides an important logistical benefit: a reduction in the volume of product that must be handled. In existing paints and coatings, solvents significantly increase the volume of product. Containers of the new coating would include only the polyester material, an issue important to military users and others who would be able to reduce transportation and storage costs, Schwerzel notes.

Early test results on aluminum and iron alloy substrates show the coating has the desired hardness and durability, though additional research must be done to show long-term properties on larger surfaces.

So far, researchers have produced only small quantities of their new coating. Scaling up the process to provide commercial quantities at a competitive cost poses the next challenge, says team member Dr. Charles Liotta, a professor in the School of Chemistry and Biochemistry and Georgia Tech's Vice-Provost for Research.

"The fundamental science, the construction of the cyclic oligomers, their physical and chemical properties, and the polymers that are produced on surfaces are all fairly well characterized," he says. "But for this to be commercially viable, we need to be able to produce thousands of tons per year. We are still exploring how to do that."

Research will also be needed to provide ideal viscosity, adhesion and other properties needed for smooth application of the coatings, Schwerzel says. The researchers also must explore other catalysts used to trigger the curing process.

"These are solvable issues," Schwerzel adds, "but they will take some time and effort in both basic chemical research and chemical engineering process design."

Regardless of the research outcome, this project by three different Georgia Tech departments has already provided benefits to the chemists and chemical engineers of tomorrow.

"This project combines expertise on the practical applications of new materials, chemical engineering and the fundamental aspects of chemistry," Liotta says. "That is a great teaching tool for our students, because it gives them an opportunity to collaborate with all the different disciplines involved."

Beyond the researchers already mentioned, the research team has included Dr. Henry Paris, former GTRI research scientist; Zhenguo Liu, graduate student in the School of Chemistry and Biochemistry, and Dr. David Bush and graduate student Kevin West from

the School of Chemical Engineering. Research sponsors included Delta Air Lines, the U. S. Air Force and Scientific Applications International Corp.

For more information, you may contact Dr. Charles Eckert, School of Chemical Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0100. (Telephone: 404/894-3690) (E-mail: [cae@che.gatech.edu](mailto:cae@che.gatech.edu)). You may also contact Dr. Robert Schwerzel, Georgia Tech Research Institute, Atlanta, GA 30332-0825. (Telephone: 404/894-3626) (E-mail: [bob.schwerzel@gtri.gatech.edu](mailto:bob.schwerzel@gtri.gatech.edu)).

[Contents](#)   [Research Horizons](#)   [GT Research News](#)   [GTRI](#)   [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## Research Notes

### Sound of Silence

**"Quiet Curtains" combine audio privacy and aesthetics.**

It's curtains for noisemakers with new high tech drapes that block unwanted decibels.

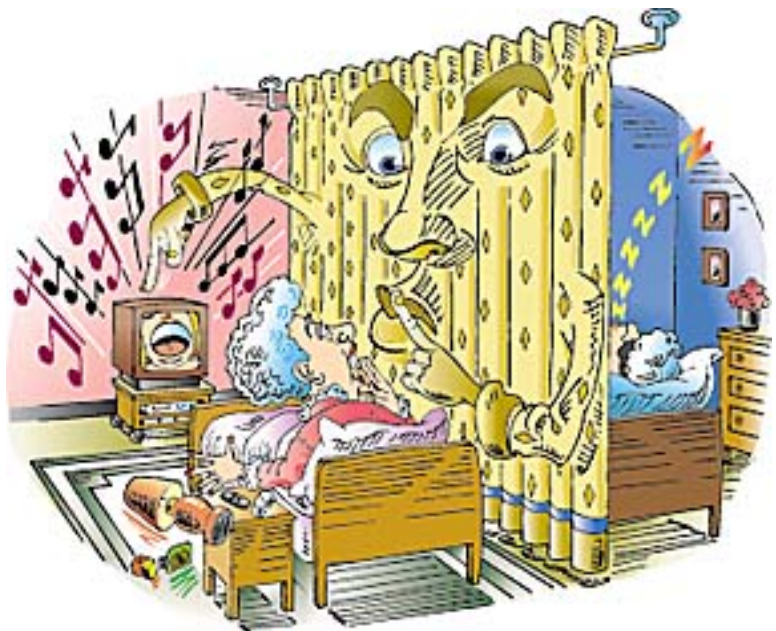
Dr. Krishan Ahuja, Regents researcher and head of the acoustics and aerodynamics branch in [Georgia Tech Research Institute's](#) (GTRI) Aerospace & Transportation Laboratory, has designed a unique modular system of curtains that blends aesthetics with audio privacy.

