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Research Horizons

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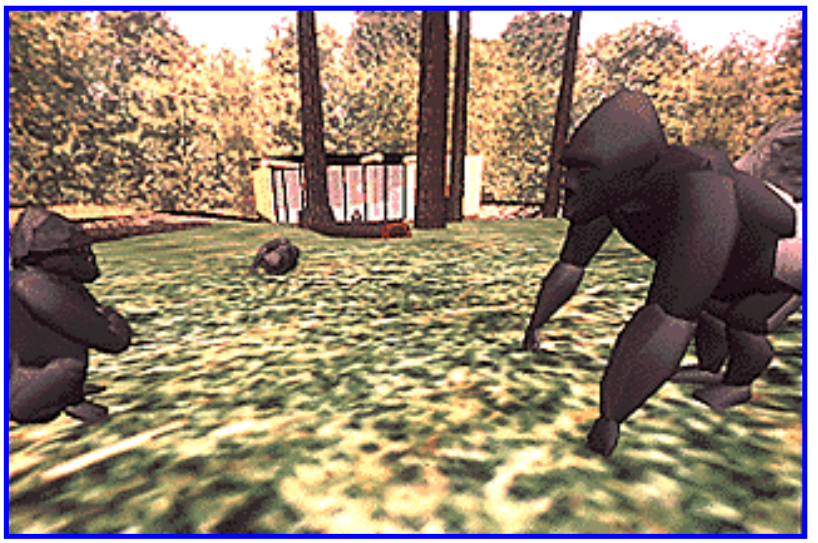

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Research Horizons
Georgia Institute of Technology

Mechanical Engineering

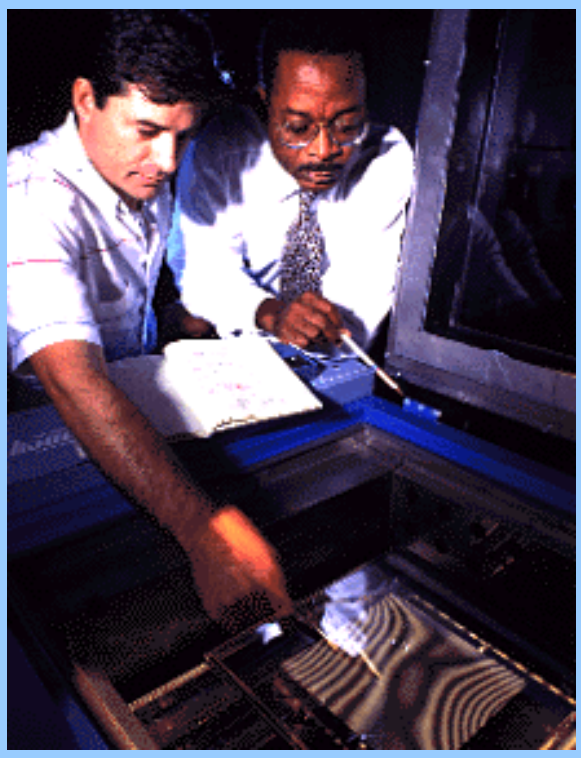
Helping Printed Circuit Boards Take the Heat

By Lea McLees

PRINTED CIRCUIT BOARDS (PCBs) and the technologies they support are among the crowning achievements of the Information Age. Encrusted with tiny transistors and wires and gilded with solder, the boards run everything from portable radios to refrigerator-sized supercomputers.

Despite their widespread use and success, the boards remain vulnerable to a simple, heat-induced threat: warpage. A board that warps while in use may cause a computer to stop working correctly. Even a slight twist or bend in a board during manufacturing can make adding components devices difficult, or may cause previously mounted electronics to break off. And that can cost manufacturers a bundle, says Dirk Zwemer, manager of Electronic Packaging Services Ltd., Co.

PHOTO BY GARY MEEK



"It's not uncommon to see yield losses of one to three percent in a mature product, and it can be much higher for some designs," he says. "In some cases, to lose a board at a stage where lots of expensive components have been added can cost a company thousands of dollars per board."

But Zwemer's company offers a way of detecting PCB warpage -- patent-pending technology developed at and licensed from the Georgia Institute of Technology. Dr. Charles Ume of Georgia

Tech's School of Mechanical Engineering developed the novel experimental technique for observing and recording PCB warpage.

Dr. Charles Ume (right) and former grad student Michael Stiteler examine moiré fringes generated when a PCB is heated in oven Ume developed.

Heat Sources

To understand Ume's techniques, developed in the Advanced Electronic Packaging Lab in Georgia Tech's Manufacturing Research Center (MARC), one must understand the sources of the heat that can warp PCBs. Heat is an integral part of processing the boards, and increasingly, of using them. Warmer temperatures are generated every time we turn on our computers, camcorders, radios and other PCB-reliant devices. The more often we turn electronic equipment on, the more often the PCBs inside the equipment are subjected to high levels of heating and cooling.

"In addition, the current trend in the industry is making the boards smaller, thinner and more densely populated," Ume explains. "If the PCB is small, thin and also densely populated with components, that is an invitation for warpage-related reliability problems."

Under operating conditions, these components give off a lot of heat in a small area. The heat, in turn, causes the PCB to warm. The degree of warpage will depend on how thin the PCB is.

Additionally, the boards are heated in ovens at about 135 degrees Centigrade during the solder masking process, when a coating that repels solder from certain areas of the boards is applied. The PCBs return to the oven, and to temperatures of about 220 degrees Centigrade, when chips are soldered to them.

Ume's Techniques

With sponsorship from Motorola, MICOM, Ford Electronics, IBM, DEC and AT&T through MARC, Ume developed a special oven with a glass top through which the PCB placed inside is visible. A white light shines on the PCB through the glass grating, and an inexpensive, compact, charge-coupled device (CCD) camera captures warpage digitally as it occurs.

The flat glass substrate etched with equally spaced parallel lines is placed parallel to the PCB. A beam of white light is directed onto the glass at a specific angle, and the etched lines on the glass create a shadow on the surface of the PCB. When the surface of the PCB is curved, a moiré pattern is produced by the geometric interference between the etched lines on the glass and the shadow of those lines on the PCB's surface. The more the PCB warps, the greater number of moiré fringes appear.

Ume counts the number of fringes, puts them into an equation, and a computer determines how much warpage has occurred. The warpage process is displayed in real time on a television screen and recorded on video and on computer.

"Electronic packaging companies can use the

warpage information to make changes in their PCB design early in the design phase," Ume says. "They may choose to make some design or process adjustments and send the board to us again to be retested. That way, there's no mass production of a product that has a problem."

