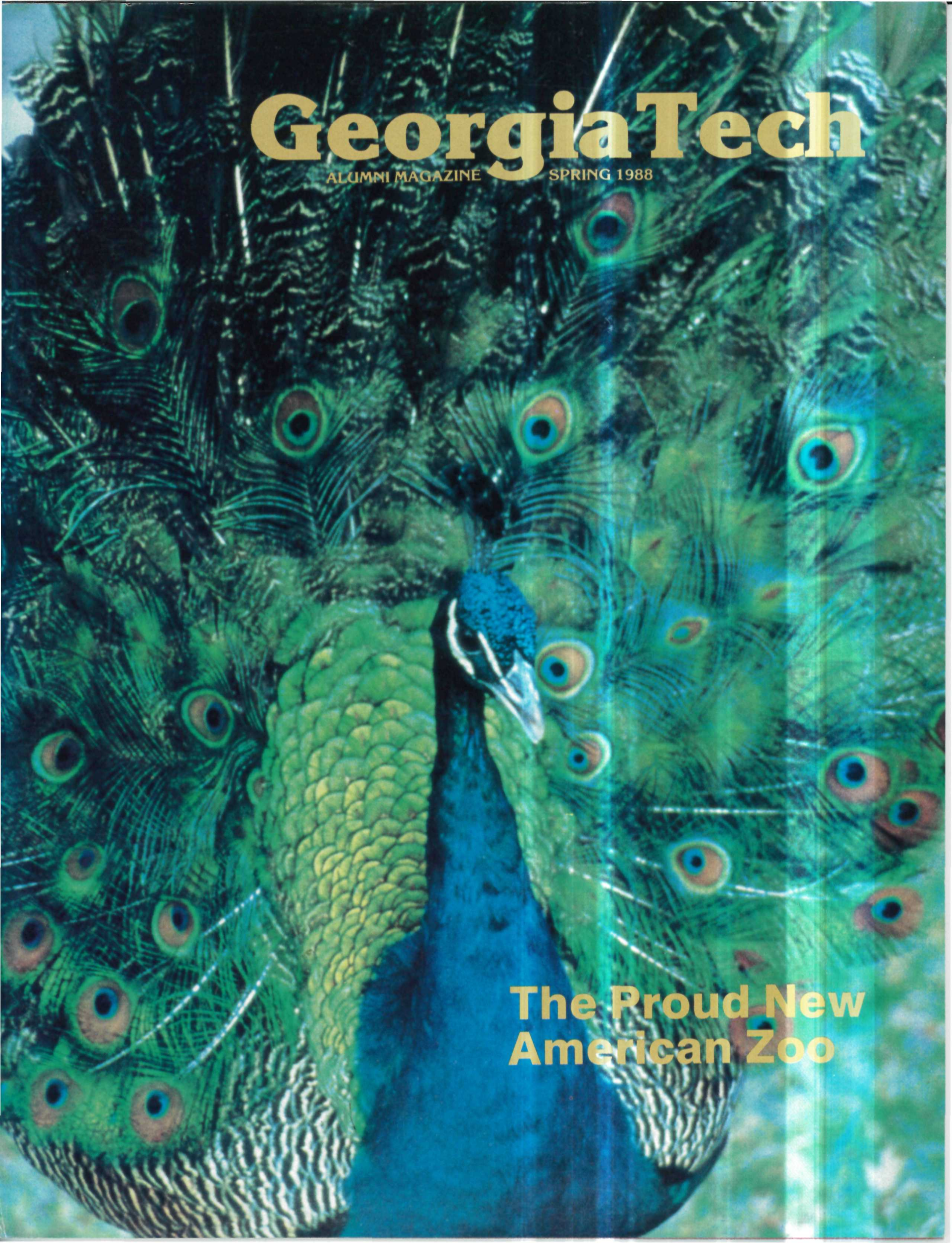
Georgia Tech

ALUMNI MAGAZINE SPRING 1988



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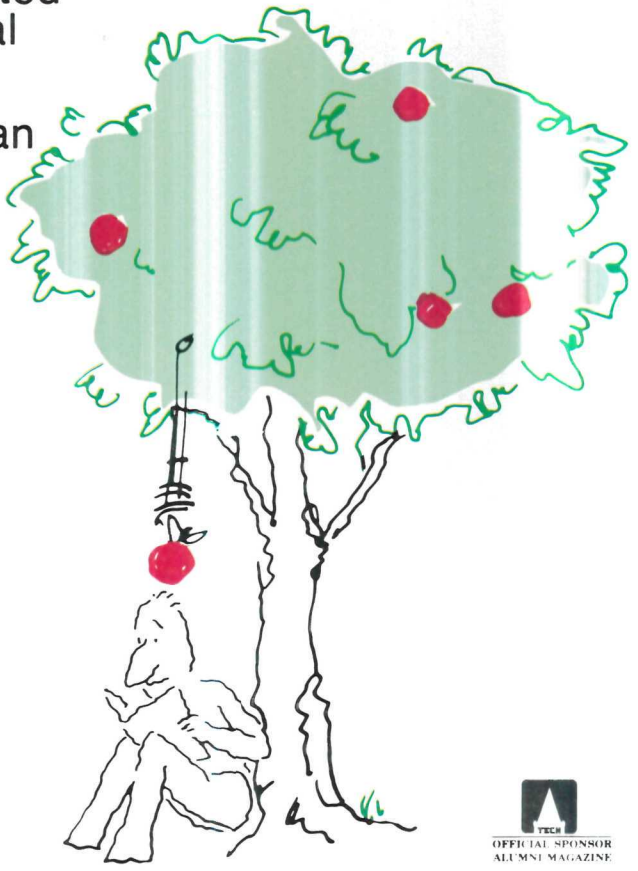

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Georgia Tech
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John C. Dunn
editor
Gary Goettling
associate editor
Melissa Fudalla Stoebe
Garon Hart
graphic design
Gary Meek
Margaret Barrett
photography

PUBLICATIONS COMMITTEE
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LETTERS

Objects to Commentary

Editor:

I am disappointed that you published the article by R.H. Bayor in the fall issue [Comment, "We Still have a Long Way to Go"].

I find his comments objectionable and filled with anger and prejudice. The article should not have been in the *Georgia Tech Alumni Magazine*.

I recommend you revise your editorial policy to prevent publication of this type of commentary.

Jack G. Owens, IE '51
Chester, Va.

Where's the Light?

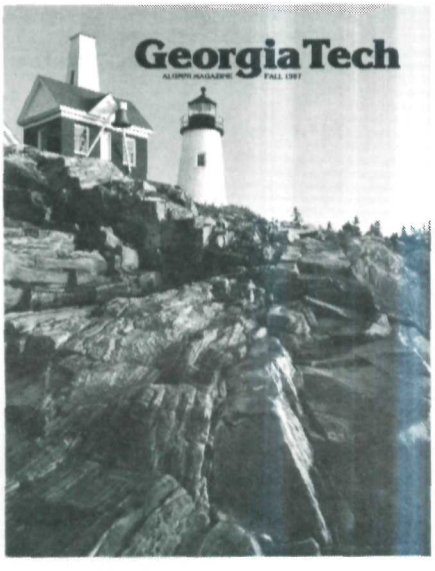
Editor:

The location of the lighthouse shown in Paul Beswick's superb photo on the cover of the fall 1987 issue should have been identified. I believe it is Pemaquid Light, Pemaquid Point, Maine.

The old light was established in the white pyramidal tower connected to the dwelling in 1827.

H. Clay Lewis
professor of chemical engineering emeritus
Decatur, Ga.

The writer is indeed correct in his identification of the photograph — ed.



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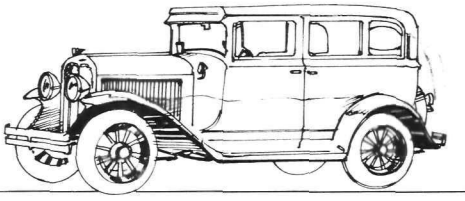

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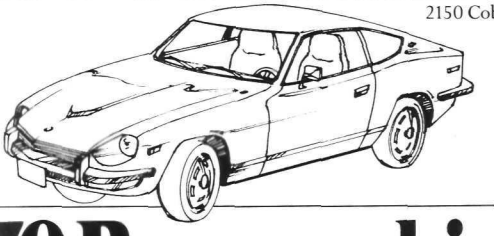

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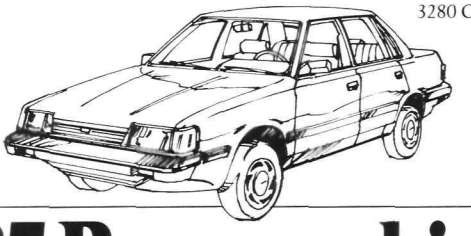

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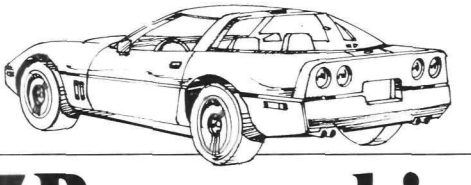

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TECHNOTES

China Presents Diverse, Scholarly Literary Collection to Library

The People's Republic of China has made an unsolicited gift of more than 1,000 scholarly volumes, many specially and beautifully bound, to Georgia Tech's Price Gilbert Memorial Library.

The concentration of the volumes, most of which are in Chinese, is in the humanities and social sciences. The books include dictionaries, encyclopedias and publications in the fields of language, literature, history, culture, philosophy, religion, economics, business and the arts, said Miriam A. Drake, director of libraries. Other titles in the diverse collection are in the area of technology and science.

"It is a high-quality collection with some really outstanding pieces," Drake said.

The volumes include the 1982 *Population Census of China*, and a 10-volume compendium of reports by Chinese officials and scholars who have visited the West recently.

Miriam A. Drake with some of the volumes China presented to the library.

"There are deluxe editions of four of the most popular Chinese novels, *The Dream of the Red Chamber*, *The Journey to the West*, *The Water Margin*, and *The Story of Three Kingdoms*," Drake said. "This is all classical Chinese literature.

"I am particularly pleased because I have a personal interest in oriental art," Drake added. "There are great treasures in China, and to have them shared this way is a wonderful thing for their government to do. There would be no other opportunity for us to acquire material of this quality."

Ruth C. Hale, assistant director of libraries, said all volumes in the collection have been placed in the stacks, with the exception of six or seven which are considered very valuable.

"Because of the beauty of many of the volumes," Hale said, "the collection is aesthetically as well as intellectually rewarding."

Georgia Tech is one of several major research libraries in the U.S. to receive such a collection. The books were presented by the State Education Commission of the People's Republic of China.

Tech Ranks Third in Engineering Research

The National Science Foundation (NSF) reported that in 1985, the most recent year statistics were compiled, Georgia Tech retained its third place ranking among all U.S. universities for the level of engineering research and development conducted. Ahead of Tech in the rankings were Johns Hopkins University and the Massachusetts Institute of Technology.

Overall, Georgia Tech conducted nearly five percent of all university-based engineering research in the country.

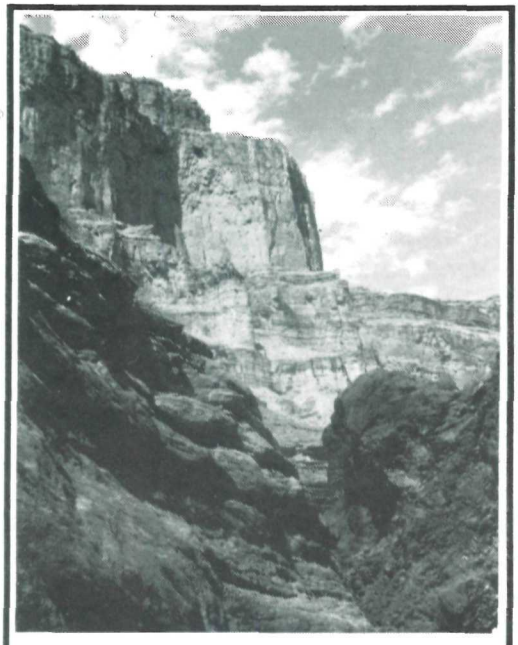
In terms of research volume, Tech programs in computer science and in aeronautical, chemical, civil, electrical and mechanical engineering all ranked in the top ten nationally.

Tech's long-term goals call for a doubling of its research program by the year 2000. In the same time, Tech plans to triple the number of doctoral students on campus. This group depends on the research program for support.

SKITTER, the Three-Legged Robot, Stands Tall in Design Competition

When it comes to getting a leg up on the competition, SKITTER wins the prize.

SKITTER, a three-legged robot designed by a Georgia Tech team for construction work on the moon, was a grand prize winner in the *Design News* "Excellence in Design" competition.



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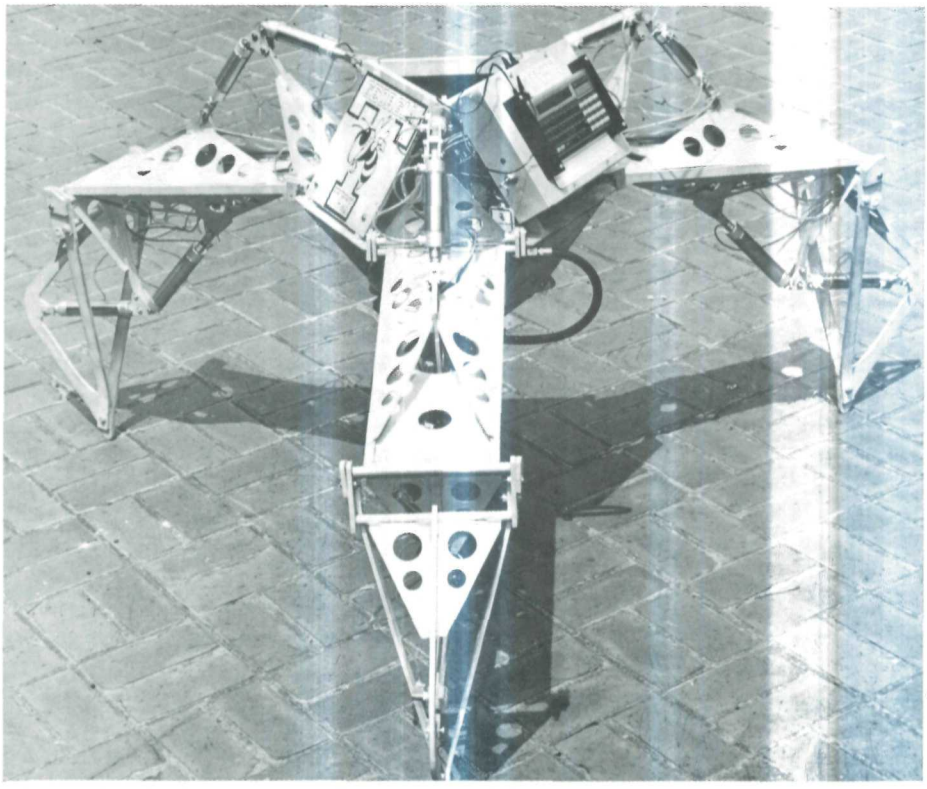


Dayton Funk

SKITTER is designed for work on the rough lunar surface.