The invention, appropriately dubbed "Quiet Curtains," stems from an effort to battle nocturnal noise in nursing homes. Typically, two types of noise disrupt patients: (1) sound from inside their rooms, such as a roommate snoring or listening to a loud television program, and (2) sound generated from the outside, such as carts rolling down the hall.

Ahuja's idea? Transform the curtains that hang around a patient's bed into a product that not only provides visual privacy, but acts as an acoustical shield.

To accomplish that, sheets of noise shielding material were sandwiched between two pieces of fabric and supported by a unique pocket system. A variety of material can be used for the noise shields — ranging from cardboard to metal. "It depends on how much noise you want to reduce," explains Ahuja, who is also a professor at the Georgia Tech's [School of Aerospace Engineering](#).

illustration by Mac Evans



Aided by two Georgia Tech undergraduate students, Jessica Shearer, a physics major, and Mary Lynn Rivamonte, an aerospace engineering major, Ahuja conducted extensive testing to determine the noise reduction capabilities of various insert materials and exterior fabric. Besides analyzing acoustical properties, the researchers looked for such qualities as durability, fire retention and strength. Finally, they selected a plastic material to use as noise shielding material for the Quiet Curtains nursing home prototype.

In benchmark studies, the prototype reduced noise by about 7 decibels (dB). What's more, by adding a floor extension and valance, noise dropped about 12 dB. This is a deceptively large number as decibels are logarithmic units of measurement, rather than linear. "A reduction of 12 dB implies a reduction of sound intensity by a factor of 16," Ahuja explains. "It's akin to saying that if 16 toddlers were screaming 'I want Mommy' all at the same time on one side of the curtain, with a 12dB reduction on the other side, it would appear as though only one toddler was screaming."

"This is an innovative step to helping nursing home patients," says Dr. Joseph Ouslander, director of the Atlanta Veterans Administration Rehab R&D Center of Excellence on Geriatric Rehabilitation, which supported development and pilot work for Quiet Curtains. Last year while studying nighttime incontinence management, the Rehab R&D Center began to examine environmental factors affecting patients' rest — namely noise — which led to Ahuja's involvement and invention.

"Sleep for these people is very disrupted to begin with," explains Dr. Ouslander, who is also professor at Emory University's School of Medicine, director of its Division of Geriatric Medicine and Gerontology and vice president of Emory's Wesley Woods Center. "If there is any environmental intervention we can do to improve their night rest, it would result in a better quality of life," Dr. Ouslander adds.

"There really hasn't been much research work done that has looked at noise in nursing homes — especially as it relates to sleep disturbance," says Dr. Bettye Rose Connell, a researcher in environment and behavior at the Atlanta VA Medical Center. "What impresses me is that Quiet Curtains are such a practical solution to a real problem. And they give us a real opportunity to do more research." Plans are under way for further testing of the curtains in nursing home settings.

Because of the noise-shielding inserts, Quiet Curtains are heavier than regular curtains. Yet they remain easy to transport by folding up accordion style. Maintenance is also hassle-free. "Just remove the noise shielding panels and you can toss the curtains in the washing machine," Ahuja says.