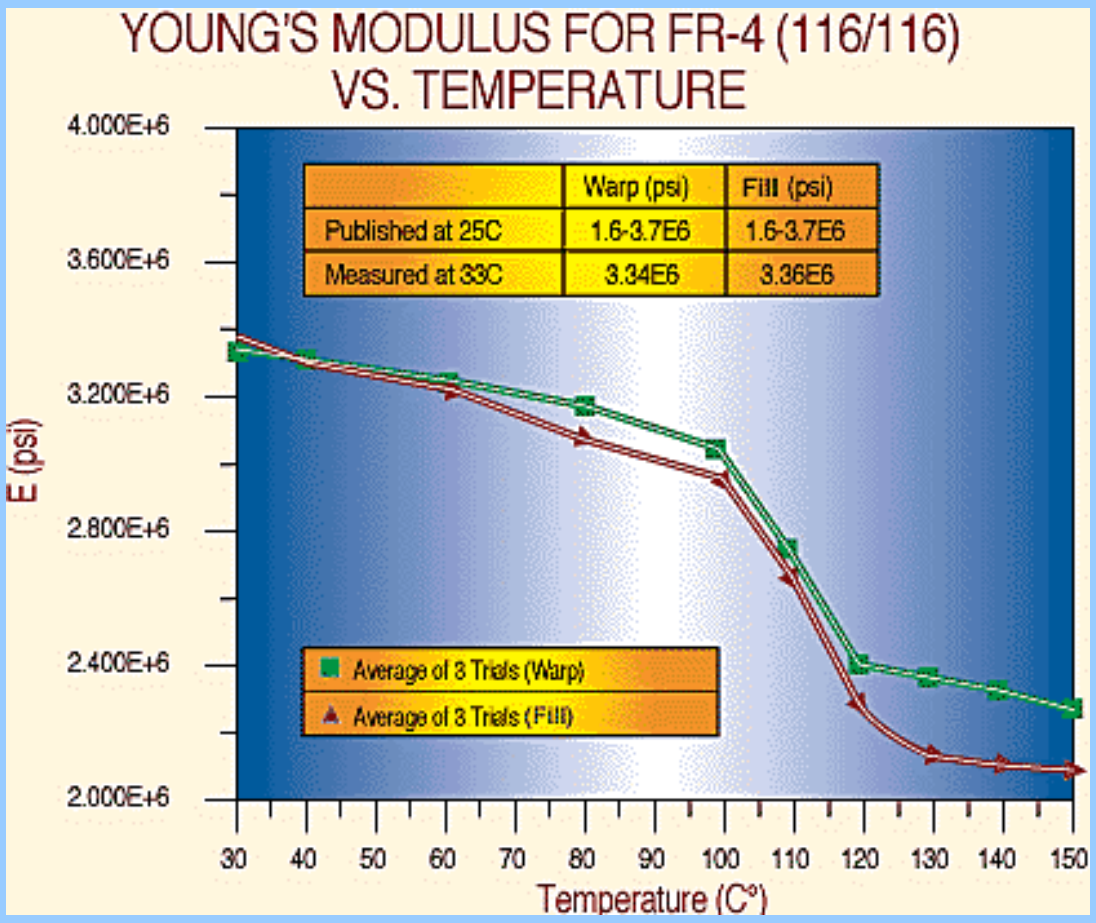


Chart of Young's Modulus for FR-4 (116/116) vs. Temperature

A patent is pending on Ume's process, which is commercially known as TherMoiré(TM).

The TherMoiré(TM) technique can be used to simulate the three major kinds of soldering processes -- infrared reflow, convective reflow and wave. The automated oven system measures warpage in real time. It can reproduce any given soldering temperature history used in producing a board, while measuring PCB warpage at any specified interval or temperature. As a result, the system can pinpoint which processes or designs may cause the most warping.

Companies can use the results to make design or process changes before production, such as changing soldering temperature profiles, reducing or extending processing times, relocating key components, and changing types of materials used in the construction of the PCB.

In addition to measuring thermally induced warpage, the technique can be used to validate manufacturers' numerical warpage predictions using the finite element technique.

"Most of the companies that manufacture PCBs have experts who can predict when a board will warp using finite element analysis," Ume says. "They can use the techniques we've developed here to check their results. We can also do numerical predictions for them."

If a certain amount of warpage is allowable, the new techniques allow manufacturers to measure initial warpage, rather than assuming that the board is flat before transistors and other items are added to it. Manufacturers can then determine how much additional warpage is added with further processing or addition of components.

Ume's techniques also allow warpage measurement of the different materials that are sandwiched together

to make a wiring board -- FR-4 laminates, fiber (prepreg), several varieties of copper foil and newly developed materials.

"These are unique measurement techniques, and the electronic packaging industry is very excited about them," Ume says. "These systems and prediction capabilities will help PCB designers and process engineers to understand how a PCB will warp when it goes through different manufacturing cycles -- even before it is built.

"Savings in scrap PCBs, rework, down time and loss in market share can run into the millions of dollars," Ume says.

Going Commercial

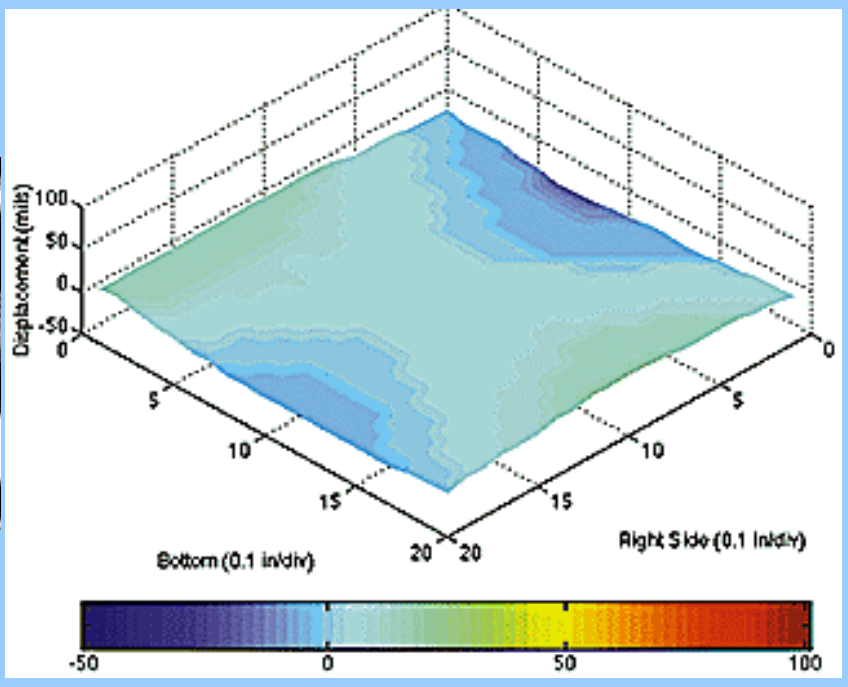
The sponsors of Ume's work asked him to turn his findings into a commercial venture. With help from Georgia Tech's Advanced Technology Development Center, the Electronic Packaging Services Ltd., Co. licensed the technology and began offering help to the electronics industry in August 1994.

Georgia Tech is a partner in the company.