The robot relies on just six moving parts and six actuators for its mobility. Its designers say SKITTER can still get around even with two of its actuators disabled.

"I was thinking about the least number of parts one can have in a stable transportation device," he said. "Monopods and bipods are limited in their ability to be statically stable. So I looked at three legs, something like a tripod, with actuators to manipulate the legs under microprocessor control."

That control comes from a small Hewlett-Packard HP71B computer with software written by SKITTER's student builders.

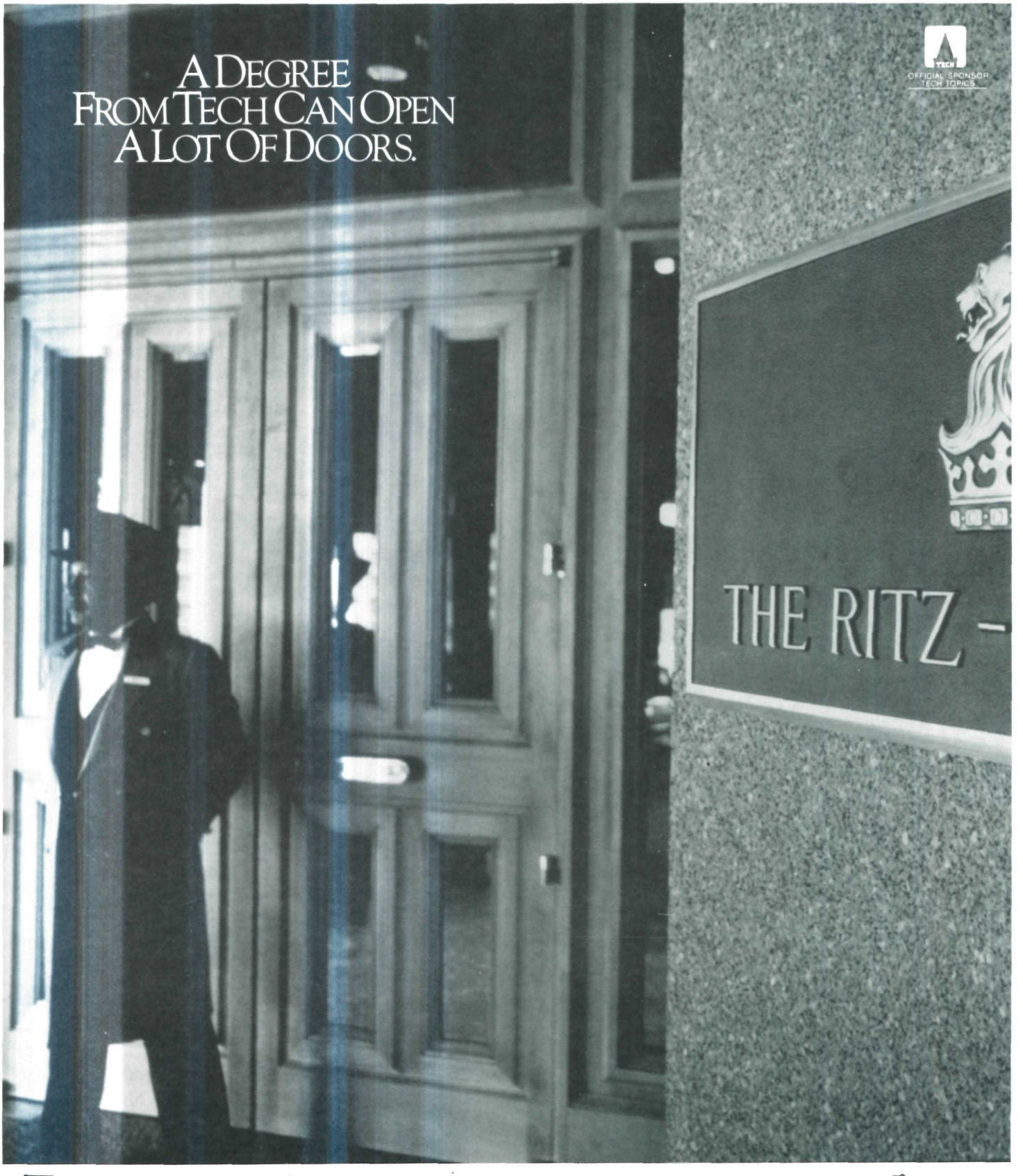
Starting with a toothpick model Brazell built on his kitchen table and followed by several months of analysis, he and graduate students Brice MacLaren, Gary McMurray and Steven Chichka developed the robot as a "proof-of-principle" model. Using about $4,500 worth of materials — and working day and night — SKITTER took form in just 20 days.

The robot has been shown in Washington, D.C., at the Advanced Missions Space Design Program Summer Conference sponsored by NASA and the Universities Space Research Association, and at NASA's Kennedy and Johnson space centers.

In its lunar version, Brazell sees SKITTER's greatest advantage as its mechanical simplicity. While wheeled vehicles offer advantages in high speed transportation over smooth lunar surfaces, he believes SKITTER's ability to walk in any radial direction or turn about any point would give it an advantage in construction work on rough, sloping or boulder-strewn surfaces.

Because the three legs together are capable of many possible configurations, SKITTER can squat down to pick up cargo, tilt to aim a drill bit, stabilize for digging operations and spread out its legs to provide a table crane platform. Each leg uses a femur-tibia arrangement much like a grasshopper's leg, with actuators at the hop and knee joints.

Jim Brazell, a mechanical engineering instructor, came up with the idea of designing the robot as a student project when returning from a NASA/University Advanced Space Design Program briefing.



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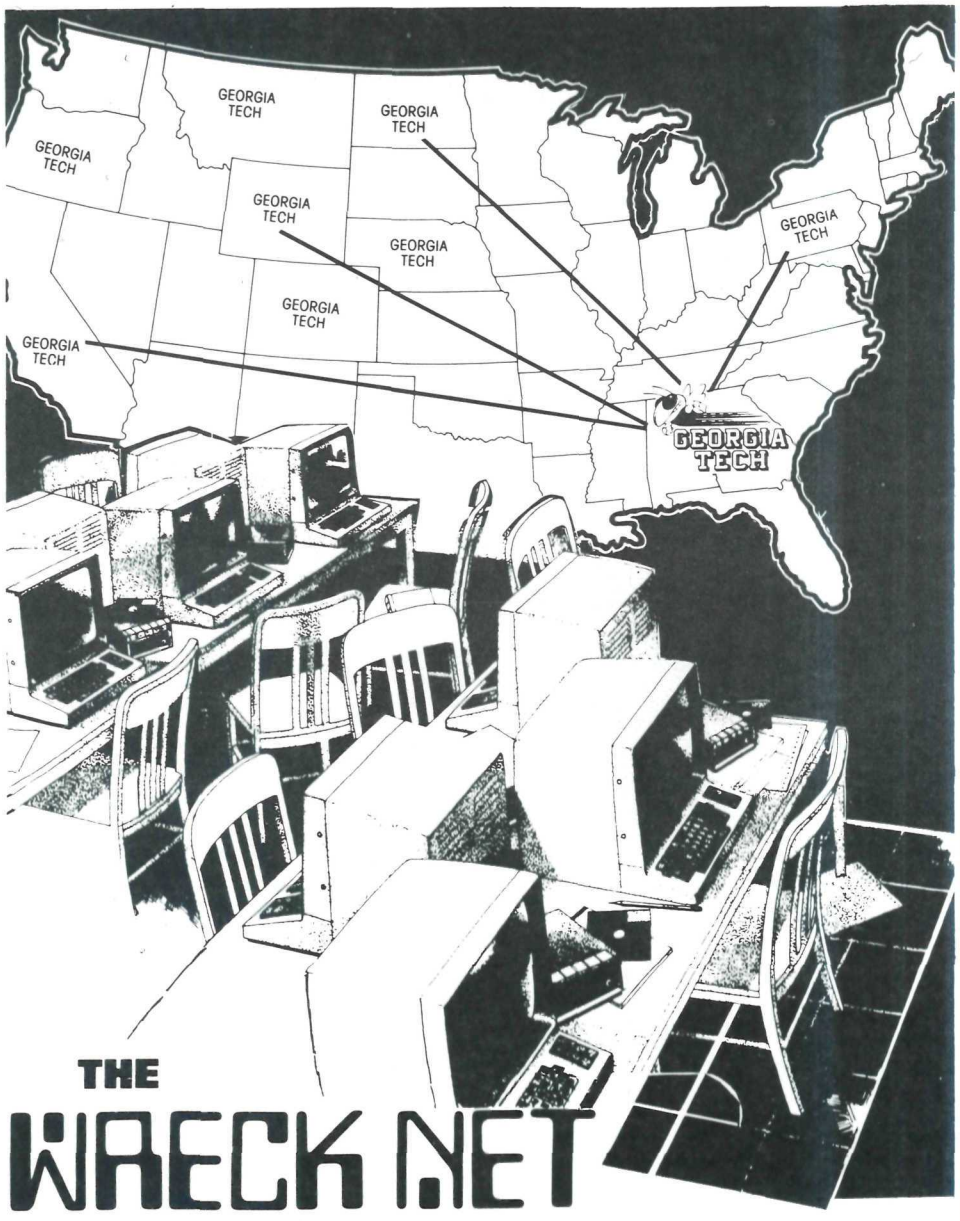

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Building Degree Program Expanded

The College of Architecture has restructured its four-year undergraduate degree in building construction with the intention of developing it into "one of the leading programs in the nation," according to Dean William L. Fash.

The expanded program "is the result of several years of intense and in-depth reasearch and study in concert with both industry leaders and academic practitioners," Fash said.

"Our expanded program has been hailed by industry representatives as a major advancement in construction education directions, and we believe it has the potential of becoming one of the leading programs in the nation," Fash added.

The expanded program features three individual options of study, which provide a highly structured and challenging blend of technical, managerial and liberal arts courses leading to a bachelor of science in building construction degree. The degree options include construction management, construction development and construction science.

Second Time Around is a First as Students Re-elect SGA Officers

Student Government Association President Sharon Just and Vice President Frank Harris made SGA history during winter quarter elections, becoming the first incumbent president and vice president re-elected to a second term.

It was also the first time that the top two SGA offices have gone uncontested in an election.

Just is a senior majoring in civil engineering, and Harris is a senior majoring in biology. Both students are President's Scholars.

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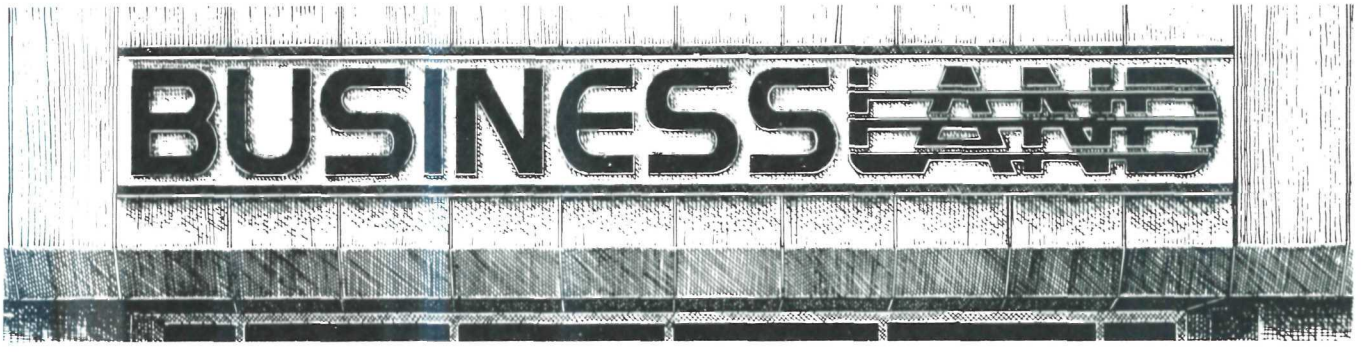

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Gloomsayers are Wrong

By Alan Pope

The drop of the stock market on Oct. 19, 1987, was a painful blow to most investors, and a catastrophe to some. But it wasn't a repeat of the crash in 1929 and it wasn't the end of the world for investors. In fact, it happened just as a new boom was getting underway in our country.

First, here are the scenes that took place:

The Growing Storm

For many years we bought Japanese cars and other products. We sent them the money, and they in turn invested the money in the United States because our interest rates were higher than theirs. Same with the Germans. We had the cars and we also ended up with the money. (If any of my readers want to sell me their cars and lend me the money to buy them, give me a call!)

In early 1986, the world in general got tired of supporting our nice lifestyle and started shying away from owning dollar bills and investing in our country. With the concurrence and active effort of our government, the value of the dollar went down. In 1987 the Germans raised their interest rates to keep more money at home, and this past September the Japanese did likewise. When we raised our rates in response, bonds became more attractive than stocks and money went out of the stock market and into bonds; consequently, the market gradually fell. On Wednesday, Oct. 14, the Ways and Means Committee, seeking more income for Uncle Sam, agreed that interest paid on the vast sums needed for corporate takeovers would not be "deductible." The action, if put into effect, could withdraw vast sums from the stock market. (No action was taken, but the damage was done nonetheless.)

The Mechanics of the Collapse

On Thursday, Oct. 15, the market fell below a widely used timing device — the 200-day moving average — and that night many mutual fund managers, pension fund managers and various other traders and advisors got a "sell" signal — all at once. Some put the signal on their telephone "hotlines," and if you were a trader in the habit of calling every day you would have heard a "sell" the next day. Very few acted, but the market still fell a lot on Friday. The big money managers — pension fund and mutual fund managers — worked over the weekend and arranged for sales on Monday. Several mutual funds have 24-hour phone service and they got so many "sell" calls Friday night, Saturday and Sunday that they knew they would have to sell a lot of stock to raise money for redemptions.

When the market opened on Monday morning, Oct. 19, the enormous Fidelity group endeavored to sell $500 million worth of stocks. The GM pension fund, managed by Wells Fargo, went for $100 million. More selling followed from all sides. The system couldn't handle the volume — nobody had that much money — and the market made its largest drop in history. The market rallied later and since then has been fairly level.