Quiet Curtains also can be equipped with a viewing window, allowing patients to watch television or have visual contact with nurses — without letting noise in. This is done by

adding a transparent noise shielding sheet, such as Plexiglas or glass, and cutting away a portion of the exterior fabric. A shade can then be added to this window, and raised or lowered when desired.

Though initially designed with nursing homes in mind, Quiet Curtains has broad consumer applications, Ahuja says. He lists offices, hotels, libraries, schools, homes, factories — even motor vehicles as potential users of the high tech drapes.

"The beauty about this is its tremendous adaptability," says Ahuja, noting that virtually any fabric, color and pattern can be used for the exterior shell. Noise reduction capabilities can also be customized. "Noise shielding panel material can be changed, depending upon one's desire or need to control low-frequency or high-frequency noise. This will be a great benefit to a potential manufacturer," Ahuja says.

Size is yet another aspect of the invention's flexibility. Quiet Curtains adapt to small spaces, controlling noise generated by computers and printers or providing just-in-time privacy for open-office environments. Or large-scale curtains can be constructed for the factory floor. "Because they're so easy to wash, Quiet Curtains are ideal for rugged industrial settings," Ahuja says.

Specific costs haven't been determined yet. "Obviously, they are going to be more expensive than conventional curtains," Ahuja says. But he is confident Quiet Curtains can be cost-efficient for a broad range of users.

Ahuja and Georgia Tech have filed a provisional patent, and commercialization efforts are under way, including a search for potential marketing and manufacturing licensees.

— *T.J. Becker*

**For more information**, contact Dr. Krishan Ahuja, Aerospace & Transportation Laboratory, Georgia Tech Research Institute, Atlanta, GA 30332-0844.  
(Telephone: 770/528-7054) (E-mail: [krishan.ahuja@gtri.gatech.edu](mailto:krishan.ahuja@gtri.gatech.edu))

## **Industrial Modernization**

### **Georgia Tech Policy Project analyzing new technology adoption.**

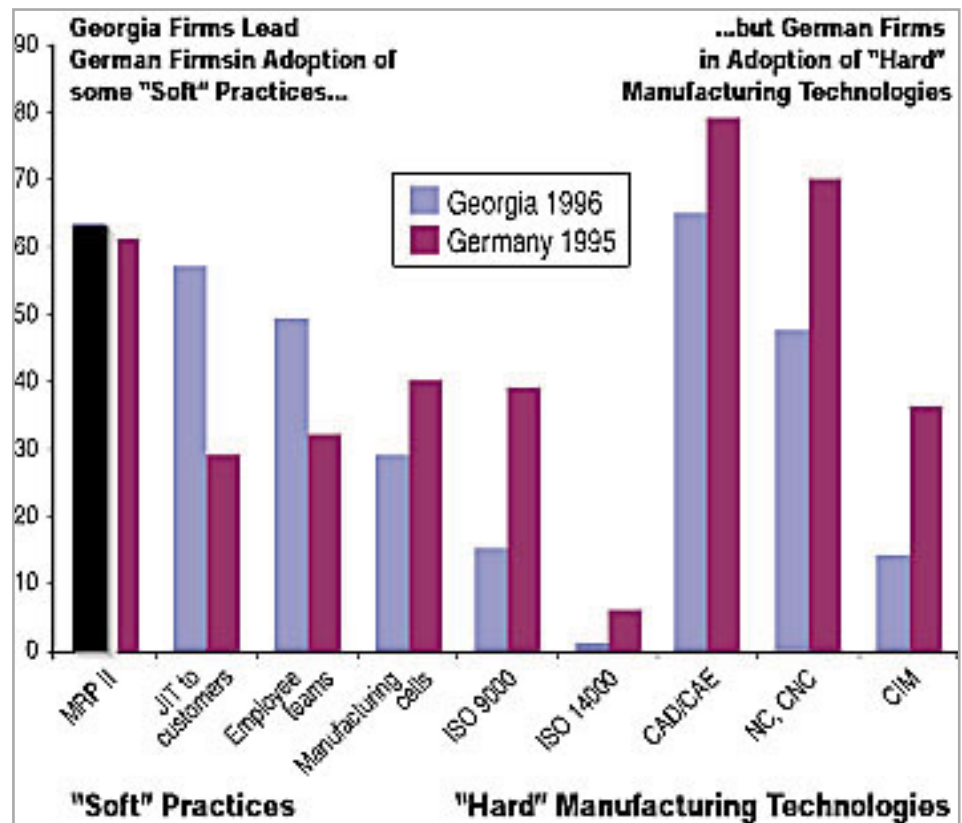
Benchmarking surveys of similar Georgia and German industries indicate that a higher percentage of German manufacturers use new technologies and methods, such as computer-aided design, manufacturing cells and ISO 9000.