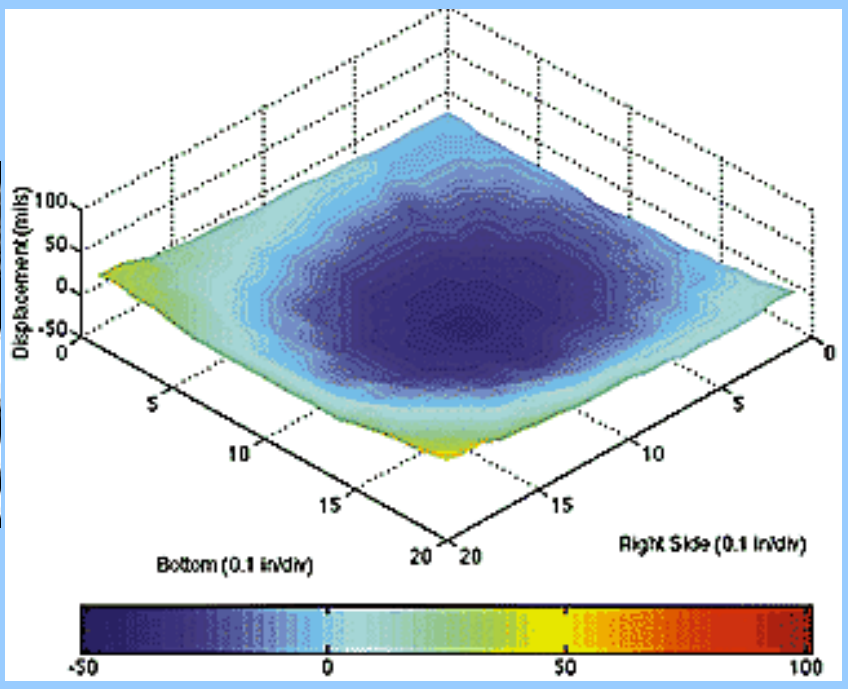
"Industrial sponsors were a driving force behind getting this technology to the marketplace," says business development manager Patrick Hassell. "Current trends in the industry, with respect to outsourcing and dowsizing of internal R&D efforts, make EPS a valuable contract services provider of fast, reliable analysis."

Although the company is aimed at helping the electronics industry, future users of the technology could include manufacturers of aviation equipment, foil, tape, resin and glass fibers, says manager Dirk Zwemer. Future possibilities include putting the technology on an assembly line and making it more automated so the average worker could use it.

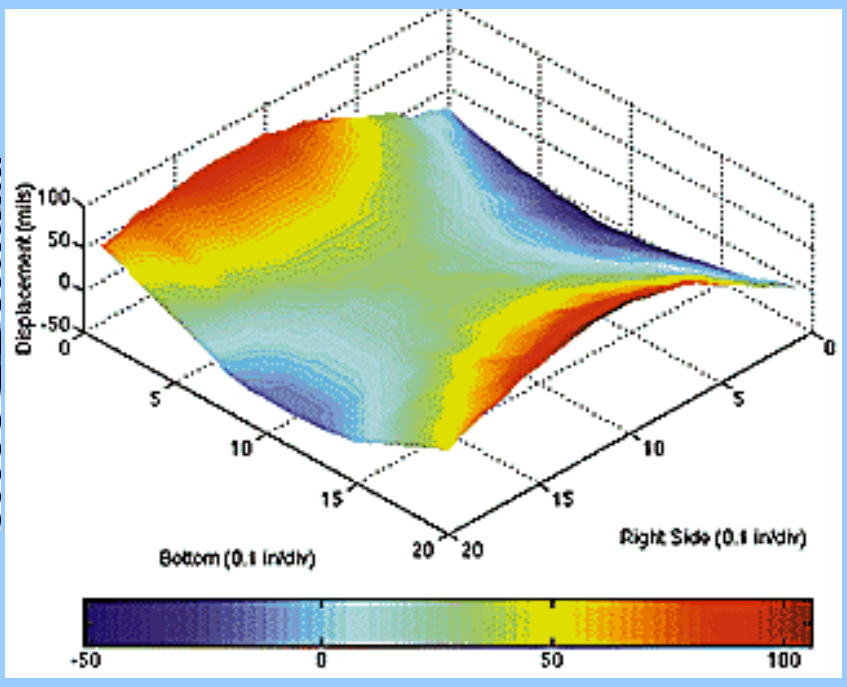
"The technical applications are larger than the original sponsors knew it would be when they started," he says. "We want to be a good example of technology transfer."



Figures 1 and 2 -- 26°C before simulated soldering process



Figures 3 and 4 -- 216°C peak temperature



Figures 5 and 6 -- 28°C after simulated soldering process

Further information is available from Dr. Charles Ume, School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0405. (Phone: 404/894-7411) (E-mail: charles.ume@me.gatech.edu)

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Research Horizons
Georgia Institute of Technology

Environmental Technology

Defusing Contaminated Soils ... With Plants

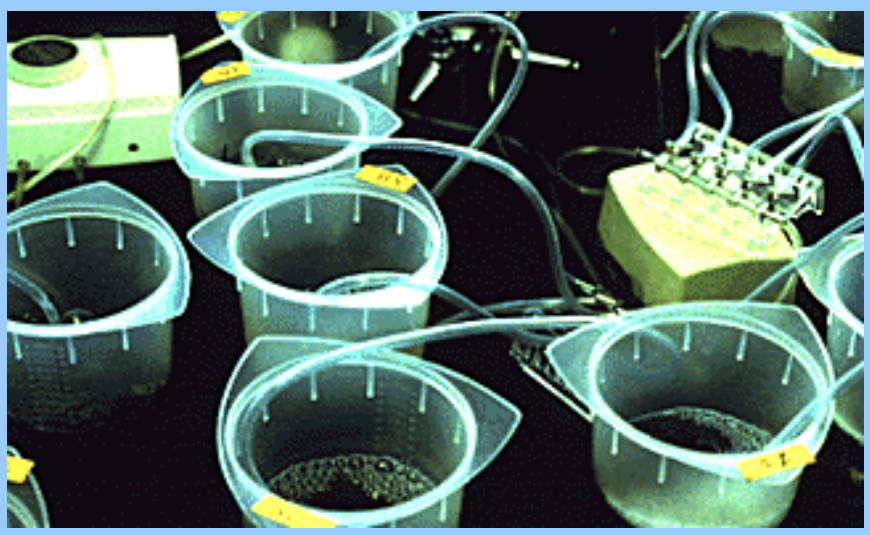
By Mark Hodges

AT MUNITIONS FACTORIES, ammunition plants and military bases, the landscape often hides serious environmental hazards. Trinitotoluene (TNT) and other explosives, such as RDX and HMX, have accumulated over the decades in soils and some groundwaters. These pollutants now threaten to contaminate public water supplies or even trigger small explosions at abandoned and operational sites.

The solution to this problem may be helping nature restore itself. To this end, researchers at Georgia Tech and their colleagues at Rice University and Louisiana State University are developing clean-up techniques relying on aquatic vegetation to defuse and detoxify TNT.

This approach, called phytoremediation, could become a useful substitute for incineration, the conventional method of disposing of TNT wastes. Incineration requires costly removal procedures.

In laboratory studies, researchers are growing different species of aquatic plants



Phytoremediation could become a useful substitute for incineration, which is the conventional and rather costly method of disposing of TNT wastes.

and assessing their ability to break down and assimilate these polluting compounds.

"The plants that seem to do the best job are submerged aquatic plants, which flourish in wetlands and are commonly viewed as nuisance plants in national waterways," says overall project director Dr. Michael Saunders, a professor of civil and environmental engineering at Georgia Tech. "We think that phytoremediation could provide an effective and economical alternative that is preferable at some sites."