Outlook

Now why do I think things are in place for a good 10 years? Well, you can't argue that stocks aren't a better buy than before the drop, but in the same voice I can't give you 100 percent certainty that they are at the bottom. But here is the situation as I see it:

- Much of the vast sums removed from the market are available for borrowing and their amount justifies lower interest rates, which are occurring as I write. Some money will be reinvested and some will enable people to buy houses and all the things that go into them. I think we face a housing boom.
- The lower dollar will mean fewer things bought abroad as soon as we (or Japanese companies running factories in America) get TVs, VCRs, radios, appliances, etc. on the *worldwide* market. (The Japanese, renowned as savers, are now switching over to "living like Americans" and will be a big market for our goods, which can now be made cheaper here than in Japan. *That's* a switch!)
- Lots of money will come in for investment in factories and land since relative to Japan and elsewhere, everything is cheap here.
- Our new society — 70 percent of us are in service jobs — doesn't suffer from "inventory lag" because services don't have inventories. This adds to the availability of money and jobs.
- There is a movement to force Congress to reduce their porkbarrel spending (they increased the president's budget six out of the past seven years) by giving the president a line item veto.

The net of all this is that we have or can buy the raw materials; we can regain the production know-how. And I think we are in the mood to add consumer goods to our service-oriented economy. This makes for a great 10-year economic outlook.

Alan Pope, AE '34, MS '39, is currently a money manager and financial writer living in Punta Gorda, Fla.

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Taking Participative Management to the Limit

By Don Nichols

In 1982, Carla LeBlanc lacked confidence. After working more than three years in two low-level manufacturing jobs, she had grown skeptical about her talents. She knew all too well that her employers hadn't hired her to think, but to do as she was told. Displays of initiative only provoked sneers from her supervisors.

But those painful, frustrating days are behind her. LeBlanc still works in manufacturing, but her newest job has boosted her self-esteem and erased many of her insecurities.

For the past five years, the native Texan has worked as a process technician at Rohm and Haas Bayport Inc., a six-year-old specialty chemical plant in LaPorte, Texas, a small community 30 miles east of Houston. There, the participative-management concept has been taken to its limit: All 67 employees play an active role in managing the plant; technicians like LeBlanc routinely perform a variety of tasks, without supervision; workers even evaluate one another and interview job applicants.

Don Nichols is a Dallas-based free-lance writer.

"The idea is to push responsibility and know-how farther and farther down into the organization, so that every person is a manager. We're trying to transfer ownership for decision making to the people who are going to get the work done," says plant manager Bob Gilbert. "I can make the best decision in the world, but if it's not accepted by the people who are going to promulgate that decision, it isn't worth anything."

"Personally, I believe American industry goes to some lengths to prevent people from being productive. We create too much hierarchy and too much control, which drives motivation and innovation underground," adds Gilbert, a 1952 chemical engineering graduate of Tech.

Not so at Bayport, where the management team numbers a meager four executives. A finance director shares the front office with Gilbert. Out in the plant, two manufacturing managers head up two operating units: Bayport Diphenyl (BDP), which produces Blazer, a herbicide used on soybeans; and Bayport Specialty Monomer (BSM), which

manufactures a monomer used in making automobile paint and film for photographic plates. Only those two managers separate the plant manager from the 46 process technicians and 15 technical people (engineers and chemists) who keep the operation running. Unlike plants operated more traditionally, Bayport has no shift foremen or supervisors.

"What we're trying to do here is unique. I've always felt that people could do work if given the opportunity and support," Gilbert says, "and that one could create a workplace where people would be responsible, and at the same time be involved in managing their own work."

Approximately one-half of the technicians work exclusively for the BDP chief; the other half answer to the BSM manager. Neither unit leader gives his staff much direction. Instead, the technicians make operating decisions among themselves, working in teams varying in size from four to seven people.

The technicians staff the plant around the clock, seven days a week, splitting their workday into two seven-to-seven shifts. Four teams work each day, two per shift — one in the Blazer division, the other in the monomer operation. Teams work four consecutive days, then are relieved by four other teams, following the same schedule. When teams return to work after resting four days, they pull the opposite shift: Those who worked night duty switch to days and vice-versa.

Cross-Training

The technicians work in the control room, the lab, the rack area and materials handling (inbound and outbound shipments). They rotate jobs with other team members every four to 12 weeks, a practice that keeps boredom low and motivation high. The multi-skilled workers train one another, read manuals and view videotapes.

Not surprisingly, Gilbert and his small staff of managers encourage their workers to learn all they can. Whenever something piques technicians' interests, management acts quickly to satisfy their curiosity. When LeBlanc and others wanted to know more about the forklift drum pickers they use, a representative of the manufacturer was asked to make a presentation. A spokesman for the company that made the plant's drumming lines paid a similar visit.

"At other places, you learn how to work something. You may not ever learn how to fix it," stresses LeBlanc. "All you do is complain when it breaks down, then wait for someone else to come in and repair it. But we're much more involved in our jobs. If we even think something is wrong with one of the lab instruments, we can take it apart without permission and put in new pieces, no matter how expensive the parts might be."

Management and labor share common goals at Rohm & Haas.

If you think through a problem, and your solution is workable, they will let you try carrying it out. The environment is so much more creative.

"In my last position, whether or not we knew how to run another job, we weren't allowed out of our work areas. We were trained to do one job, and that's the only one we did. You couldn't even push a button for someone else," LeBlanc adds. "I worked there two years, but I was going nuts after a year-and-a-half. Here, I haven't been bored yet. There is always something to learn."

Although the technicians constantly work to expand their capabilities, they do have limits. After all, none have college degrees in fields related to the chemical industry. When tough-to-solve problems are encountered, they turn to the technical team in each unit for support.

Professionals who work regular hours during the week staff the technical teams: development chemists, quality control chemists, maintenance engineers and process engineers. Like the technicians, they work unsupervised, and make team decisions. Both teams are small — eight in the BDP unit, seven in the BSM — so their technical-minded members tackle a myriad of jobs in addition to helping technicians troubleshoot. They also design new equipment, figure budgets and manage 15 to 20 outside contractors who occasionally work at the plant.

"In another plant, I probably would specialize [in one area of engineering] — mechanical, electrical, instrument or civil. But, at Bayport, it is an accepted norm that we perform many duties. We pick up little bits of jobs which are not necessarily defined as ours," says Bill Knipe, the BSM maintenance engineer in charge of the unit's hardware.

Provide a Service

Knipe and other members of the technical staff tell the technicians how much to make of a product, and where to dispatch it. They never tell them how they want the work done. That's not their job.

"We don't supervise the technicians directly. They don't report to us, as much as we provide a service to them," Knipe explains. "Technicians initiate any work that needs to be done. If they feel it is beyond their capacity, they call in a member of the technical team to help out.

"We take over when they consider it necessary and they think it better that a particular job be done by someone with a little more technical ability. Of course, they are gaining more expertise themselves, so they are increasingly able to solve more problems," he adds.

Technicians feel free to question judgments made by the technical experts. For instance, when BSM technician Jesse Adams detected a noise emitting from a silencer, he reported the problem to Knipe. Unlike Adams, the engineer could not hear a noise and thought no problem existed. The technician kept disagreeing, so finally Knipe requested a noise-level test.

"Surprisingly enough, that test proved beyond a doubt that Jesse was right and I was wrong. He showed me that he had valuable input to offer on technical matters," Knipe says matter-of-factly.

Adams suggested moving the silencer, but Knipe merely covered it with an acoustic hood. "I explained to Jesse that we would just be transferring a nuisance somewhere else, which would have been illogical."

"Even if Jesse had been wrong, it wouldn't have mattered. The point is, Adams had the opportunity to voice his perception. That's how we work," emphasizes David Donar, the BDP maintenance engineer.

Donar knows. A safety-conscious technician recently complained when Donar didn't immediately replace a leaky pump that was blowing seals. The engineer opted to try different kinds of seals, hoping one would work better.

"We just sat down and talked about it. He was looking at the sure fix, which is hard to do without considering the costs. His way would have required a large capital investment, so I explained to him why we couldn't do it. We still have the same pump, and the seals are working fine now," Donar says. "Many of the technical people who have left just couldn't take that kind of feedback from the technicians."

Bob Gilbert

Too Threatening?

"Some people can't work in a system like this. It's too threatening to them," Gilbert agrees. "But there are a whole bunch of [human] resources out there that American industry isn't tapping — resources that we are trying to tap here. Lots of people could do this if they tried. People just don't reach out and try doing things like they ought to."

The manager doesn't take sole credit for designing and implementing the plant's innovative system. Other Rohm & Haas executives, managers and employees played key roles — especially Roy Djuvik, formerly the company's operating director in North America, now retired. Consultants hired to assist in the challenging endeavor were indispensable, as well.

Setting Up Bayport

The first order of business? Outcome statements that clearly defined the plant's goals needed to be written. Gilbert and the consultants interviewed several high-ranking corporate officials, asking for their input on what Bayport should be. They also met with 25 company employees involved in the project, including people from the central engineering division, and the corporate and regional personnel offices.

Gilbert and the consultants studied the data for three months, then agreed that the plant should be employee-oriented, and cost-effective, among other things. To ensure those outcomes, they defined the plant's corporate culture: Management and labor share common goals; people affected by decisions have input; and decisions are made by consensus.

They also defined the attributes the process technicians needed to succeed in such an out-of-the-ordinary work environment: responsible, motivated, versatile, able to learn, honest, communicative, open and sensitive. Bayport still seeks those "dimensions" in recruits, but the way employees are selected has been revised.

When the first 16 technicians were hired in 1981, the Texas Employment Commission screened potential applicants, testing them for ability to perceive spatial relations, mechanical aptitude, and mathematical and English comprehension. Those who scored high enough were sent to the plant, where they were interviewed and rated separately by two members of Bayport's management or technical teams. The interviewers later agreed on an overall rating for each candidate, offering employment to those scoring highest.

Applicants were asked pointed questions specifically designed to highlight the necessary "dimensions." "We might have asked applicants to explain what they did in their last position if they saw someone doing something unsafe. We were trying to elicit a response that would demonstrate their behavior," Gilbert says. "We were looking for concerned individuals who would stop coworkers from doing something unsafe, or who demonstrated a desire to help others with problems."

A Rocky Start

The results could have been better. During its first two years of operation, the plant's turnover rate was nearly 50 percent. When the system was slightly

I can make the best decision in the world, but if it's not accepted by the people who are going to promulgate that decision, it isn't worth anything.

The control room at Rohm & Haas.

modified in 1983, however, turnover dropped to less than 10 percent. Initial interviews are no longer left solely to the administrators or technical people; technicians also have been trained to rate applicants. More importantly, applicants who pass that first interview now must return to the plant and meet the teams they might join.

"Those teams decide whether or not they can get along with them, and they decide whether or not they are hired," Gilbert stresses.

Initial implementation was "something like parenting," says Gilbert. "You might read a book on being a parent, but you really don't learn how to be a good one until you have a child, and then learn from the child. Unfortunately, that means the oldest always suffers," he adds.

Now, even the technical people are hired in similar fashion. Gilbert recently visited the University of Texas at Austin to search for a process engineer. He found a young graduate he liked, but she wasn't hired until she visited Bayport and was approved by other staffers.

"She was interviewed by technicians, a technical team and the unit's manufacturing manager. They agreed to offer her the job. Had they not, that absolutely would have been the end of it. It was their decision to make," Gilbert says.

The manager takes pride in calling the system flexible. Changes like those made in the recruiting process take place regularly, whenever the need arises. No one hesitates to point out trouble spots.

Minor changes usually happen quickly and informally, with little fanfare. Although the technicians have never punched a time clock, they were dubious about the plant's electronic security gate. Since they gain entry with pass keys, the

workers felt management could use a clock affixed to the gate to document their time. When complaints were made, Gilbert had it removed.

Evaluations

A task force — a specially appointed team of technicians, technical people, and management — tackles major problems, sometimes spending weeks or months trying to resolve them. The evaluation systems used by the technicians has been studied repeatedly and modified.

Originally, technicians in each unit completed written evaluations on one another every six months. They did not distribute the forms among themselves, but gave them to their manufacturing manager. After studying the data, the manager met privately with each technician to give an overall evaluation. This "middle man" approach created friction, so the technicians began face-to-face meetings. Rating peers who worked different days was difficult, so employees' evaluations were narrowed to members of their own team and those who relieved them. Currently, technicians critique only individuals in their own groups. The relief team is judged as a whole, and unit-wide critiques take place every two years.

Merit raises linked to the evaluations created the most difficulties. The pay-for-skills raises were determined partially by the score technicians received from their peers. The lower the rating, the less money. Many hesitated to make honest appraisals, not wanting to deprive anyone of a pay increase. Others were unduly harsh. To solve the problem, the raises were dropped. Technicians, whose starting salary is $21,000, now are given periodic pay hikes as they demonstrate a proficiency in each job they perform. If they progress on schedule, they can earn $33,000 per annum within three years, then receive raises competitive with similar jobs in the area.

"The merit raise was unfair," says Maria Mendoza, a process technician in the BSM unit. "If you and I had a personality conflict and you didn't like the way I worked, you could cut my pay [raise] in half. A lot of super, high-performance people weren't getting top dollar because they weren't liked as well as others. You know, they weren't happy-go-lucky types of people, or maybe they just didn't talk to everyone."

Mendoza likes the present evaluation system, but would like to see more spontaneity. "You're supposed to give feedback on a daily basis, if necessary. You're not supposed to wait until evaluation time every six months. Some technicians do wait, however, and they are wrong. By the time six months come around, I might not even remember the problem someone hits me with, but it has been eating that person up. We're trying to have open, constructive criticism," says Mendoza.

Feedback makes her try harder. When criticized by others for repeatedly letting stronger men on her team work tough-to-handle oxide cars, the slender technician fought back. Her pride was at stake.

"I knew I was neglecting that work, but it was easier to let quicker team members do it. After I got hit [with criticism] at two evaluation periods, I just told myself that I would do it and prove I knew the oxide area. So, now I do it," she says emphatically.

Friends and families frequently ask the Bayport workers why they work at jobs that seemingly offer no promotion opportunities. The question apparently doesn't offend them, nor come as a surprise. Most have asked themselves the same question, only to have their fears quickly dispelled once they gave the issue some thought.

"Right now, there is nowhere to go. But we're hoping the system will evolve so that there will be a couple of alternatives — profit-sharing, maybe, or gain sharing," says Mark Bierdman, a BDP process technician. "Possibly, when a technician has been here eight or nine years...and an engineer moves on, we'll create a [new position called] technical representative, to replace process technicians working with new ones.

If we even think something is wrong with one of the lab instruments, we can take it apart without permission and put in new pieces, no matter how expensive the parts might be.

We were looking for concerned individuals who would stop co-workers from doing something unsafe, or who demonstrated a desire to help others with problems.

"For me, if I never get a promotion until the day I retire, it's still worth it to work in this environment. I can live without ever being a foreman because people listen to a lot of the things I have to say. That makes me feel good about myself," he adds. "At most places, people don't care what you think. That's the way you need to do it, and that's all you need to know. You want to work a little harder here, I think."