The lagging use of

these technologies in Georgia may help to explain lower productivity in the state's firms when compared to their German counterparts, according to Georgia Tech researchers.

These surveys are part of Georgia Tech's Policy Project on Industrial Modernization that analyzes and evaluates new technology adoption in industry and assesses implications for industrial and economic development policy. Dr. Philip Shapira, a professor in the [School of Public Policy](#), and Dr. Jan Youtie, a senior research associate in the [Economic Development Institute](#), direct the project.

Courtesy of Dr. Jan Youtie



New technologies and methods are slower to gain acceptance in Georgia industries compared to their German counterparts, according to a recent Georgia Tech study.

Launched in 1996, the project has undertaken several efforts. Among them:

- Establishment of a Web site ([www.cherry.gatech.edu/mod](http://www.cherry.gatech.edu/mod)) that makes available more than 100 research papers on industrial modernization, some 25 multimedia presentations by leading experts, survey instruments, maps, archive documents and on-line courses. The site has experienced nearly 14,000 visits in the past two years from policy analysts, practitioners and others around the world.
- Four Atlanta workshops on the evaluation of industrial modernization attended by specialists from this country and abroad. Attendees have presented more than 60 papers on various aspects of industrial modernization.
- Participation in national and international projects — including those undertaken by organizations such as the National Institute of Standards and Technology (NIST), the Competitiveness Policy Council and the National Academy of Sciences — and delivery of short courses on industrial modernization in Brazil, Austria, Mexico and South Africa.

Georgia Tech participates in NIST's nationwide Manufacturing Extension Partnership (MEP), and the Policy Project has helped sustain federal funding of the state affiliate (GaMEP) through program evaluation. Other GaMEP initiatives of the project include a biannual survey of Georgia manufacturers; assessments of manufacturing extension practices; and evaluation of USNet, a multi-state consortium to promote industrial networking. The project also conducted Georgia Tech's first Internet-based course, "Seminar on Industrial Modernization," that continues to be taught.

Research conducted by the Policy Project has revealed interesting elements of industrial modernization. For example, industrial modernization resources are leveraging from \$3 to \$13 in private investment for every public dollar spent which, in turn, will likely lead to favorable public and private returns over time. Also, firms that collaborate in inter-company networks experience net financial benefits, employment growth, shared technical capabilities and improved skills.

The project's analyses and evaluations have implications for economic development in the state. For instance, the benchmarking of German and Georgia firms will help identify the diffusion of new technologies and business practices, determine gaps and needs, and assess impacts of companies' participation in manufacturing assistance programs. This can improve state-level policymaking and the technical assistance delivered by organizations such as Georgia Tech.

One new initiative of the project is publication of Georgia Manufacturing Vital Signs, which provides concise analyses of developments in Georgia's manufacturing sector. These will help guide companies, economic developers and state policymakers. The most recent study looks at productivity differences between large and small firms and users of external services (see chart).