Plants' Potential Well-Known

In independent studies, scientists already have found that some aquatic plants are able to assimilate TNT and convert it into less hazardous chemical compounds. The research teams at the three participating universities are building on these results in a multiyear study sponsored by the U.S. Environmental Protection Agency through the South & Southwest Hazardous Substance Research Center.

Louisiana State University faculty researchers are describing how TNT moves from contaminated soils to water and are using this knowledge to build models of the process. Dr. K.T. Valsaraj, an associate professor, is leading a team that drew samples of TNT from soils and is studying the fundamental physical and chemical processes involved when the compound dissolves.

Researchers at Georgia Tech and Rice University are conducting basic studies of the way plants transform TNT and the "pathways" the compound follows during breakdown and assimilation. Dr. Jackie Shanks, a professor of chemical engineering, has shown that TNT transformation results from vegetative processes and has described the key variables required to break down the contaminant. Environmental engineer Dr. Joe Hughes has tagged TNT with carbon-14 and followed its migration through living plants.

At Georgia Tech, Saunders and Dr. Spyros Pavlostathis, both professors of civil and environmental engineering, have led an effort to assess the TNT-reactivity of a variety of submerged aquatic plants. They have focused on optimal methods of cultivating plants, assessing phytoremediation kinetics and the role of microorganisms and sediments in breaking down TNT. They also are determining if plants need a period of acclimation or continuous exposure to TNT to attain effective reactivity.

The Georgia Tech researchers have assessed the phytoremediation potential of approximately 20 aquatic plants, both as monocultures and parts of polycultures. They judged the most promising to be opportuntistic, structurally simple species, such as Myriophyllum spp., Elodea spp. and selected algal species.

Transformation Mechanisms

The mechanisms used by plants to transform and assimilate TNT have produced much scientific uncertainty and debate. According to one theory, a plant enzyme, known as nitroreductase, triggers the initial reduction of the TNT molecule.

PHOTO COURTESY MICHAEL SAUNDERS

Aquatic vegetation in this experimental lagoon is continually fed with soluble TNT.

Georgia Tech and Rice researchers have found evidence that the aquatic plants assimilate TNT and use it for structural growth.

Three key processes appear to take place. TNT nitro groups are reduced to form a series of amino-nitro toluenes. This process takes place within several hours and makes the contaminant nonexplosive. The TNT derivatives may be conjugated, a process in which the plant attaches compounds of higher molecular weight, such as glucose, to the contaminant. Conjugation allows detoxification, cellular transport and cellular storage of TNT.

This process acts in concert with plant growth processes and takes weeks to complete in parallel with plant growth processes. The final key process in phytoremediation is assimilation of TNT constituents into plant tissues.

The Georgia Tech group found that aquatic plants do not use the TNT amino-nitro toluenes as nutritive sources of nitrogen. Instead, they incorporate these contaminant byproducts into storage, where they are used to produce cell tissue. The assimilation process also takes several weeks to finish. These remediation processes conform to the plant's life cycle, but they take place faster than when TNT is broken down by microbial systems.

Another important finding has been determining where TNT degradation occurs. As Hughes' carbon-14 study showed, transformation does not appear to take place in the soil or water, but instead happens inside the plant and at the plant surface. Some of the resulting amino-nitro toluenes leak into the surrounding water, where they are taken back up into the plant and assimilated.

Sunlight's Impact Studied

Reactivity with vegetation is not the only factor affecting the breakdown of TNT in solution. Dr. Chris Tiller, a Georgia Tech assistant professor of civil and environmental engineering, tested the effect of sunlight on TNT transformation.

When exposed to photolysis, TNT-contaminated water turns red or pink if it lacks reactive aquatic plants. The resulting "redwater" contains condensation and polymerization products so difficult to break down that they are considered a remediation dead end.

Tiller found that the presence of reactive vegetation in the water triggers such a rapid transformation of TNT that sunlight has little dampening effect.

In Tiller's words, "Photo doesn't hurt phyto."

Field Studies In Progress

Researchers at the Georgia Tech Research Institute have built a pilot-scale phytoremediation system on campus and are using it to test the conclusions of their laboratory studies.

In this experimental lagoon, aquatic vegetation is fed with soluble TNT on a continuous basis. The field study began in the summer of 1995 and is still underway. Georgia Tech researchers have supported another field demonstration at a military ammunition plant, with funding from the U.S. Army.

Through these field tests, the researchers are learning some of the problems that must be resolved before a phyotoremediation technology is ready for practical use. Much development work remains to be done, but the prospects look good that plants can effectively defuse this explosive national environmental problem.

Further information is available from Dr. F. Michael Saunders, School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0512. (Telephone: 404/894-7693) (E-mail: michael.saunders@ce.gatech.edu)

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Research Horizons
Georgia Institute of Technology

Graphics, Visualization, Usability

Gorillas in the Bits

By Amanda Crowell

AS A SOFT BREEZE BREAKS through the springtime heat at Zoo Atlanta, a young female gorilla's mind turns to troublemaking. Tired of grooming and napping, she heads toward a large silverback male resting in the shade of an immense oak tree.

At first, the old male simply glares at the youngster as she playfully lunges at him and strikes aggressive poses she's learned from the other apes. But when his stares and annoyed coughs go unheeded, he suddenly charges the juvenile, screaming and beating his fists against his chest. Wisely, she flees.

Excited and a little scared, the female retreats to a nearby wooden shelter and pulls off her helmet. This gorilla, as it turns out, is actually a human student seeing firsthand how apes interact

PHOTO BY JOE SEABO

Tara Sconza, an eighth-grader at The Westminster Schools, tries out the virtual reality

in the wild, through virtual reality.

gorilla exhibit with help from Lori Perkins, conservation biologist for Zoo Atlanta.

The experience is part of a unique educational program created by Georgia Tech and Zoo Atlanta.

"The best way for kids to understand gorilla behavior is to become a gorilla," says Kyle Burks, a research associate with Zoo Atlanta's Conservation Action Resource Center (ARC). "This experience is probably the closest we could come in the world to doing that."

In May, researchers from the two organizations conducted a one-day trial run of the world's first virtual reality gorilla exhibit in the Ford African Rain Forest's Gorillas of the Cameroon Interpretive Center.

Local schoolchildren were on hand to try out the system, which put them into a "real" gorilla habitat as a member of a gorilla family.

"While watching the students interact with the virtual gorillas, I was most impressed by how quickly they learned to behave like gorillas in appropriate ways," says Burks. "That's evidence of how great the model and the experience really are."

Dr. Jean Wineman, an associate professor and director of the doctoral program in Georgia Tech's College of Architecture, agrees.

"Participatory experiences have been shown to increase motivation and retention of information," Wineman says. "We expect this will be a powerful experiential educational tool in sensitizing children to the gorilla world and giving them an understanding of the behavioral interactions that create gorilla society."

A Realistic Model

To make the project an effective teaching tool, researchers worked hard to make both the virtual environment and the virtual apes as realistic as possible. They used photographs, videos, contour maps, architectural blueprints and design layouts to properly recreate the gorilla's environment.