Donar, the BDP maintenance engineer, echoes Bierdman's enthusiasm, yet sees less long-term opportunities for professionals at Bayport. That's not to say he feels his experience at the plant will lead nowhere.

"They let you think here, so you can be your own person. If you think through a problem, and your solution is workable, they will let you try carrying it out. The environment is so much more creative," he says. "It would have been easy for us to spend $70,000 on a new powder-charging system. But I have come up with some ideas to modify the current system. I have designed an apparatus to crush the powder into small pieces, and it costs very little.

"It's really tough for me to see any future here, though. There are only so many problems you can solve. It's not the place to be if you're looking to move up into different levels of engineering.," he admits.

"From Bayport, I think I would go into my own business. Working here, with all the diversity and self-regulation, makes you not afraid to take risks. And a lot of our training is in people skills and managerial skills, which you don't get in a traditional engineering plant," he adds.

Lots of Attention

The plant's participative management system attracts lots of attention. Gilbert frequently finds himself explaining it to other curious executives. Occasionally, skeptics even force him to defend it.

"Everybody wants to know how much better we are doing [than other Rohm & Haas plants]. That is a hard question for me to answer because we don't make the same products anyone else does. It's difficult to compare us apple to apple, orange to orange," he says.

Still, the plant manager readily offers a few facts and figures that seem to speak well of the Bayport facility and its innovative operating policies. Not too long ago, a customer's inspectors visited the plant to make a quality audit. They had never given a supplier's plant a higher grade than 83 percent, but Bayport scored 96. Another time, when representatives of a potential customer made a visit, they decided to buy all of their company's needed supply of a particular product from the plant. The Bayport staff would have been satisfied with an order half that size.

"In the past three quarters, we have not shipped any out-of-specification product from our monomer division, and our volume has gone up. That compares to 30 to 40 percent in-spec when we first started operating," Gilbert brags. "In the specialty chemical industry, if someone is shipping 90 to 95 percent in-spec, they are doing very well,"

Other Rohm & Haas operations are taking cues from Bayport. Plants in Bristol, Pa.; Houston; Knoxville, Tenn.; and Louisville, Ky., have introduced less-sophisticated, but similar management systems.

"The idea of team participation and team management is diffusing into the company. But we're still way out ahead of the others," Gilbert says. "I like to think that we've created a good system of working that benefits both our people and Rohm & Haas.

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New Zoo Design Brings the Savanna to Atlanta

By Gary Goettling

In the director's office at a southwestern zoo, the pelt of a rare clouded leopard — once a resident of the zoo — was stretched across the wall. Up north, an assistant zoo director's office furnishings included a trash receptacle made from an elephant's foot. On the West Coast, a sea lion was made "safe" for a petting zoo by having its teeth extracted.

In the not-so-distant past, many American zoos amounted to little more than concentration camps for animals. And while, tragically, that's still true in many places, recent years have ushered in a revolution that is transforming the conventional zoo into a very different kind of experience.

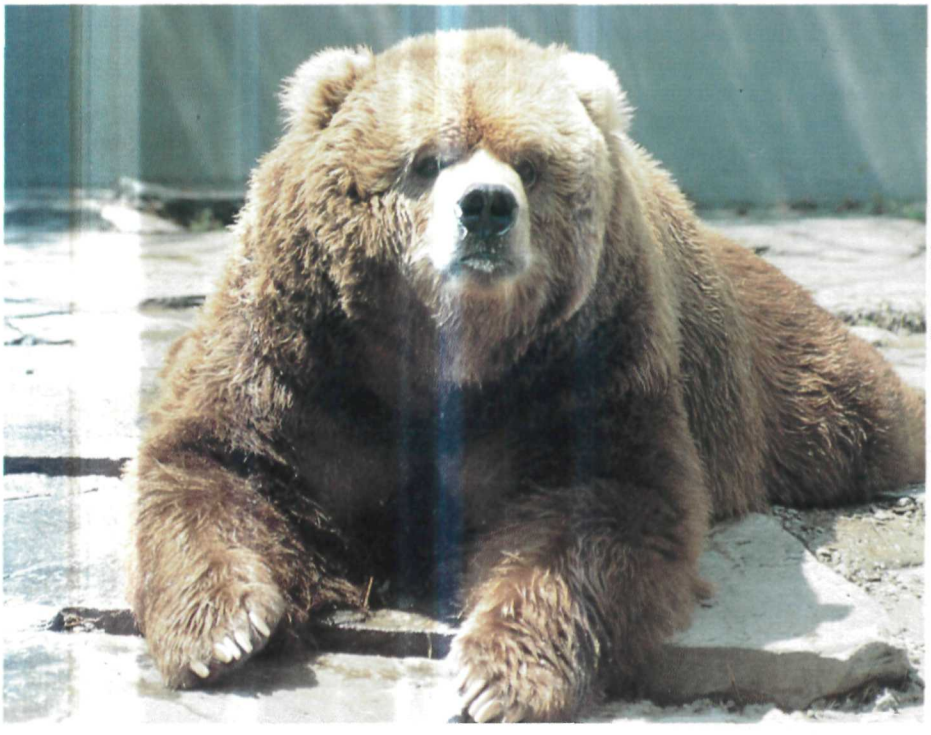
The focus of most zoos traditionally has been on exploiting the entertainment value of seeing wild animals. Radical changes in animal environment design are making life in captivity more bearable for the animals, and engaging the fascination of zoo-goers while calling their attention to another form of endangered life — the wilderness.

This revolution in zoo design, called "landscape immersion" by its handful of practitioners, brings together landscape architecture, biology, animal behaviorism and many other disciplines to create enclosures that closely duplicate the environment in which a particular species lives.

With ingenious staging, touches of drama and a Disneyesque attention to detail, the zoo-goer is "immersed" into the animal's environment.

"Our purpose is to give visitors the feeling of going on safari and actually visiting these parts of the Earth," says Jon Coe, one of the pioneers of the landscape-immersion approach.

Margaret Barrett

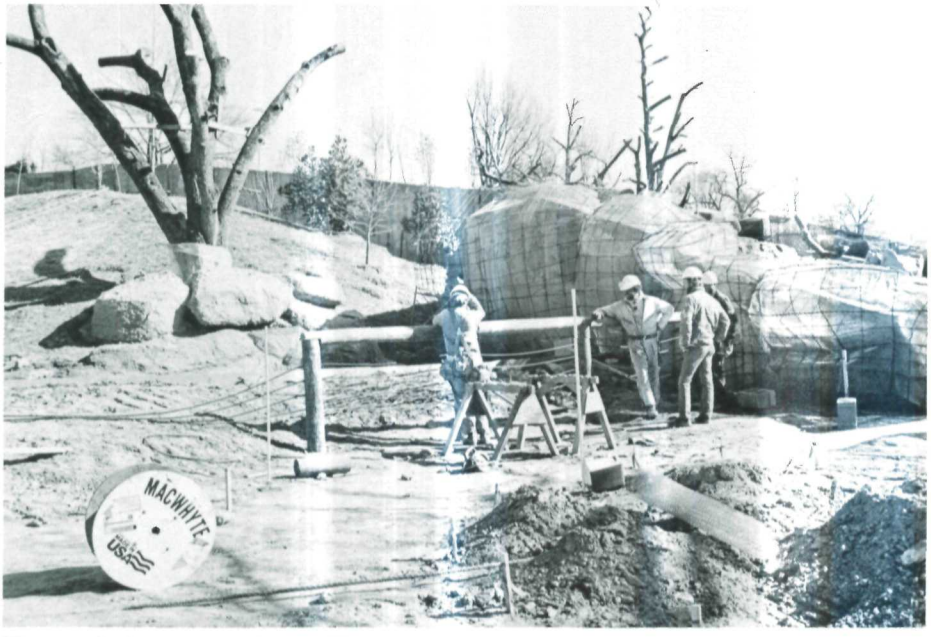


Courtesy Zoo Atlanta

Margaret Barrett

Top: Flamingoes in a lagoon-type habitat at Zoo Atlanta. Naturally white, the birds' get their coloring from a shrimp diet, which imparts the characteristic pink color to their system.
Left: Kodiak bear in repose at Zoo Atlanta.
Above: The ostrich-like emu is a native of Australia; this particular bird lives at Zoo Atlanta.

I have had an opportunity to be a leader in changes here that are not just making this zoo nice for the community, but they are making this zoo a leader.



Gary Meek

The zoo is being transformed into a very different experience.

Coe is an associate professor of landscape architecture at the University of Pennsylvania and a senior partner in the zoo planning and design firm Coe Lee Robinson Roesch, based in Philadelphia.

Coe pays particular attention to zoo-goers' sight-lines and manipulates the habitat's features to create the illusion of expanse. Habitat terrain is stepped-up higher than the zoo paths, so visitors must look up at the animals. Moats separating territories are hidden, giving the impression of several species sharing the same landscape. Viewing areas are situated so that the visitors' field of vision encompasses only a specific environment — a scene of grazing rhinos is not marred by the city skyline looming in the distance, for example. Barriers separating the animals from people are so cleverly concealed as to seem — for a few disconcerting moments at least — nonexistent.

Trees and plant life, chosen for their similarities to those of the environment being copied, lend an amazing look of authenticity to the scene.

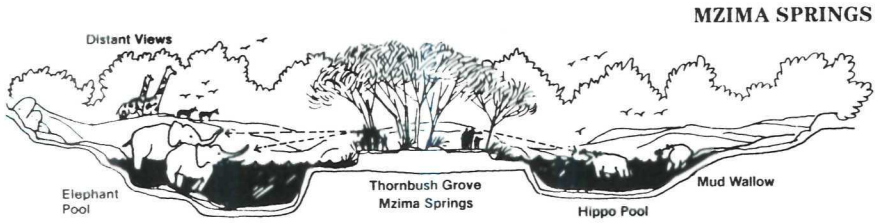
Coe stresses the importance of sight-lines to making a visit to the zoo a more powerful experience, especially for children. He says the notion that traditional zoos are for children is a "misunderstanding."

"People took their kids to the zoo because they *thought* they were for kids. *Zoos* thought they were for kids. But if you take a look at a zoo through a stroller's-eye-view, you see almost nothing in most zoos.

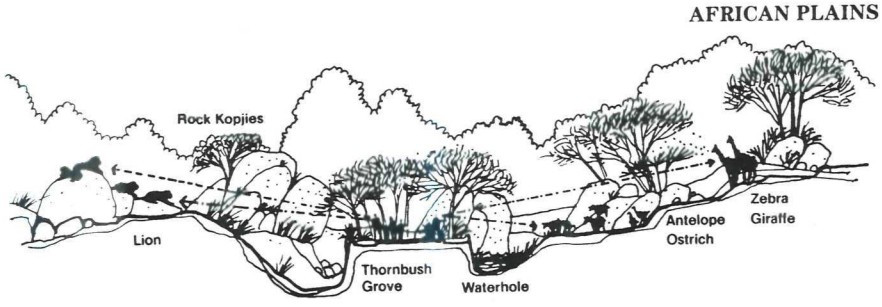
"We're becoming much more conscious of children as major zoo visitors," he says, articulating some of his design questions. "What *is* there for children at a zoo? What can they see without being held up by their parents? What can they do? What are the things that would appeal to their intellect?"

In 1977, Coe and Grant Jones, another zoo habitat innovator, designed the gorilla exhibit for Woodland Park in Seattle. Their rain forest simulation created a sensation when it opened and gave the current trend its standard of excellence. It is still acclaimed by many experts as the best zoo exhibit ever made.

To see the gorillas at Woodland Park, visitors must step off a paved walk onto a narrow path crowded by thick vegetation,



Mzima Springs will be a savanna habitat for elephants, crocodiles, hippos, turtles and assorted waterfowl.



A sketch of the African Plains habitat shows innovative spatial relationships between visitors and the animals.

Courtesy Coe Lee Robinson Roesch

With ingenious staging, touches of drama and a Disneyesque attention to detail, the zoo-goer is immersed into the animal's environment.

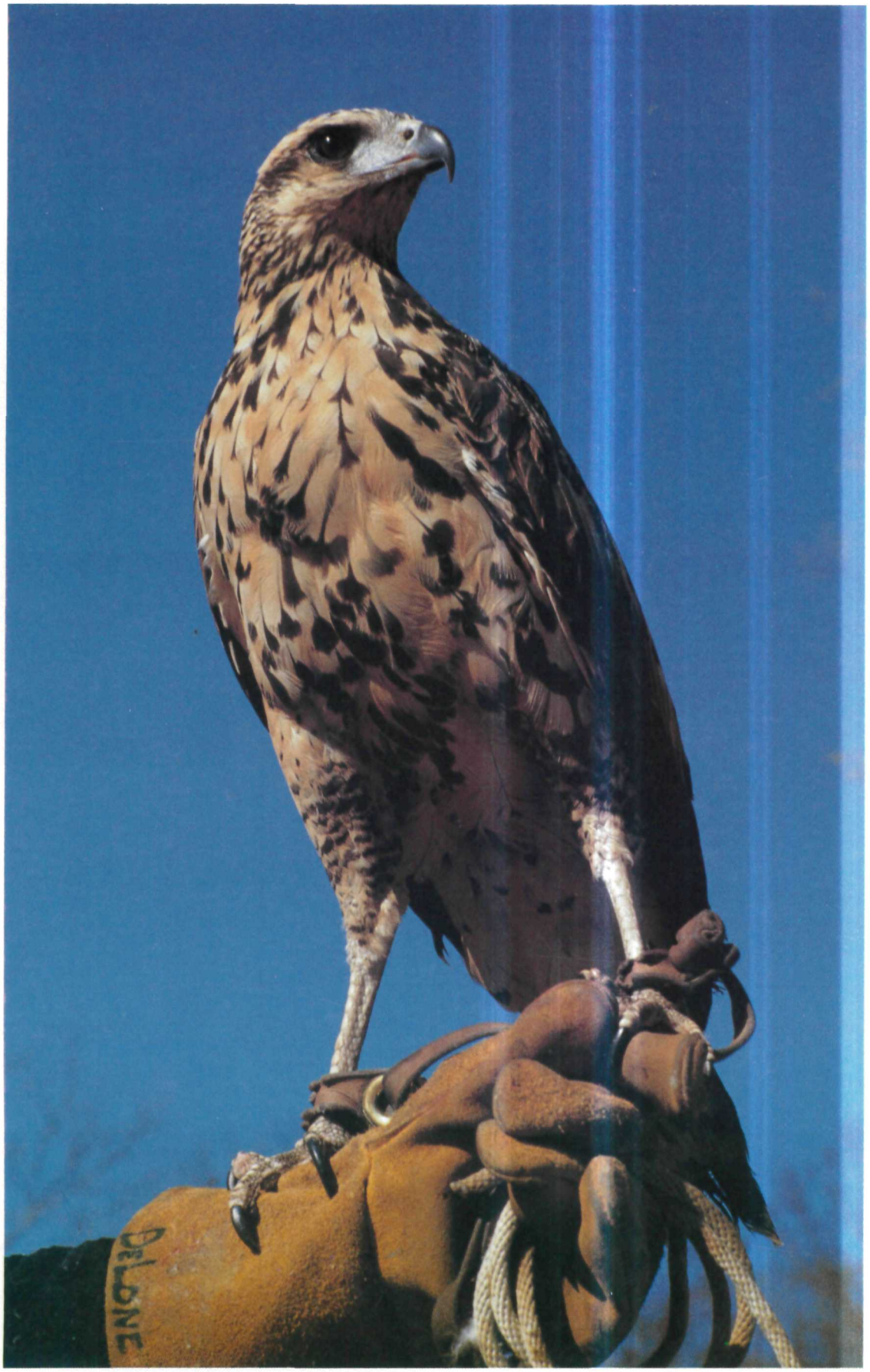
which leads to a wooden lean-to. One side of the lean-to is glass, and looks out upon a rich, green, tropical-like clearing. Boulders are located near the glass; a fern-lined stream twists past caves. Birds roost in the high treetops, and more boulders are tiered in the distance. The impression is one of wide expanse, yet the habitat measures only about one-third of an acre.