— *Jan Youtie*

**For more information**, you may contact Dr. Philip Shapira, School of Public Policy, Georgia Institute of Technology, Atlanta, GA 30332. (Telephone: 404/894-7735) (E-mail: [philip.shapira@pubpolicy.gatech.edu](mailto:philip.shapira@pubpolicy.gatech.edu)) or Dr. Jan Youtie, Economic Development Institute, Georgia Institute of Technology, Atlanta, GA 30332. (Telephone: 404/894-6111) (E-mail: [jan.youtie@edi.gatech.edu](mailto:jan.youtie@edi.gatech.edu))

## *Awards and Honors:*

**Georgia Tech faculty receive recognition.**



**Dr. Said Abdel-Khalik**, Southern Nuclear Distinguished Professor in the School of Mechanical Engineering, received the 1999 Glenn Murphy Award from the American Society for Engineering Education (ASEE). This award is given annually to a distinguished engineering educator in recognition of notable professional contributions to the teaching of undergraduate and graduate nuclear engineering students.

**Dr. Michael Bergin**, a professor in the School of Earth and Atmospheric Sciences and the School of Civil and Environmental Engineering, was one of 60 young researchers selected nationwide to receive a Presidential Early Career Award for Scientists and Engineers. Awarded by President Bill Clinton, these Presidential Awards are the highest honor that the U.S. government can bestow upon young professionals at the outset of their independent research careers.

**Dr. Barry Bozeman**, director, State Data and Research Center, and professor, School of Public Policy, is the 1999 recipient of the American Society for Public Administration's Charles H. Levine Memorial Award for Excellence in Public Administration. The Levine Award recognizes public administration scholars who have demonstrated excellence in teaching, research and service.

**Jim Coleman**, a senior research scientist at the Georgia Tech Research Institute, received the AFCEA International Meritorious Service Award. This honor is presented annually to AFCEA members who make significant contributions to the organization, while recording exceptional professional performance in the fields of communications, electronics, intelligence and information systems.

**Dr. Robert M. Craig**, professor in the College of Architecture, has been elected president of the Southeastern American Society for Eighteenth Century Studies, a multidisciplinary society of specialists in 18th century history, art, literature and other period studies. Craig will plan and chair SEASECS 2000 — the Millennium Conference, to be held in Savannah in March 2000. He has served as second and then first vice president in recent years.

The Basic Energy Sciences Division of the U.S. Department of Energy presented **Dr. Patricia Dove**, a professor in the School of Earth and Atmospheric Sciences, with the "Best University Research for a Sponsored Project Award" during the Interfacial Processes Symposium held in February 1999. Dove's sponsored research project is titled "Investigating the Physical Basis of Biomineralization."

Research Corporation named **Dr. Rigoberto Hernandez**, an assistant professor in the School of Chemistry and Biochemistry, a recipient of the 1999 Cottrell Young Faculty Award. Cottrell Scholars Awards are for beginning faculty members who wish to excel at both research and research-enhanced teaching. The awards are for \$50,000 and may be used largely at the scholar's discretion.

**Dr. Edward W. Kamen**, associate director of the Manufacturing Research Center and a professor in the School of Electrical and Computer Engineering, has written a book titled *Introduction to Industrial Controls and Manufacturing*, published by Academic Press. It is a text and reference book that combines the topics of process control, discrete logic control and the fundamentals of manufacturing.

**Dr. James D. Meindl**, Joseph M. Pettit Chair in Microelectronics in the School of Electrical and Computer Engineering, received the 1999 Semiconductor Industry Association (SIA) University Researcher Award. It honors his lifetime contributions to university research programs on semiconductor technology. Meindl also serves as director of Georgia Tech's Microelectronics Research Center.

**Dr. Catherine Ross** is now executive director of the Georgia Regional Transportation Authority. She was vice provost and professor in the College of Architecture's City Planning Program and was recently elected vice chair of the Atlanta Development Authority (ADA). It is a public authority created to promote the revitalization and growth of the city. Ross also was elected secretary and treasurer of the Residential Development Division (Urban Residential Finance Authority), the housing development arm of the ADA, focusing on creating affordable housing and promoting neighborhood revitalization. In addition, she was recently elected vice chair of the Downtown Development Authority.