PHOTO COURTESY LARRY HODGES

"This is the most accurate and detailed model of a real outdoor area that has ever been created for a virtual environment," says Dr. Larry Hodges, an associate professor in the College of Computing and an associate director of the Graphics, Visualization and Usability Center. "Brian Wills [a research scientist in the College of Architecture] spent over 700 hours creating the computer model of the habitat."

Accurate models, in turn, will help researchers design better habitats -- a goal of any zoo conservationist -- and build better exhibits for spectators. Wineman plans to use the virtual reality zoo concept as a design tool in a course called Environmental Psychology, offered under the College of Architecture and the School of Psychology. It will be co-taught by Dr. Terry L. Maple, director of Zoo Atlanta and a Georgia Tech psychology professor.

"Current zoo design is based on the concept of 'landscape immersion,'" Wineman says. "A visitor should feel that he or she has entered the animals' world and comes upon the animals unexpectedly, as one might in the wild. The virtual exhibit as a design tool will provide an analysis capability that will allow designers to assess proposed design solutions, alter them and reassess the results."

But creating an accurate environment is only half the work. The virtual gorillas also have to look and behave like real gorillas.

Using videos, anthropomorphic data and behavioral data on movement and interaction, Georgia Tech doctoral student Don Allison created virtual gorillas that simulate real movement and generalized behavior.

"Our job was, 'Can we do something that would be accurate gorilla behavior?'" Hodges explains. "So if an adolescent male gorilla approaches the dominant silverback male gorilla, the Zoo Atlanta researchers could tell us the range and probabilities of the silverback's actual responses."

Zoo researchers were impressed with the program's first run, which wasn't easy to achieve. Unlike monkeys, apes are not extremely active animals, and much of their social

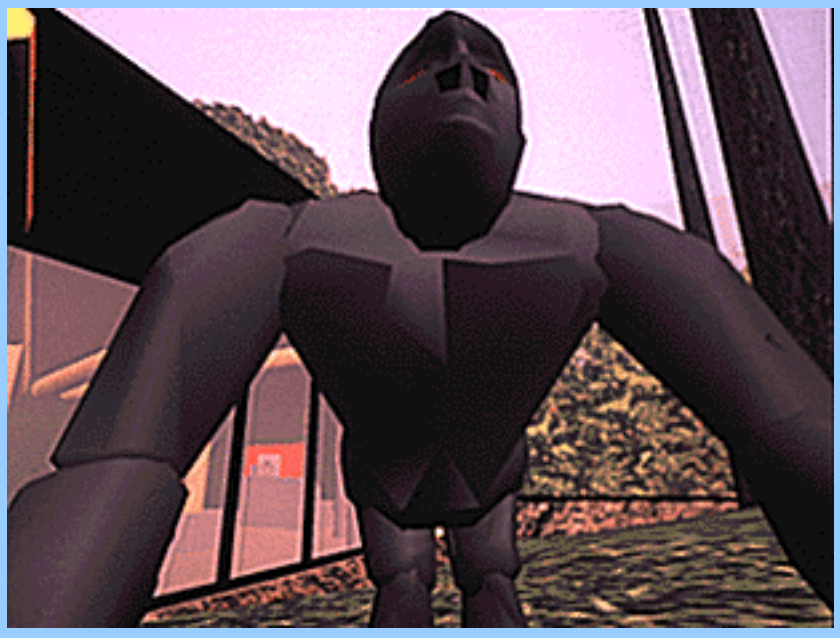
interaction is subtle -- a cut of the eyes, a flick of the hand or an annoyed cough.

"People always expect them to be like monkeys, who do run around," says Lori Perkins, conservation biologist with the Conservation ARC. "The Georgia Tech researchers certainly could have gone in that direction. They could have made a cartoon gorilla. But the whole point was to make it realistic."

Exploring the Virtual Environment

The students who tested the virtual reality program began their journey in the Gorillas of the Cameroon Interpretive Center, an observation building for one of the zoo's four gorilla habitats. This particular habitat is the home of Zoo Atlanta's most famous gorilla, Willie B. The 38-year-old, 439-lb. silverback shares his home with three adult females -- Kinyani, Mia Moja and Choomba -- and two of his offspring, 2-year-old Kudzoo (Choomba's daughter), and Mia Moja's daughter Olympia, born in June.

PHOTO COURTESY LARRY HODGES



In the virtual reality program, the student became part of a generic gorilla family by "melting" through the observation building's glass windows into the habitat. She assumed the role of a juvenile gorilla who becomes restless in the company of an adult male and an adult female, both of whom are resting contently.

The male demands the largest area of personal space, roughly five meters. He will rebuke an annoying or aggressive approach with mock charges, chest beating, enraged screams and/or direct physical attack.

Females, by contrast, are more tolerant and will accept a submissive approach -- slow, with no physical contact -- as an invitation for grooming. Females also will warn the juvenile before attacking, with aggressive stances, gruff coughs and discontented stares.

The juvenile, who is at the bottom of the hierarchy, will always back down from a fight. To make sure human children understand and adhere to this social order, researchers built a "timeout" function into the program.

If the juvenile continues to move toward an adult gorilla, despite its rebukes, the virtual reality screen goes black, then reads, "You're in timeout." When the program resumes, the student is back in the observation building and is no longer a gorilla.

"You're dealing with real kids here," Hodges says, laughing. "We figured some kids would go up and harass the adult gorilla and wouldn't back off and learn how to act properly, from the signals the adult was giving."

Future Development

In the future, researchers hope the virtual reality gorilla exhibit will become a permanent feature at the zoo, as well as a traveling exhibit for schools. To do that, they'll need to refine the program to run on smaller, less expensive computers.

And since the demonstration in May was meant only as a trial run, to test the system and gather feedback from real children, many changes and additions are in the works. These include letting zoo visitors explore all of the gorillas' habitat, such as the usually off-limits night quarters; providing more information about care, conservation and research activities at the zoo; and adding more gorillas to the virtual reality program.

"A recurrent comment from the children who were involved in the demo was their interest in having a 'child' gorilla to interact with," Wineman says. "The advantage of a young gorillas is that they tend to display a more varied and playful array of behaviors."

Other refinements include guidelines on how to interpret the adult gorillas' vocalizations, differences in the volume and direction of the vocalizations, and more automation of the gorillas' behavior. Currently, their reactions are controlled by a computer student working at a central machine.

For Zoo Atlanta officials, using virtual technologies provides them with an additional avenue to link children with the natural world via technology.

"Our Zoo Atlanta team of scientists and educators first began to plan a 'virtual zoo' three years ago," says Maple, who also is one of the world's foremost authorities on gorilla behavior. "We instantly thought of Georgia Tech as our design partner, and we are extremely impressed with the scholarly approach taken by Dr. Hodges and Dr. Wineman, who have worked closely with our behavior experts.

"With the help of Georgia Tech, we hope to work together to expand this project so that the 'virtual zoo' will one day be a reality," he adds.

Funding for the project comes from Zoo Atlanta and Georgia Tech's EduTech Institute.

The Graphics, Visualization and Usability Center provided virtual reality and computer resources.