The gorilla family interacts, usually in the clearing, seemingly oblivious to the gaping spectators. In summer, the clearing is cool and shady. During the winter, the gorillas are tempted back to the clearing by the warmth of heating coils buried inside the boulders. By accommodating their needs, the half-dozen gorillas who live at Woodland Park are usually within view of the lean-to's glass wall.

The concept also serves a useful scientific function as well, Coe says. "We know almost nothing about the needs of captive animals in a comprehensive way," he said. "By creating or re-creating as closely as possible the habitat in which the species evolved, we're probably providing answers to questions...about their needs we don't even know exist yet.

"Through millions of years of development they have adapted to certain habitats. The closer we can provide those habitats, the closer we are to taking care of them properly," at zoos and in the wild, he adds.

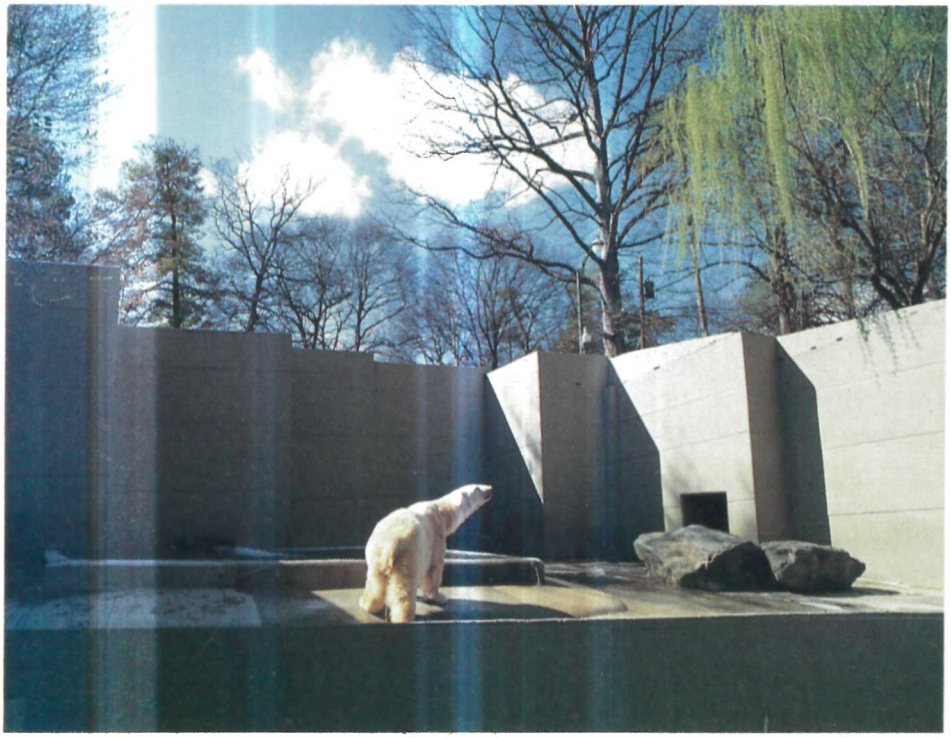
Coe and Jones, who worked together until Coe formed his own company a few years ago, consulted field scientists, gorilla experts, biologists and architects



Gary Meek

This falcon is also getting new quarters at Zoo Atlanta.

Courtesy Zoo Atlanta



Margaret Barrett

Top: An orangutan in a natural environment at Woodland Park in Seattle. Bottom: This open-air habitat reflects an architectural style more appropriate for a highway overpass than a polar bear. A new habitat for bears at Zoo Atlanta is in the planning stage.

while designing the Woodland Park exhibit. Coe himself went to Africa to study rain forest ecology firsthand.

Their work established zoological landscaping and design as a distinct new architectural specialty.

Previously, the conventional zoo exhibit was a small, tiled, steel-barred prison with all the ambiance of a gas station bathroom. Such environments stood in poignant contrast to the signs describing the animal's natural home.

With little stimulation or diversion save for the taunts of obnoxious zoo-goers, many animals became lethargic, bored, aggressive or neurotic.

By the late '50s, the first innovation in zoo design, the open-air enclosure surrounded by a moat, was a fixture at most American zoos. For the most part they were designed by architects without consideration for the animals to live there, in something of a "one-size-fits-all" approach. Built of concrete and sometimes sculpted to suggest rock, open-air habitats, while visually more exciting to the public, offered little improvement in the living conditions of their captives.

The Woodland Park exhibit will soon be eclipsed by an even grander habitat Coe designed for the zoo in Atlanta.

Gorillas of the Cameroon, set to open this spring, will contain 16 gorillas organized into three or four family groups, on loan from the Yerkes Primate Center of Emory University. The Atlanta exhibit will be the largest collection of captive gorillas in the world. The four-acre habitat will provide at least a dozen viewing areas for the public, and accommodate scientific study of the apes in a "wild" setting.

The number and configuration of family groups to inhabit Gorillas of the Cameroon depends in part on Willie B. A popular long-time resident of the zoo and namesake of the late Mayor William B. Hartsfield, the silverback gorilla has spent almost all of his 29 years in solitary confinement. He is now being shown videotapes of jungles and other gorillas to acclimate him to a new life "on the outside."

"We know a lot more about gorilla behavior now, so there's more in [the Atlanta exhibit] for gorillas to do," Coe says. "We are also going a lot further in the interpretive end. At Woodland Park, the view and the paths were beautiful, but there was little to explain what you saw. In Atlanta there will be a lot more information and graphics, and it will be presented in more interesting ways," he says.

In many respects, Zoo Atlanta represents a textbook example of the "new" zoo. The 98-year-old facility was stung four years ago by public disclosure of poor management and unconscionable

Gary Meek

Habitats under construction at Zoo Atlanta will transform the 98-year-old facility into one of the best in the world.

treatment of animals. The zoo lost its accreditation with the American Association of Zoological Parks and Aquariums (AAZPA), which named it one of the ''10 worst'' zoos in the country.

Despite its position on the ''10-worst'' list, many experts say conditions at the Atlanta zoo were typical of one-third to perhaps one-half of all zoos in America. Whether or not it was fair for the media to spotlight Atlanta's shortcomings misses the point; the negative publicity was felt at zoos throughout the country and forced renovation onto several priority lists. Many zoos, including San Diego, Pittsburgh, St. Louis and Cincinnati, have initiated large rebuilding projects that include landscape-immersion habitats.

For its part, the 40-acre Atlanta zoo reacted quickly with a thorough shakeup at all levels of the organization, even changing its name to Zoo Atlanta to emphasize its break with the past.

Dr. Terry Maple, a professor of comparative psychology at Georgia Tech and an expert in primate behavior, was named the new director and given a mandate to improve conditions at the zoo.

''I have had an opportunity to be a leader in changes here that are not just making this zoo nice for the community, but they are making this zoo a leader among zoos,'' he says.

Like Coe, Maple is an academician deeply involved with zoo work who finds his two careers mutually supportive.

''Georgia Tech professors take leave all the time to work with government and industry,'' Maple says, ''but what I am doing is a little different because this is very closely tied to my research career. I am documenting and studying this whole process by which this zoo changes. It is an academic exercise as well as a community exercise. I am taking a great deal of interest in this process not just as a manager, but as a design and research

professional. In a way, the zoo is a living laboratory of change.''

One of Maple's first moves was to engage Coe's firm as consulting architects for one of the most ambitious renovation projects in the country.

Coe has designed several habitats for Atlanta in addition to the Gorillas of Cameroon.

Orangutans of Ketambe is planned as a dense jungle habitat containing species of gibbon, antelope, leopard, Asian tropical birds and, of course, orangutans.

Mzima Springs will be a re-creation of an oasis in an East African grassland for African elephants, crocodiles, turtles, hippopotamuses and exotic waterfowl. The habitat will provide viewing from several different vantage points, including blinds and floating boardwalks.

An African Plains habitat will feature lions, black rhino, giraffes, gazelle, Grant's zebra and impala in a savanna-like setting. The exhibit will also include a walk-through aviary.

A geodesic dome addition to the Reptile House will enclose a realistic tropical South American environment for tapirs, anteaters, capybaras, marmosets, sloths and large snakes such as the Anaconda.

Georgia's famous Okefenokee Swamp will be re-created in a habitat featuring cougars, black bears, raccoons and alligators. A special area will offer underwater viewing of otters. A netted section will contain many birds indigenous to the swamp.

A polar/marine habitat will provide outdoor as well as underwater viewing of polar bears and sea lions.

In addition, an exhibit of the coastal marsh features and wildlife of the Georgia coast is also under development.

Renovations are expensive — Zoo Atlanta is spending $25 million on design and construction — and all but impossible for zoos operating under shrinking municipal budgets. The solution in Atlanta and other places has been to operate the zoo as a non-profit corporation. The facility is then able to pursue sources of private funding to augment its government support.

Atlanta has been a leader in attracting corporate sponsorship. ''We are probably one of the first zoos to really take off on the corporate connection,'' Maple says. ''We have a very strong relationship with the Ford Motor Company. We have a very strong relationship with Coca-Cola. We don't mind giving recognition to the people who give us money. It doesn't bother us in the slightest. We try to do it tastefully.''

Maple sees the new Zoo Atlanta as a place where ''animals and people confront each other under exciting, but very safe, circumstances.''

Of special concern to him is the zoo's responsibility to promote conservation and animal ecology.

''Zoos, in my opinion, are positioned better than any other institution right now to do wildlife conservation effectively,'' he says. ''If the zoo pitches conservation and pitches it well, it can be believed and accepted. It can influence people.''

Presenting the animals in more natural surroundings underscores their dependence on environment for survival. Maple hopes that point is impressed on zoo visitors.

''If people can't learn to appreciate a zoo animal, and thereby appreciate the wild, the wild is going to disappear. We can only stop it by education and by decisions that we make.''

Zoos are also becoming more active in technological approaches to wildlife conservation. Sperm banks for endangered species as well as recently developed techniques of embryo transplantation and *in vitro* fertilization many one day position zoos to re-introduce animals back into the wild.

''All zoos ought to be thinking that is a worthwhile objective,'' Maple says. Unfortunately, because the wild ''is in such bad shape'' itself, few species could be re-introduced now with much chance of survival.

Zoos owe much of their resurgence to the involvement of directors such as Terry Maple, who see zoos as logical tools with which to help preserve a precious natural resource.

An educated public can make more-informed political decisions. A conscientious public can make better personal decisions by recognizing the obscenity of

If people can't learn to appreciate a zoo animal, and thereby appreciate the wild, the wild is going to disappear.

Gary Meek

Dr. Terry Maple and friend.

products made from the horns, bones and hides of endangered animals.

The current revival has also been fueled by a number of interrelated changes which have occurred over the past 15 years. Foremost among those changes is the tremendous body of knowledge about animal needs — both physical and psychological — which has developed, and an increased sensitivity to those needs.

Hospital-stark cages, intended to reduce the risk of disease, instead fostered stress, which can be even more damaging to an animal's health. In any case, advances in veterinary medicine have made the "cage" approach to health an anachronism.

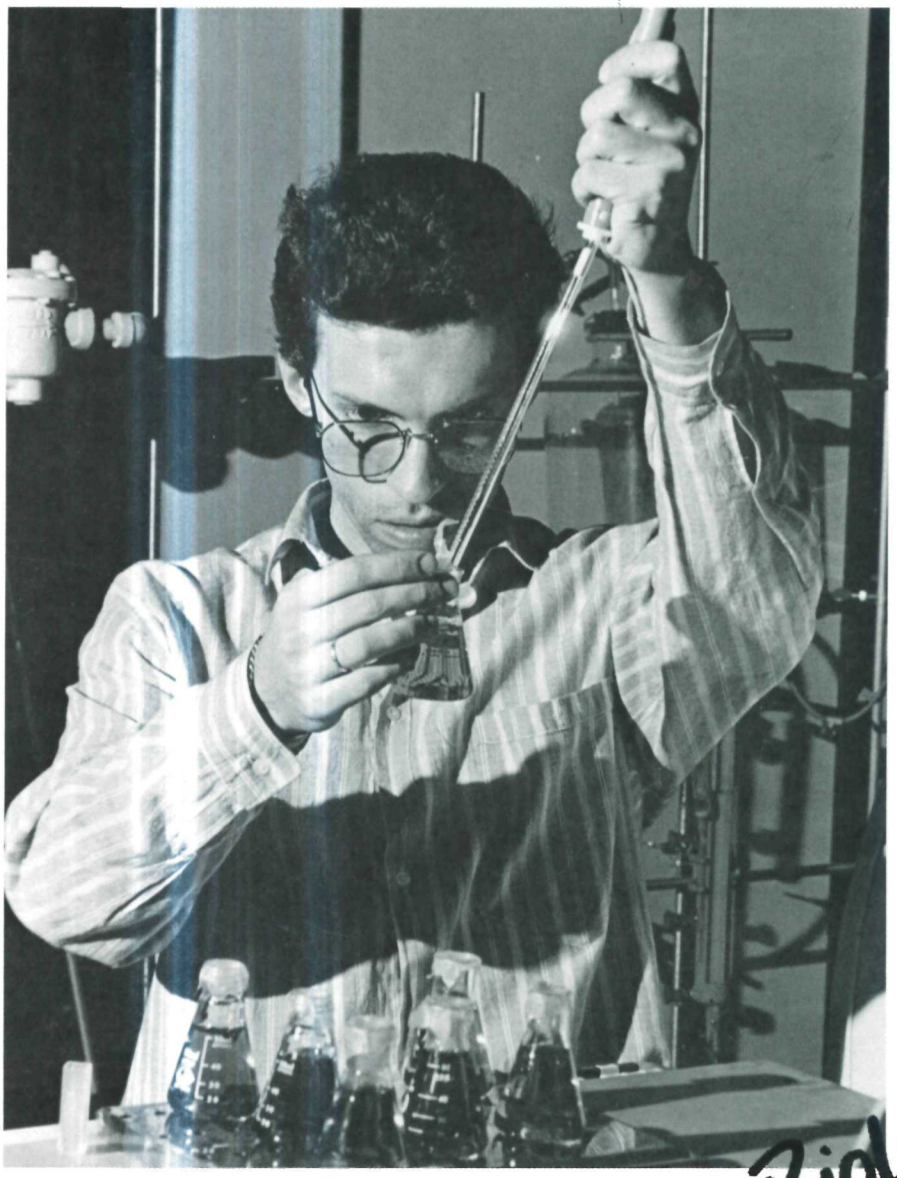
In addition, zoos have a lot more competition for the family entertainment dollar than before. The proliferation of theme parks, electronic amusements and various forms of home entertainment has forced zoos to produce a unique, more sophisticated product.