The Society of Plastics Engineers (SPE) named **Dr. Robert J. Samuels**, a professor in the School of Chemical Engineering, the 1999 SPE Research Award winner. The award, sponsored by the Bayer Corporation and the Southern California Section, is one of eight international awards presented annually by the society.

**Dr. Michael F. Schatz**, an assistant professor in the School of Physics, received a 1999 Cottrell Young Faculty Award from the Research Corporation. Cottrell Scholars Awards are for beginning faculty members who wish to excel at both research and research-enhanced teaching. The awards are for \$50,000 and may be used largely at the scholar's discretion.

**Dr. Charles Ume**, an assistant professor in the School of Mechanical Engineering, received the 1999 E. G. Bailey Award from the Instrument Society of America. The award recognizes Ume's research project titled "The Design and Development of a Novel Automated On-Line Flatness Measurement and Analysis Instrument."

The National Science Foundation awarded **Dr. Z. John Zhang**, assistant professor in the School of Chemistry & Biochemistry, a Faculty Early Career Development (CAREER) award for his teaching activities and research work in the study of magnetic nanoparticles. Also, Zhang was named a Beckman Young Investigator by the Arnold and Mabel Beckman Foundation of Irvine, Calif. The Beckman Foundation makes grants to non-

profit research institutions to promote research in chemistry and the life sciences.

**Also see [Research Links](#) news briefs.**

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999

## Research Links...

### Weighing the Very Small

A "nanobalance" small enough to weigh viruses and other sub-micron scale particles is one application for newly discovered electronic and micromechanical properties of carbon nanotubes.

Electrical voltage can be used to induce electrostatic deflection and vibrational resonance in individual carbon nanotubes, according to a report published earlier this year in the journal *Science*. This ability to selectively deflect or induce resonance in individual nanotubes opens new potential micromechanical applications for the tiny structures, which are smaller than the finest features on modern microcircuits.

Researchers at the Georgia Institute of Technology studied the behavior of multiwalled nanotubes using a transmission electron microscope with a unique sample holder designed and built by Dr. Philippe Poncharal of Georgia Tech. The holder allowed them to rotate specimens, apply electrical voltage and observe many fundamental effects. The work was sponsored by the National Science Foundation and the U.S. Army Research Office.

"This opens a broad new field of study," says Dr. Walter de Heer, a professor in Georgia Tech's [School of Physics](#).

"To show that we can manipulate individual carbon nanotubes while examining them with an electron microscope is breaking new ground. This allows us to use the microscope in a much more interactive way with direct visualization and control that enable us to manipulate the nanotubes the way you would manipulate macroscopic objects on a desktop."



A transmission electron microscope image shows "nanobalance": a resonating carbon nanotube used to determine the mass of the attached carbon molecule.

**For the full text** of this article, see [www.gtri.gatech.edu/res-news/BALANCE.html](http://www.gtri.gatech.edu/res-news/BALANCE.html).

**For more information**, contact Dr. Walter de Heer, School of Physics, Georgia Institute of Technology, Atlanta, GA 30332-0430. (Telephone: 404/894-7879) (E-mail:

[deheer@electra.physics.gatech.edu](mailto:deheer@electra.physics.gatech.edu)); or Dr. Z.L. Wang, [School of Materials Science and Engineering](#), Georgia Institute of Technology, Atlanta, GA 30332-0245.  
(Telephone: 404/894-8008) (E-mail: [zhong.wang@mse.gatech.edu](mailto:zhong.wang@mse.gatech.edu))

## Tracking Real Estate

Title searching has gotten a lot easier in Georgia, thanks to a unique statewide database that puts property information online — a boon for both the real estate community and the general public.