Further information is available from the Virtual Reality Gorilla Exhibit: http://www.cc.gatech.edu/grads/a/Don.Allison/gorilla/gorilla.html

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Research Horizons
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Sensors and Electromagnetics

Rotman Lens Offers Inexpensive, Electronically Scanned Antenna

By John Toon

RESEARCHERS AT the Georgia Institute of Technology have designed and built a prototype Rotman Lens that operates at millimeter wave frequencies. Because it has no moving parts, no phase shifters and can be implemented in plastic, the electronically scanned device offers an inexpensive, rugged, reliable and compact alternative to current millimeter wave antenna technologies.

PHOTO BY STANLEY LEARY

The Georgia Tech prototype is believed to be the first Rotman Lens to operate at a frequency as high as 37 GHz. Variations of the antenna could be used in a range of military and civilian applications, including tank radars, all-weather aircraft landing systems, communications equipment, missile seekers and automobile collision avoidance systems.

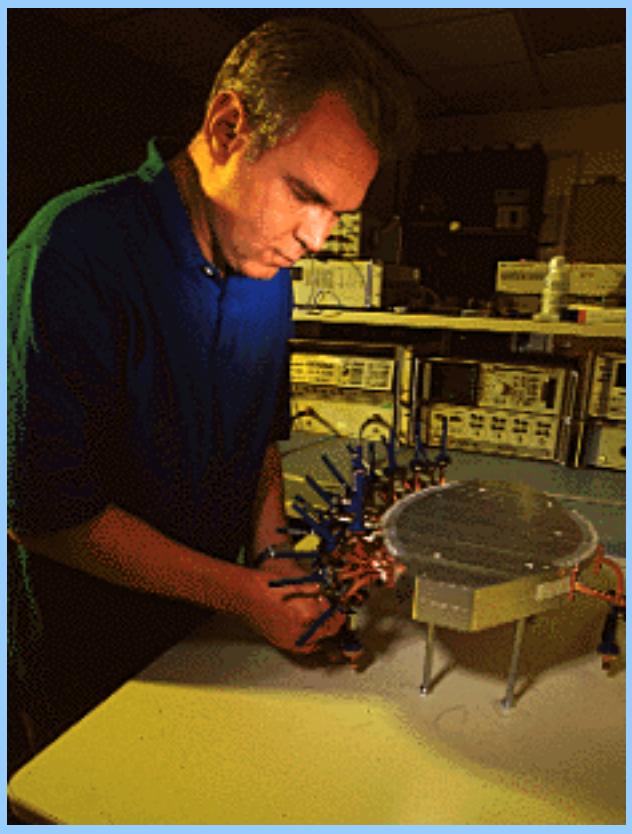
"We have taken a first step toward the goal of a really inexpensive millimeter wave antenna that would be useful in a growing number of applications," says Dr. Ekkehart (Otto) Rausch, senior research scientist at the Georgia Tech Research Institute. "Radars and communications devices in the millimeter wave region are becoming more widely used.

There are many applications where you would like to have an antenna that is very low-cost, simple, rugged and reliable."

The research was supported by the U.S. Army Research Laboratory.

Through a Glass Brightly

The device got its name because of its ability to focus microwave or millimeter wave energy coming from a particular direction by passing the electromagnetic energy through a pair of parallel plates that are shaped like a lens. Beam-forming or focal ports are located on one side of the plates, fed by a switch array. The array ports are on the opposite side, each connected to an antenna element. Energy fed into a specific focal port will emerge from the antenna elements and produce a beam along a particular direction.



Dr. Otto Rausch adjusts the Rotman Lens. Variations of it could be used for many military and civilian applications.

Switching the input from focal port to focal port steers the beam electronically in one direction across a 45- degree arc. The switching could be done with pin diode switches, which are also simple, reliable and inexpensive.

Previous Rotman lens antennas have been developed at frequencies of 18 GHz or below, Rausch says. Most have been produced in microstrip. Microstrip, however, is very lossy at high frequencies, and therefore is not suitable in the millimeter wave region. Instead waveguides and an air dielectric must be used between the parallel plates to reduce the losses to an acceptable value between 1 and 2 dB.

With modeling assistance from Dr. Andrew F. Peterson in Georgia Tech's School of Electrical and Computer Engineering, Rausch designed and fabricated an antenna milled out of a solid block of aluminum. Production of the aluminum antenna demanded tolerances of 0.0005 inches. Rausch talked with more than 20 fabrication facilities before locating a New Jersey company capable of using electrical discharge techniques to carve out the necessary shapes at those tolerances.

"Everything about this lens, from the width of the waveguides to the shape of the absorber foam, matters a great deal," he says. "The surface roughness and even the placement of the screws all have been designed according to strict design principles."

The lens was designed with the assistance of Jay Sexton and fabricated with the technical expertise of Mitch Cole, who laid out the design in AutoCAD. Greg Hampton made the accurate waveguide

extensions required for the measurements. Measurements were made by Mitch Kappa, and Kevin Murphy assisted with analysis.

Production antennas could be hot-pressed in plastic, which would then be coated with a conductor like gold. The antenna feed horns and switch array could be made the same way, allowing the antennas to be very low in cost.

Besides the low cost, compact size and ruggedness, the Rotman lens antenna also offers very low throughput loss and sidelobe emissions. In the prototype developed by Peterson and Rausch, sidelobe power can be suppressed by a factor of one-thousand below the energy of the main beam. The power loss through the lens itself is less than 2 dB.

Most antennas operating at millimeter wave frequencies use mechanical scanning or phase shifters, both of which have disadvantages. Mechanically steered antennas are slow in response and suffer reliability problems due to shock and vibration. Phase shifters are costly to fabricate and introduce considerable RF losses. By avoiding those drawbacks, the Rotman lens antenna could open new applications for millimeter wave radar.

Potential Applications

To be successful in some applications that Rausch envisions, the antenna's operating frequency must be expanded, and the capability to scan in two dimensions added. Potential applications include:

- Autonomous aircraft landing systems: Poor visibility caused by heavy fog can keep pilots from seeing enough of the runway to allow a safe landing. A synthetic vision system based on millimeter wave radar could produce images through the fog, allowing aircraft to land even when runways are obscured. Such a system would require a reliable, compact and inexpensive antenna system to be affordable.

- Synthetic vision for ground vehicles: Operators of ground vehicles such as tanks also need to see through fog and smoke, but the vibration and harsh operating conditions limit use of conventional antennas. A Rotman lens antenna could be integrated into the tank's structure, eliminating the need for an external dish and providing necessary reliability and ruggedness, Rausch says.

- Automobile collision avoidance systems: Collision avoidance systems built into automobiles could provide drivers with warnings of approaching vehicles. If implemented in plastic, the new antenna could lower the cost of such systems enough to make them practical.

- Commercial communications: Rotman lens antennas could be used in short-range, building-to-building wireless communications. Implementation in plastic could help lower the capital costs for such systems.

- Missile seekers: Its low cost, reliability and compactness could find application in airborne systems such as missile seekers.

A paper on the Rotman lens was submitted to the 1996 Antenna Applications Symposium. Another abstract on the Rotman lens was submitted to the 1997 National Radar Conference.