For many years, the measure of a zoo's greatness, in the public mind, was the size and variety of its collection. With emphasis shifting to quality, zoos are better able to cope with their economic and marketing challenges, and also provide better care for their increasingly-precious animals.

Even many small zoos are opting for fewer animals, in a landscape environment, rather than try to be some sort of Noah's ark. That old standard of "greatness" must be discarded so that zoos don't take on more than they can handle.

"There aren't too many *zoos*," Maple says. "There are too many *bad* zoos."

Or, in Jon Coe's words, "If you can't do it right, you shouldn't do it."



Gary Meek

Graduate student Harry Kitzos

Better Living through ~~Chemistry~~ Biology

By Sally Tyler

On a warm, early spring afternoon, Thomas Tornabene, chair of Georgia Tech's School of Applied Biology and director of its Research Center for Biotechnology, reflects animatedly on the center's work. "I've always been a dreamer. I always wanted to do great things. Although I enjoy teaching, I didn't want to spend my life just teaching science. I want to be able to say I've done research that helped solve world problems, and that is what we are doing here at the research center."

A partial list of ongoing biotechnology research at Georgia Tech supports his brave assertion; Leon Zalkow (chemistry) is discovering antitumor agents, Michael Saunders (civil engineering) is probing in situ biological decontamination of groundwater, Jung Choi (applied biology) is working with the molecular

genetics of plant tissue cultures, and Marilyn Black (Georgia Tech Research Institute) is measuring human exposure to environmental pollutants.

How can one discipline include so many diverse areas of research? Tornabene has a succinct definition of biotechnology which encompasses all such areas. To him, it is "biology-based industrialization that uses living cells as efficient miniature chemical factories." His colleague Sheldon May (chemistry) has an even simpler definition. "Here at Tech, it's any research in the life sciences which may have an application for the way we live." And at Georgia Tech, the emphasis is definitely on application.

"We all grew up with the phrase 'Better living through chemistry,' but I think because of the kind of research we're doing now, by the year 2000 the phrase will be 'Better living through biology,'" says Dwight Hall (applied biology). Applications for biotechnology research have an almost dizzying broad range, including "left-handed sugar," which is a real sugar with all the taste and no calories; hormonal "clamps" which may eliminate the need for some surgeries; and new ways to lessen industrial pollution.

The Research Center for Biotechnology was founded in 1983 to offer a coordinated, interdisciplinary approach to this burgeoning academic field. The center is composed of faculty members from applied biology, chemistry, chemical engineering, civil engineering, physics and the Georgia Tech Research Institute. Tornabene's aim for the center is to offer the most complete program possible; one which consists of teaching, research and testing and development through the pilot plant stage.

The work at Tech takes many forms. Sheldon May heads a 15-member research group which explores enzyme catalysis and has done groundbreaking work with "pro-drug" molecules. The latter could have significant impact on the development of new pharmacological products. "Most drugs are developed after biological activity, with an inherently active molecule. These pro-drug molecules are inactive until they encounter a certain target and then they go to work."

Margaret Barrett

Graduate student Jim Goodloe works with a methane generator.

It is this "rational design of pharmacological products" which makes his work unique and which has elicited much excitement over his continued research.

May's research, funded in part by the National Institutes of Health and the American Heart Association, could have particular application in drugs aimed at controlling high blood pressure. "Many anti-hypertensive agents currently on the market have disadvantageous side effects. Since pro-drugs only work on specific targets, any side effects would probably be more localized and occur to a lesser extent," says May.

There are three pharmaceutical companies currently showing interest in May's work, although signing an exclusive contract for product development with one of them is still in the distant future. May must first file a patent, but must complete more extensive testing before he is ready for such a step.

Of his current testing efforts, May says, "I like the research center's beginning-to-end approach. Our testing is not just in-vitro, we're interested enough to test on animals." Such attempts at comprehensive testing have given him the opportunity of doing joint work with faculty members at Mercer University's School of Pharmacy, located in Atlanta. "Working with the people at Mercer has been a very positive experience," says May. "There has been an increase in biotechnology research interest there since we started this project. This type of work really lends itself to collaboration, with different departments at Georgia Tech and with other schools."

Although research into new types of drugs is one of the most greatly expanding areas of biotechnology, it is genetic engineering which the layman associates most with the field. Genetic engineering is the speciality of Dwight Hall (applied biology), although he prefers to call it molecular or microbial genetics. "I investigate how microbes regulate the expression of various genes. If we understand this regulation, then we can turn on and turn off genes to good effect," he says.

Hall, who has been at Georgia Tech 11 years and in his current research group for five years, teaches a senior level lab on recombinant DNA. "It is very rewarding to be in a field that is growing tremendously in student excitement, and it's also nice to be involved in an area that receives so much interest from industry. DuPont, Merck and all the other major chemical and pharmaceutical companies are using much more biotechnology these days," he says.

When reminded of lingering wariness and the persistent perception on the part of the public that genetic engineering has the dangerous potential for creating monsters, Hall chuckles. "I hear that kind of stuff a lot and I always try to emphasize that as much as we know, we may never know enough to create a new life form. We're just moving around a few useful genes."

Hall also maintains that humans have employed a much less sophisticated form of genetic manipulation for thousands of years. "What I'm doing is simply a new twist on the old theme of microorganism

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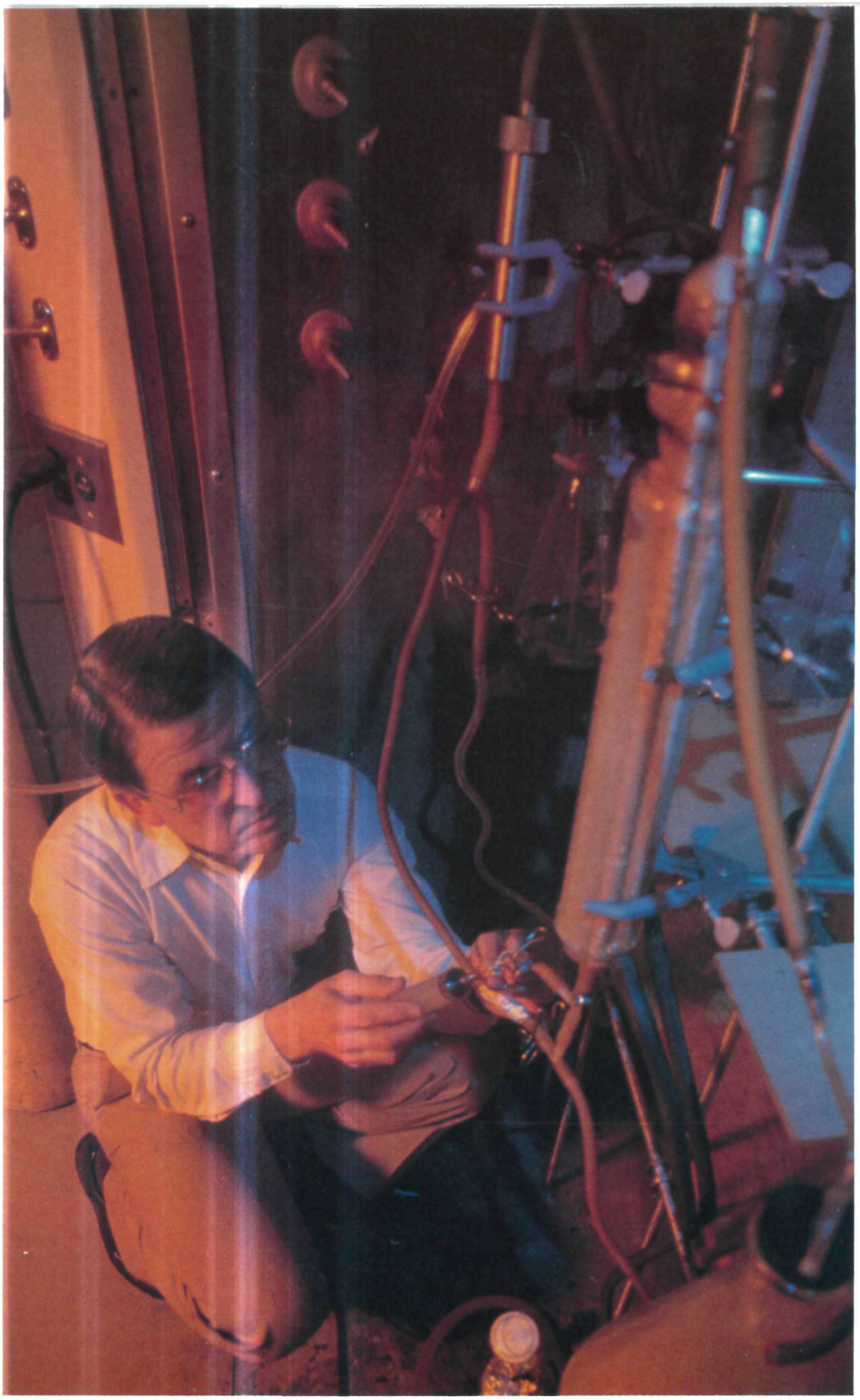
Sally Tyler is an Atlanta-based free-lance writer.



Gary Meek

Dr. Thomas Tornabene: "I want to be able to say I've done research that helped solve world problems."

manipulation which has been used in fermentation to create wine, cheese and bread, practically since time began.''

Tornabene is also quick to defend his center's record of ethics. ''Researchers in biotechnology are often charged with bioethical neglect of ecology, but because of our center's multidisciplinary approach, we're better able to see the big picture of our specific area as it relates to the environment,'' he says.

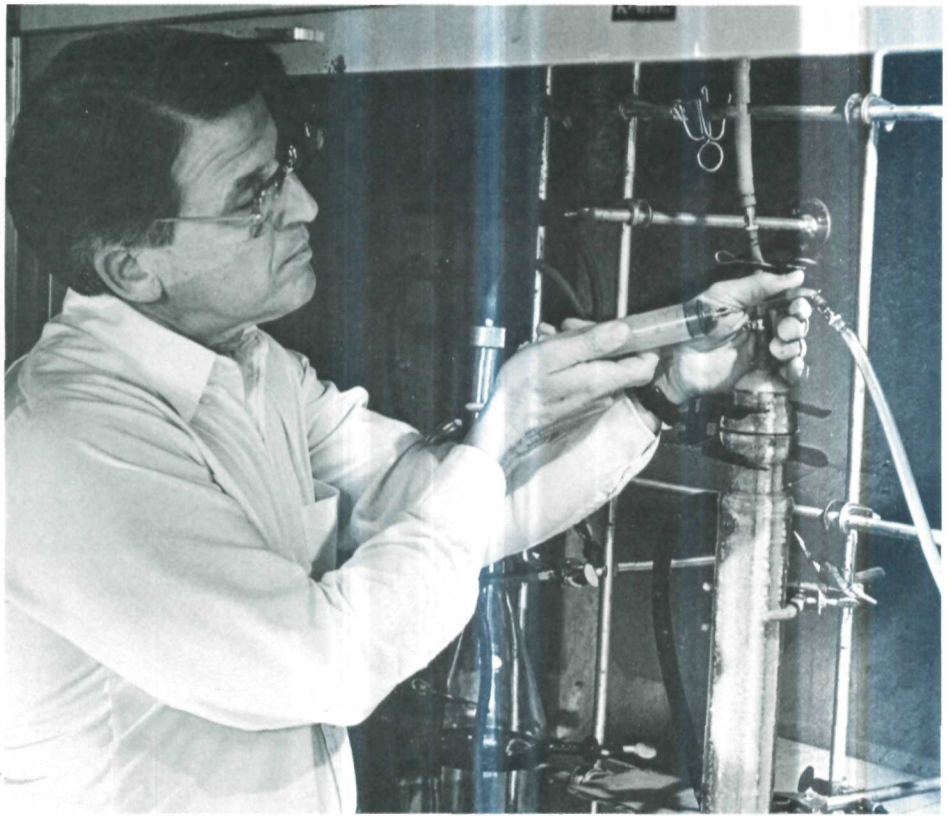
He points to the work of colleague David Dusenbery as an example. ''He [Dusenbery] is doing research with the nematode, which does millions of dollars of crop damage each year in this country,'' says Tornabene. ''But instead of perfecting a better insecticide to kill the worm, Dusenbery is investigating how to grow crops with more natural nematode repellants.''

In concert with Tornabene, Hall studies a strain of bacteria called pseudomonas. This particular type of bacteria was chosen because it creates special, long-chain hydrocarbons. ''These hydrocarbons are used as industrial lubricants and until now have only been obtained from crude oil, which is very expensive. We are using the bacteria to make the same, useful chemicals,'' he says.

The goal of their research is to make these chemicals more cheaply and more plentifully than the current extraction from crude oil, favored by industry. ''We're not at that stage yet, but I think it's not that far away. And when we get there, it's going to generate a lot of interest,'' says Hall.

The self-effacing professor continues to be excited by challenges on the biotechnology research horizon. ''I'm really interested in gene therapy, which has much long-term application in work with inherited diseases. If someone has a bad gene which is causing a disease, we will learn how to give them a good gene. In some instances, it's the case that people do have a good gene; it's just turned off. I'd like to be able to learn how to turn it on again,'' says Hall.

The director of Georgia Tech's Biotechnology Research Center since it was founded in 1983, Thomas Tornabene continues to conduct his own research and teaching, while administrating the complex functions of a multidisciplinary center with ties to industry and other research institutions. ''I really like my role,'' he says. ''I have my own work, and I cannot emphasize enough that research is always central here, but I am allowed to be somewhat of a businessman.''