About 1.5 million property deeds are filed in Georgia each year. Up to now, counties have varied greatly regarding the indexing of these documents, making title searches both cumbersome and frustrating.

In the works for three years, the project was mandated by the Georgia General Assembly in 1995 and is officially being launched in January 1999. The database, developed by the [Economic Development Institute](#) (EDI) at the Georgia Institute of Technology, contains an index of all property transactions, including the name of the seller and buyer, location of property, any liens on the property, and the book and page where the actual deed is filed in the county.

The index can be searched free of charge at county courthouses, or subscribed to on the Internet through the Clerks' Authority ([www.gsccca.org](http://www.gsccca.org)). Although its biggest users are expected to be title searchers, banks, finance companies and government agencies, the system benefits anyone seeking property information in Georgia.

"Georgia is taking a leadership role with this project," says John Myers, project director and director of EDI's Center for Public Buildings (CPB). "No other state has a consolidated, statewide index for real and personal property, much less an on-line system."

To further enhance the system, GSCCCA is in the process of re-indexing three years of historical data for real estate records, and plans to have them on line in late 1999 or early 2000. Additionally, images of the actual real estate instrument (from participating counties) are also being added to the online system.

courtesy Ga. Dept. of Industry, Trade and Tourism



Title searching at Georgia county courthouses, such as this one in Lincoln County, is now easier because of a new statewide database that puts property information online.

For the full text news release, see [www.gtri.gatech.edu/res-news/TITLE.html](http://www.gtri.gatech.edu/res-news/TITLE.html). For more information, you may contact John Myers, Economic Development Institute, Georgia Institute of Technology, Atlanta, GA, 30332-0640. (Telephone: 404/894-3864) (E-mail: [john.myers@edi.gatech.edu](mailto:john.myers@edi.gatech.edu)).

## Measuring Scientific Research

How do you measure the impact of basic research on society? What does "quality" mean when applied to scientific research activities?

These are among the questions faced by the research community as it deals with new government-mandated requirements for accountability. These often controversial efforts to increase accountability are hampered by the difficulty in measuring creative activities like research, concerns about a growing burden of reporting and a lack of standard measuring tools.

Dr. Susan E. Cozzens, director of the [School of Public Policy](#) at the Georgia Institute of Technology, addressed these questions in a study she presented earlier this year at the annual meeting of the American Association for the Advancement of Science (AAAS) in Anaheim, Calif. There, she described "best practices" in research assessment.

"There are some very tough methodological questions, and there are no breakthrough methods out there," Cozzens adds.

In her research, Cozzens reviewed the best assessment methods available and looked at what techniques managers actually use to make decisions about research programs. Predominantly, decisions are made on the basis of a modified "peer review" process in which panels of experts offer their evaluations. Over the past 10 years, Cozzens found, the traditional peer review process has broadened to include input from potential users of the research such as industrial companies.

Though the specific assessment techniques may be changing, evaluation of projects being considered for funding has always been important and highly competitive in the U.S. research enterprise. But Cozzens' study found a growing interest in ongoing monitoring of these projects once they receive funding.

For the full text of this article, see [www.gtri.gatech.edu/res-news/QUALITY.html](http://www.gtri.gatech.edu/res-news/QUALITY.html). For more information, contact Dr. Susan Cozzens, School of Public Policy, Georgia Institute of Technology, Atlanta, GA 30332-0345. (Telephone: 404/894-6822) (E-mail: [susan.cozzens@pubpolicy.gatech.edu](mailto:susan.cozzens@pubpolicy.gatech.edu))

Research Links Contributors: *T.J. Becker and John Toon*

**Also see [Research Notes](#) news stories.**

[Contents](#) [Research Horizons](#) [GT Research News](#) [GTRI](#) [Georgia Tech](#)

---

Send questions and comments regarding these pages to [Webmaster@gtri.gatech.edu](mailto:Webmaster@gtri.gatech.edu)

Last updated: October 25, 1999