Further information is available from Dr. Otto Rausch, Georgia Tech Research Institute, Sensors and Electromagnetic Applications Laboratory, Georgia Institute of Technology, Atlanta, GA 30332-0857. (Telephone: 770/ 528-7777) (E-mail: ekkehart.rausch@gtri.gatech.edu)

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Last updated: 27 Nov. 1996

Research Horizons
Georgia Institute of Technology

RESEARCH NOTES

New Quarters for GCATT

Building will facilitate research for new information technologies

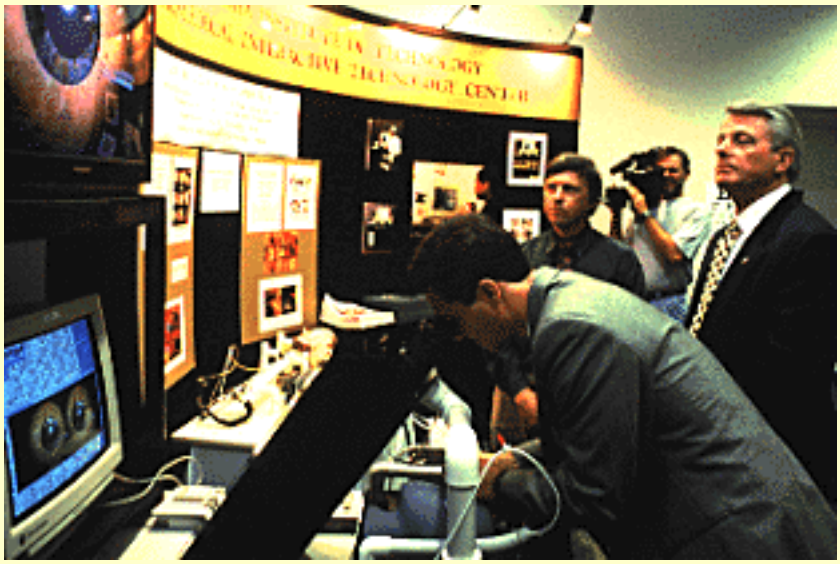
The Georgia Center for Advanced Telecommunications Technology (GCATT) recently began work in a new building that will support the development of new technologies, applications and high tech companies in the information industry.

Formed in 1991, GCATT is a center at Georgia Tech and a division of the Georgia Research Alliance (GRA), an economic development partnership of state government, universities and industry. GCATT fosters the growth of Georgia's information industry through collaborative programs in research, education, healthcare and public policy.

Projects supported by GCATT include:

✔ constructing a high-speed network testbed for technology and applications research.

PHOTO BY GARY MEEK



Mike Sinclair (standing left) and Georgia Gov. Zell Miller observe a guest examining an eye surgery simulator during the GCATT Open House. Sinclair is director of Georgia Tech's Interactive Multimedia Technology Center.

✔ highlighting Georgia K-12 teachers who are successfully integrating technology into their classrooms through the program "Search for Innovative Teachers -- Teaching with Technology."

✔ working with the Centers for Disease Control to build a statewide Information Network for rapid dissemination of healthcare data.

✔ hosting symposia on public policy issues that affect the growth of the information industry.

The building houses collaborative projects among leading information industry companies and the GRA universities. GRA scholars, synergistic laboratories for research in areas such as multimedia, distance learning, telemedicine and virtual reality, as well as exhibit space are all located inside the building. The GCATT building also is the product of Gov. Zell Miller's vision for Georgia to become the world center for telecommunications technology.

Universities participating in GCATT and the GRA are: Clark Atlanta University, Emory University, Georgia Institute of Technology, Georgia State University, Medical College of Georgia and the University of Georgia. Contributors to GCATT and to the GCATT building are: AT&T, Bay Networks, BellSouth, Cisco Systems, Cox Enterprises, DENON, Equifax, Georgia Power Foundation, Georgia Tech Foundation, Hitachi, Lucent Technologies, Robert W. Woodruff Foundation, Scientific-Atlanta, The State of Georgia, Turner Broadcasting System, Turner Entertainment Networks and VSI Enterprises.

Further information is available from Steven Spell, GCATT, 250 14th Street, N.W., Atlanta, GA 30318. (Telephone: 404/894-9211) (Fax: 404/894-1445) (E-mail: msgcenter@gcatt.gatech.edu)

Two GTRI Research Groups Renamed

New names represent growth in roles, direction

GTRI has changed the names of two research groups to reflect their growth. The Arlington Research Group (ARG) is now the Arlington Research Laboratory (ARL) and the Aerospace Sciences Laboratory has been renamed the Aerospace and Transportation Laboratory (AERO).

The Arlington Lab provides test and evaluation support to U.S. Air Force Headquarters. Arlington's research has grown significantly since it split away from its parent unit, the Electronic Systems Laboratory, about a year ago. The Arlington Lab director is Ed Eagar.

Since 1992, GTRI's Aerospace Sciences Lab has moved from a sponsor base of more than 60 percent Department of Defense research to today's majority of advanced transportation research. This growth, which is acknowledged in the name change, came about through director Bob Cassanova's leadership of a multi-lab initiative to increase sponsored advanced transportation research. The initiative also contributed to the expected establishment of the interdisciplinary Georgia Transportation Institute at Georgia Tech.

PHOTO BY BOB CASANOVA

The Aerospace and Transportation Laboratory participated in the FAA-sponsored "Operation Helistar," which explored helicopter operations in Atlanta during the Centennial Olympic Games.

Further information about the Arlington Lab is available from Ed Eagar, Arlington Research Laboratory, Georgia Tech Research Institute, 1700 North Moore Street, Suite 1910, Arlington, VA 22209. (Telephone: 703/528-0883) (E-mail: ed.eagar@gtri.gatech.edu)

Further information about the Aerospace and Transportation Laboratory is available from Dr. Bob Cassanova, Aerospace and Transportation Laboratory, Georgia Tech Research Institute, Atlanta, Georgia 30332-0844. (Telephone: 770/528-7826) (E-mail: bob.cassanova@gtri.gatech.edu)

Suspect Speech

Digital analysis of an individual's speech patterns could lead to an intoxication test

Slurred speech is often a sure sign that someone's been drinking. Now, a Georgia Tech researcher is working with colleagues from Indiana University to digitally quantify this telltale sign, which could lead to a simple, non-invasive way to test a person's sobriety.

"This is basically an effect of fine motor control," says Dr. Kathleen Cummings, an instructor in the School of Electrical and Computer Engineering. "We're looking at specifically what happens during speech production at your vocal cords, how steadily you can produce the excitation going through your vocal cords."

Preliminary results show that intoxicated speech is marked by jumpy changes in pitch and energy production and unsteady opening and closing of the vocal cords.

Much work is left to be done, but Cummings says translating her research into a practical public safety device could be relatively easy. Law enforcement officials could record someone's speech at an accident or traffic stop, then analyze it later by computer against a sample taken at a different time.

Or, devices could be placed on motor vehicles, aircraft or assembly lines that would test a person's speech against previously recorded and digitized samples. If the test showed that the person was intoxicated, access would be denied.

Although researchers plan to let others sort out

Researchers Recognized

Recognitions, honors given Tech staff members

- Dr. Jude Sommerfeld, a professor in the School of Chemical Engineering, was named a fellow of the American Institute of Chemical Engineers.