Gary Meek

Dr. Thomas Tornabene operates an alcohol generator.

In his role as administrator, Tornabene is responsible for obtaining much of the capital needed to operate the center and fund its research. ''The operating costs are enormous for the center. Our NMR [nuclear magnetic resonance spectrometer] costs $40,000 a year to keep the instrument running.''

Outside of Georgia Tech, where does all the money to sustain the center come from? ''Although recent budget restrictions have made it somewhat harder to get research and development grants, the Institute's resources, industry and the federal government continue to be our best sources,'' says Tornabene. Most of the government money is appropriated through entities such as the National Institute of Health and the National Science Foundation.

As the federal government continues to encourage biotechnology research, many states are getting in on the action by increasing state funding and establishing state agencies to serve as liaisons between industry and researchers. While North Carolina's state government is strongly supportive of work being done at its Research Triangle, some see Georgia as lagging behind in its commitment to biotechnology research. ''We can't depend on the state for our funding,'' says Tornabene. ''Most schools consider grants 'soft money' and state fundings 'hard money,' but here at Georgia Tech it's just the opposite, because we can't be sure of the support we will get from the state government.''

There are approximately 200 undergraduates in the School of Applied Biology, with its concentration in biotechnology, and 80 individuals involved in graduate work with the research center. Of these students, Tornabene says: ''They make tremendous sacrifices to be in this program. Our requirements are rigorous because of our multidisciplinary nature, but students gain so much through the classroom and through working on their own. The cur-

Although research into new types of drugs is one of the most greatly expanding areas of biotechnology, it is genetic engineering which the layman still associates most with the field.

riculum itself may be tougher, but students are heavily recruited by both graduate schools and industry because of what they learn here.''

On his wish list for the department's future, Tornabene includes the allocation of fellowships to the center and the establishment of a biotechnology lab for the college's juniors and seniors.

Of the first crop of undergraduates to have come through the program with concentrations in biotechnology, some went to medical school, some continued their research in graduate programs, and some applied what they had learned in related industries. Georgia Tech's nascent program is rapidly gaining in national stature and is responsible for the recruitment of many of the school's most outstanding students.

Carolina Castillo is a senior from Nicaragua who plans to enter medical school after completing her studies in applied biology. She can be found on one of the year's first warm and sunny days, as she can be found almost any afternoon, working in a laboratory in the Cherry Emerson building. She is occupied with growing anaerobic bacteria on sulfur compounds, but her work has been repeatedly impeded by problems with precipitants in the mixture. Nonetheless, she works diligently to address the problem. ''I really like conducting independent research, but it's not easy. They certainly don't baby you in this program,'' she says. ''But that's one of the reasons I came here in the first place. I wanted a really rigorous program.''

Castillo talked with Tornabene before deciding to major in applied biology. ''He told me what the program was like and I thought it would help prepare me for med school. It is my understanding that many students from Tech score higher on the physics part of the MCAT than do other biology majors because of the strong interdisciplinary requirements of this department,'' she says.

The soft-spoken brunette admits with a laugh that Tornabene helped sell her on the major's required fermentation lab by telling her she would learn to make beer in it. Castillo now recalls that the quarter she took the lab she didn't make beer, but what she learned ''more than made up for it.''

David Minter, a senior applied biology major from Augusta, Ga., agrees with Castillo's assessment of the program. ''It is tough, but I think it's character-building. I think it's important to learn that some of the most important and most rewarding things are not necessarily the easiest,'' he says.

Minter has already been accepted through early admission into the Medical College of Georgia's fall class, but he was not always so sure he would be. ''I always knew I wanted to be a doctor and I thought the program here would be excellent preparation, but I had some doubt as to whether I'd ever get into med school because of my GPA.'' Due to the department's various course demands coupled with lab/research requirements, Minter's grade point average was not as stellar as it had been in high school. ''I felt better after talking to med school admission people who told me that Tech's applied biology GPA is the most realistic in terms of the GPA most students can expect in med school, because this program is most like the demands of med school,'' says Minter.

Both Castillo and Minter have taken ''special problems'' courses and have conducted independent research under the supervision of the department's Jack Jones. ''I would highly recommend doing independent research to any student in this department,'' says Minter. ''This is one of the few schools that allow undergraduates such an opportunity.'' Castillo echoes his enthusiasm. ''The professors here welcome student interest in doing research, but it takes a strong commitment on the student's part. For the most part, this is not a one-quarter thing. It may take up to three quarters to complete a project, as it's doing with my work,'' she says.

While teaching and research comprise the program's initial phase, Tornabene believes he program's work can only be complete if carried through to the pilot plant stage. His greatest success to date in that area is seeing the construction of a pilot plant for the conversion of sugar cane waste into methane in Sao Paolo, Brazil. This project drew on the expertise of Jack Jones (applied biology) and graduate students Harry Kitsos (chemical engineering) and James Goodlkoe (applied biology).

The research on this project had initially been funded by the National Science Foundation, but Tornabene was uncertain where the funding for the pilot plant stage would be found. ''I had been trying to attract various industries in funding the project, but I had been going about it by talking to industrial engineers of various large corporations. They were thrilled by the process, but had absolutely no impact on investment decisions,'' he recalls. ''Then one day a guy called me up out of the blue and said he had heard about the process through the grapevine. He represented a group of relatively young investors in New York who were interested in supplying the venture capital for the pilot plant. After we talked, they were the ones who first approached the Brazilians with the deal.''

Brazil's financial woes have placed the government in dire straits with many other national creditors. The Brazilian government is desperate for a cheaper fuel source on which to run its shipping fleet, and methane may be the ticket. Tornabene sees the process developed at Georgia Tech as providing many benefits. ''We take their waste water, eliminate the polluting waste, and give them both clean water and methane.''

As talented students continue to respond to the program's growing reputation; as Hall, May and other researchers near the patent application phase of their research; and as Tornabene eyes the possible start-up of a new pilot plant in Milan, Italy; the Research Center for Biotechnology's future looks bright.

GEORGIA TECH PLOTS ITS STRATEGY IN THE SUPERCONDUCTIVITY RACE

By Connie Cummings

At some labs in the United States and in other countries large numbers of scientists and technicians are, at times, working round-the-clock shifts, searching for the perfect room-temperature superconductor. Others are trying to find practical methods of putting this new class of materials to use. The race to find and produce a stable and practical superconductor continues to be one of great intensity in the scientific world, not unlike a fierce Olympic rivalry, where only the first person across the finish line wins the gold medal.

Like the Olympic gold medal winner, the winner in this race will receive a multi-faceted reward. There could indeed be a Nobel Prize involved. There certainly will be a "bouquet" in the form of great prestige to the winning individual(s) and institution(s) or company(ies). And there will probably be great financial rewards since commercial applications are the ultimate goal.

Connie Cummings is a free-lance writer based in Atlanta.

Also in this race, the spectators could be very big winners as well because, ultimately, if the potential of these high-temperature superconductors is reached, it will mean a revolution in a number of technologies that could affect our everyday lives. Among the much-touted potential manifestations of superconductivity: new ways of transmitting and storing electrical energy with virtually no loss of power; magnetically levitated super-fast trains; tiny, super-fast computers; and long-range electric cars.

The Olympic analogy can be taken even further. Some labs, like some Olympic teams, have very strong financial backing so that scientists are allowed to devote a lot of time and energy to this mission. Other institutions cannot afford to pour large sums of money into the superconductivity race, so their scientists must compete on comparative shoestring budgets. But as in the Olympic Games, the greatest financial support does not necessarily translate into a gold medal in any given event. It does increase the odds, however.

Gary Meek

Dr. Brent Carter holds a high-temperature superconductor sample.

Other institutions cannot afford to pour large sums of money into the superconductivity race, so their scientists must compete on comparative shoestring budgets. But as in the Olympic Games, the greatest financial support does not necessarily translate into a gold medal.

At Georgia Tech, as at other scientific and technological institutions, researchers and administrators alike have taken a keen interest in the development of new higher-temperature superconducting materials and ways to finance research in the field. President John Patrick Crecine last fall appointed Dr. John W. Hooper, Regents Professor in electrical engineering, to find out who is doing what in the area of superconductivity at Tech and to coordinate a program that would help attract much-needed outside funding for research projects. And, a very important part of Hooper's agenda is to develop a proposal for legislative support of the Institute's endeavors in superconductivity research.

"Right now, we're trying to position ourselves," Crecine says. "I think Tech has a great deal to contribute in this area."

Hooper says Tech is well-positioned to become a major player in the superconductivity arena.

"Georgia Tech is noted, I think, for its ability to do work in areas that are very broad in nature," Hooper says.

"We also do some sharply focused research and development activities," Hooper adds, "but we're particularly adept as an institution at putting teams of people together from diverse backgrounds and melding all of that into a very effective program."

He and others believe that's what will be required for successful superconductor research and development.

Hooper has identified some 45 individuals on the Georgia Tech campus, from many departments, schools and labs, who are either already involved in superconductivity research or who have an interest in using their expertise in that area. He says he will conduct some small group meetings to further encourage joint research projects.

Some projects were given a boost this spring.

When Crecine handed Hooper this assignment, he gave him $100,000 in seed money to distribute as support for promising superconductivity research projects that would have a good chance of attracting more substantial outside funding.

"The emphasis there is on work that will provide a demonstration of Tech's capabilities in the superconductivity area," Hooper says.

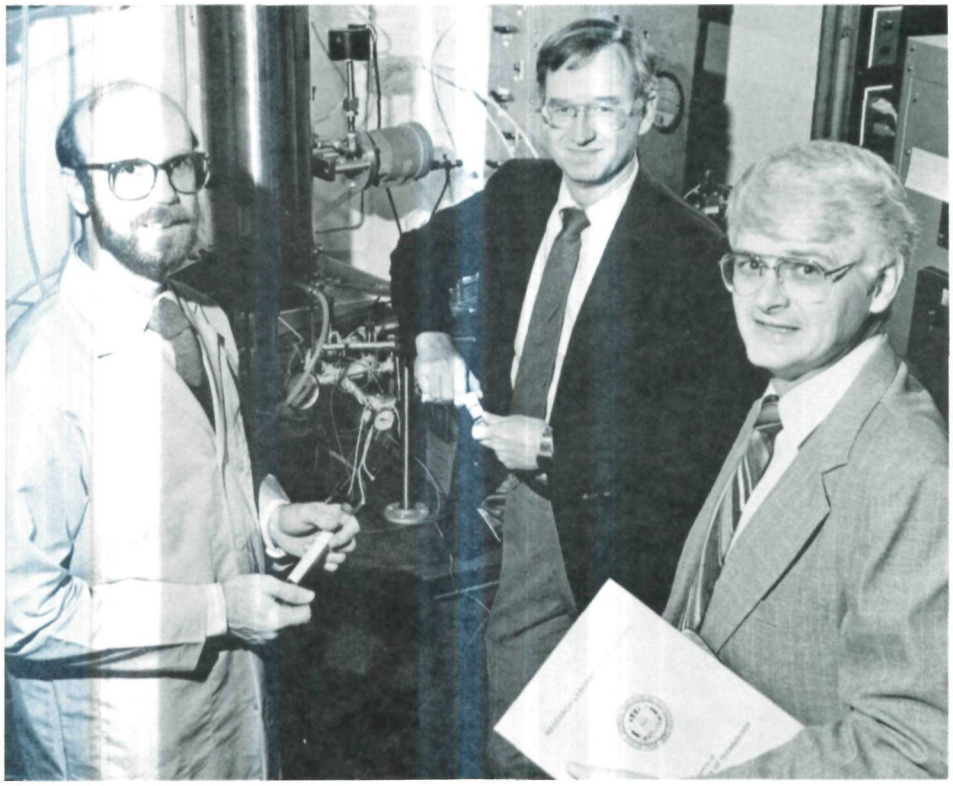
That money was distributed in early March to seven research projects, with seed funding amounts ranging from $9,000 to $31,000.

Of the two most prominent superconductivity projects already underway at Tech, one was granted seed money, the other was not. But participants in the project not funded with Tech seed money had already managed to attract major outside funding — the only superconductivity project at Tech to do so — and the scientists were requesting equipment funding to support their project. Hooper informed them that Tech already has made a commitment to fund equipment needs for that project.

That project involves making a ceramic "wire" using a chemical vapor deposition process to deposit thin films of a superconducting material onto a non-superconducting substrate. In other words, they will be looking for a way to turn the new brittle superconducting ceramic materials into a flexible wire able to actually carry enough current to power high-powered magnets, extremely efficient motors and other electrical devices.

The researchers on that project are Dr. Brent Carter and Dr. Norm Hill in the School of Materials Engineering, and Dr. Jack Lackey in the Energy and Materials Sciences Lab of the Georgia Tech Research Institute.

The Georgia Tech researchers and American Magnetics Inc. will receive a $14 million contract through the Defense Advanced Research Project Agency (DARPA) and the Office of Naval Research, pending successful contract negotiations. That contract is part of a $15 million federal superconductivity research program.



Gary Meek

From left, Drs. Brent Carter, Norm Hill and Jack Lackey stand in front of a chemical vapor deposition chamber.

"The coating of fibers through chemical vapor deposition (CVD) is an existing technology," Lackey explains. "What we are doing is marrying that technology with the new superconductor technology."