- Six young faculty members recently were honored with NSF Career Awards:

    - Dr. Janet Hampikian, Materials Science and Engineering
    - Dr. Berdinus A. Bras, Mechanical Engineering
    - Dr. Raja Das, College of Computing
    - Dr. Mark R. Prausnitz, Chemical Engineering
    - Dr. Joy Laskar, Electrical and Computer Engineering
    - Dr. Angus P. Wilkinson, Chemistry.

legal issues, they will compare their results against other factors that alter the way a person speaks, such as colds, diseases, injuries or speech impediments.

Regardless of how the research is used, Cummings and her colleagues hope their work adds to the basic knowledge and understanding of how speech is produced.

The project is sponsored by the Alcoholic Beverage Medical Research Foundation.

Further information is available from Dr. Kathleen Cummings, Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0250. (Telephone: 404/894-3335) (E-mail: kate@ee.gatech.edu)

Business Incubator

Advanced Technology Development Center is tops in nurturing new businesses

Georgia Tech's Advanced Technology Development Center (ATDC) was recognized recently for its business incubation work.

ATDC received the 1996 Randall M. Whaley Business Incubator of the Year Award at the 10th National Conference of Business Incubation.

The center was selected from a pool of six nominees chosen from 550 eligible North American incubators.

Modeling and Simulation

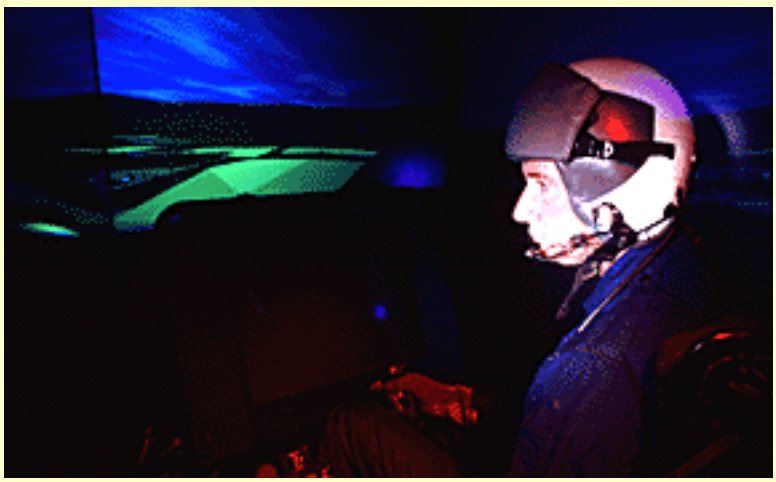
Tech offers expertise ranging from graphics to information systems

Modeling and simulation technology is making fundamental and widespread contributions to the economic, as well as military, strength of the United States.

Areas in which Georgia Tech offers expertise include:

✔ Scientific modeling: Scientists and engineers at Georgia Tech make sense of the physical world by simulating basic physical processes.

PHOTO BY STANLEY LEARY



Aerospace engineers conduct modeling and

✔ Education and training: The EduTech Institute at Georgia Tech sponsors several programs in exploratory simulations to improve learning effectiveness. Multimedia in Manufacturing Education is a highly visible program that develops manufacturing-related interactive courseware and provides the infrastructure and resources necessary to enhance manufacturing education in the classroom and on the job.

simulation research in this flight simulator.

✔ Graphics and visualization: Georgia Tech houses the Graphics, Visualization and Usability (GVU) Center, where research spans realistic imagery, algorithm animation, medical imaging, scientific data visualization, adaptive user interfaces, human-computer interaction and virtual environments.

✔ Information systems: Computer scientists on campus have produced useful models and simulation tools for the medical arena, human-machine interaction and traffic management systems. They offer guidance in computer networking and battery technology.

✔ Military applications: Tech researchers have developed a wide variety of military application models and simulations, ranging from numerical simulation of basic phenomenology to support for the Defense Modeling and Simulation Office's (DMSO) High Level Architecture (HLA) framework, which makes the interoperability of all types of military models and simulations possible.

✔ Modeling, Simulation and Gaming (MSG) of Warfare Short Course: This course provides a forum for the military, industry and academia to discuss and experience the various technologies currently available to the analytical, training community.

Further information and a brochure about modeling and simulation research at Georgia Tech are available from the Modeling and Simulation Initiative Focus Group, Georgia Tech Research Institute, Georgia Institute of Technology, Atlanta, GA 30332-0832. (Telephone: 404/894-3523) (Fax: 404/894-9081) (E-mail: modeling@gtri.gatech. edu)
(WWW: http://www.gtri.gatech.edu/ model.htm)

A Red Carpet Honor

Tech's Tincher presented textile chemistry's highest honor

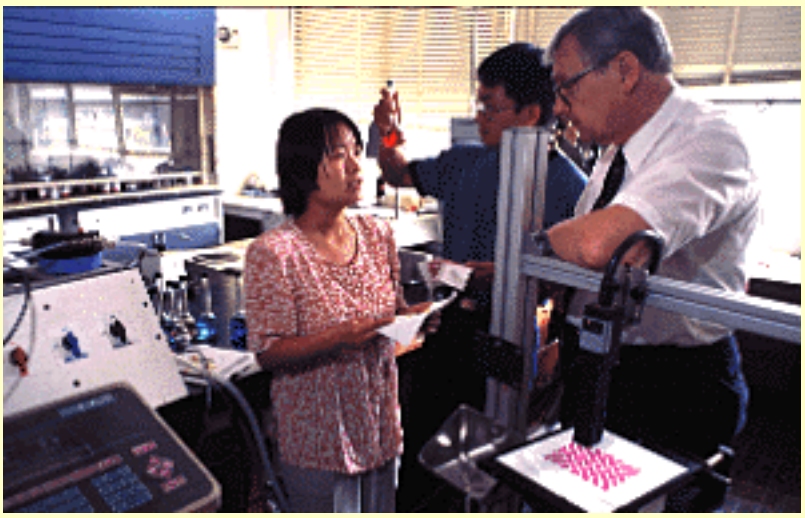
A Georgia Tech professor in the School of Textile and Fiber Engineering has received the

highest honor presented in textile chemistry in the United States.

Dr. Wayne C. Tincher was honored with the 1996 Olney Medal by the American Association of Textile Chemists and Colorists. He is the first Georgia Tech faculty member selected for the award in the program's 51- year existence.

Presented yearly, the Olney Medal recognizes "outstanding achievement in textile or polymer chemistry or other fields of chemistry of major importance to textile science."

PHOTO BY GARY MEEK



Dr. Wayne Tincher works with graduate students exploring new systems for textile coloration.

Tincher's research areas include manufacturing technology for carpets and apparel, particularly in dyeing, finishing and color measurement. He currently is conducting research on new systems for textile coloration that are consistent with demand-activated manufacturing.

A Georgia Tech faculty member since 1971, Tincher has served as research director for the Apparel Manufacturing Technology Center, is the Institute's research director for the National Textile Center program and teaches classes regularly.

-- "Notes" compiled by Amanda Crowell, Amy Fraser, Margaret Horst, Lisa Mullikin, Lisa Sills

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