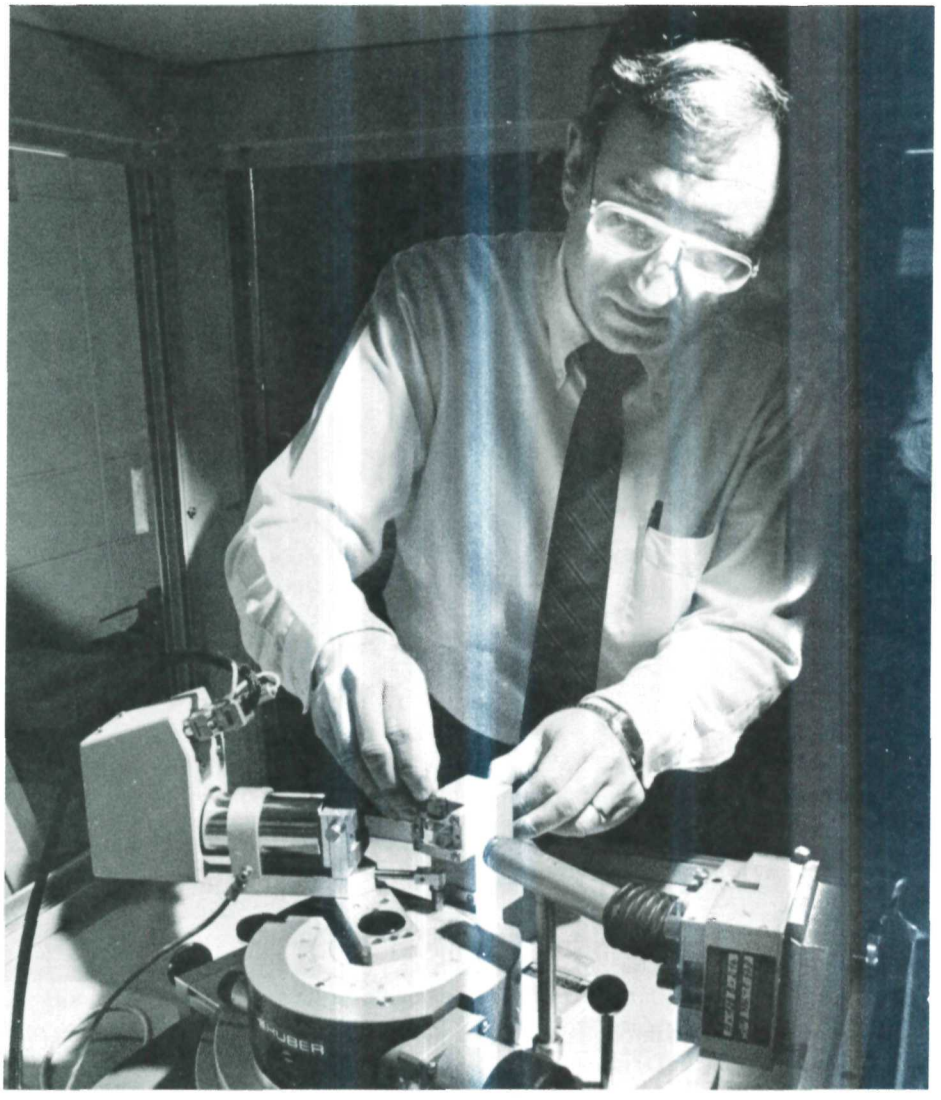
The single largest allocation of Georgia Tech seed money — $31,000 — went to physicist Ahmet Erbil. His work has already received considerable media coverage and scrutiny from his peers.

Erbil's name was splashed on the front pages of the *Atlanta Journal and Constitution* last fall when he announced he had observed superconductivity at temperatures substantially higher than the boiling point of water, a stunning leap in the temperature at which superconductivity has been observed. His findings were also reported in the *New York Times*, *the Wall Street Journal*, *Science* magazine and *Science News*, among others.

Scientists who heard him report his findings at the Materials Research Society's fall meeting greeted the news with a combination of cautious optimism and open skepticism. Some apparently felt burned by a spate of unverifiable claims of ever-higher temperature observances of superconductivity. Those claims were made during a year of wild excitement in the world of physics and materials sciences following the announcement by researchers at the University of Houston and the University of Alabama of a compound that became superconducting at 95 degrees Kelvin, or -288 degrees Fahrenheit. That, in itself, was a huge jump in the temperature at which a material had become superconducting.

Erbil's samples showed evidence of superconductivity at temperatures up to 500 degrees Kelvin, or 440 degrees Fahrenheit. Like the other recently announced higher-temperature superconducting materials, his samples were yttrium-barium-copper oxide compounds — a ceramic.

The speed at which the critical temperature of these new superconductors has been raised is phenomenal. It took 20 years, from 1953 to 1973, to raise the temperature at which certain materials became superconducting from 18 degrees Kelvin (-427 degrees Fahrenheit) to 23.2 degrees Kelvin (-418 degrees Fahrenheit). It took another 10 years to find a material that became superconducting at 35 degrees Kelvin (-396 degrees Fahrenheit).



Dr. Norm Hill

Gary Meek

Then, in December 1986, the so-called Houston-Alabama group observed superconductivity at 57 degrees Kelvin (-357 degrees Farenheit) and a month later, in January 1987, by changing their samples to include the rare earth yttrium, raised the temperature to over 90 degrees Kelvin. Since then, reports of higher temperature superconductors have continued to be made, including Erbil's findings.

"It's like if mankind had gone from the bicycle to the gas turbine automobile going 100 miles per hour in a matter of 12 months," Dr. Edward W. Thomas says. Thomas is director of the School of Physics, where Erbil is an assistant professor.

"It has gone from being an oddity," Thomas adds, "which a few scientists used for distinct scientific purposes, to something which maybe has to be incorporated in all the technology which involves electrical transmission."

The importance of the higher-temperature materials cannot be overstated. The older superconductors were never very practical since they only became superconducting at extremely cold temperatures. That meant liquid helium had to be used to cool them, a process which is very expensive and hard to handle. Thus the need to raise the temperature of superconductors — to reduce the cost of cooling, and ideally, to eventually eliminate that need altogether.

The newer superconducting materials can be cooled with liquid nitrogen, which is much cheaper and easier to use. If Erbil and others can improve the quality of their samples and come up with a usable room-temperature superconductor, cooling would then not be necessary and a lot of dreams could come true.

And that is what Erbil is trying to do.

"At this point," Erbil explains, "we're aiming at a scientific point — existence of a certain phenomenon at about 500 degrees Kelvin. We're not talking about a technological breakthrough."

The active phase of his sample, he says, is only .03 percent, which is much less than the active phase of the Houston-Alabama group's material, for instance, whose active phase was between one and two percent.

"In the immediate future we will still be working on these types of materials," Erbil says, "on the purification and expansion of the active phase...in the hope that we can enhance the [superconducting] properties."

Erbil and Thomas feel that it is important for Georgia Tech to continue to do basic research into this new class of materials, to support the technological applications being developed on other parts of the campus. That includes actually making the superconducting materials, studying their properties and characterizing them so that they will be intimately understood.

As was the case when the Houston-Alabama group first announced its new 95-degrees-Kelvin superconducting material, Erbil's material is still a mystery even to him.

"It's a recipe we're following," says Erbil.

"Yes," adds Thomas, "it's a bit like baking a cake and not understanding why it rises."

So, identifying the active phase of his sample will be vital.

Where Georgia Tech may have a chance to really shine in the superconductivity arena is in applications — the technology-related areas, involving the exploitation of materials that may be developed at other labs, as well as any that might be developed at Tech.

"The consensus," Hooper explains, "is that we need to spend a lot of time learning about the current materials [the ones that must be cooled with liquid nitrogen] rather than putting our major emphasis in trying to be *the* world leader in material synthesis."

But, he says, that does not preclude supporting the kind of basic science Erbil is involved in.

It may indeed be that projects like the DARPA-funded chemical vapor deposition project may actually hold the greatest promise for Georgia Tech in its bid to be a major player. While scientists elsewhere continue to work on raising the temperature at which materials become superconducting, Tech could proceed to put any recently established superconducting materials to work by unlocking the complicated puzzle of how to make these ceramics flexible.

"We've got the right background to attack this problem," says GTRI's Lackey, who is himself a ceramist and involved in the chemical vapor deposition project.

He says Tech's existing program in advanced ceramics gives it a headstart since the new superconducting materials are ceramics.

One of his associates on the CVD project, Brent Carter, says it will take a long-term commitment if Tech is really going to be successful.

"The materials are obviously complicated — much more complicated than previous superconductors," Carter says.

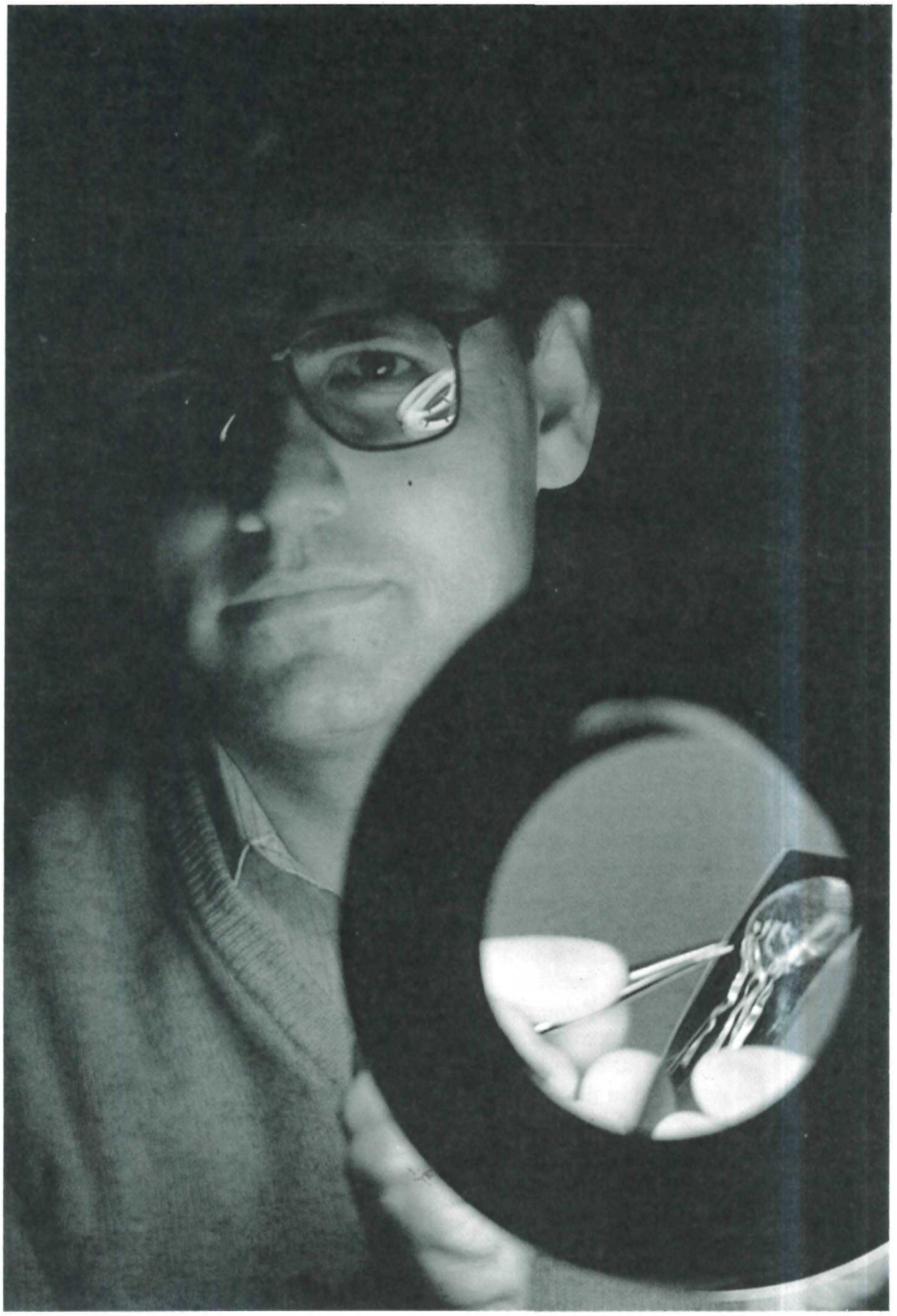
"It's going to take a lot of research — a very large knowledge base is going to have to be built up, and a lot of experience will have to be gained. You can't let other people do that for you."

"If we don't jump on the bandwagon," Carter adds, "we'll be left behind, no doubt about that."

Dr. Chris Summers is a research scientist at GTRI who is also interested in finding ways to deposit thin films of the new superconducting materials onto other substances so that they can be used in a variety of applications, including a number of defense-related applications. He is also a member of GTRI's Strategic Technical Guidance Committee, which this spring helped prioritize GTRI's research projects. A number of those projects concerned superconductivity.

"At the moment," Summer says, "everyone's thinking about hybrid concepts — you can add a superconductive material here or there and it will do something better for you.

Superconductors could even be used to power super-quiet ships at sea by using the ocean itself as part of the superconducting power source.



Gary Meek

Dr. Ahmet Erbil

"After that stage, people are going to be thinking of completely new things that are going to be superconductive from the ground up," he adds.

Summers believes Tech really needs to position itself so that it can actually use the new materials as they become available, whenever and wherever they are developed. And he says that's right up Georgia Tech's alley, so to speak.

"I think, in a way, for a lot of engineers, this could be a sort of renaissance for them," Summers says. "This is a new way of doing business."

School of Physics Director Thomas says it's definitely gong to take some creative thinking.

"You may have to totally redefine what you mean by the windings of a motor," he says. "You may have to start entirely from scratch."

One who is involved with the kind of applications that excite the imagination is Dr. Kent Davey, associate professor of electrical engineering. He has long been interested in development of so-called "mag-lev" trains which would use superconductivity to elevate trains by magnetic levitation. But he says superconductors can be used for another purpose.

"You can use [superconductors] both for levitation and the propulsion of the train," Davey explains, "by interacting with a current that's being switched on through the track at various points. The current and the stable superconducting coil on the train will interact and give you your force for being transported along."

Davey says superconductors could even be used to power super-quiet ships at sea by using the ocean itself as part of the superconducting power source.

Davey feels that Georgia Tech should definitely concentrate on the applications area.

"That's where I think we have an expertise," Davey says.

"That would be our piece of the pie," he says, "and that's a big piece."

And what about the students at Georgia Tech?

A graduate-level course in superconductivity is being taught during spring quarter by Ahmet Erbil. But more than that, it is obvious that by actually having superconductivity research underway on campus, student exposure to this phenomenon of the future will be hands on. In fact, graduate students are involved in every superconductivity project recently granted seed money and some are involved in other superconductivity-related research projects.

And Hooper says the coordination and stimulation of superconductivity research at Tech will have the kind of side effects that are just plain good for a university.

"It requires the kind of teamwork that we should be doing in a university," says Hooper. "It's the same kind of side effect that is just plain good for a university," says Hooper. "It's the same kind of research and teaching that should be going on at Georgia Tech whether it's related to superconductivity or not.

"The systems development work, the device fabrication activities, the whole range of things involved in this effort, are part and parcel of what a university is all about," Hooper adds.

"So, in a sense," he says, "it's an excellent test-bed, as it were, for the further development of Georgia Tech. You end up with a stronger university which is then better able to work on the next problem, whatever that is."

Hooper said a proposal seeking more than $7 million from the state legislature to support research at Tech on superconductors is under consideration, but has not been presented to the Board of Regents, which must approve it before it is submitted to the legislature. Tech would urge a funding method similar to that used for the new Microelectronics Research Center which was funded through the state's research consortium and matching non-state funds. Hooper and others at Tech feel strongly that an actual "center" for superconductivity is not needed. In fact, the consensus is that the superconductivity effort might best be coordinated long-term through the Microelectronics Research Center.

Hooper will submit his proposal to President Crecine by the end of June and then Crecine and the Tech administration will decide what the Institute's priorities are for the coming legislative session.

But regardless of exactly what the funding situation turns out to be at Georgia Tech, it appears certain that this important phenomenon will certainly not be ignored.

Erbil says while it's a very fashionable subject now, it will ultimately be an endurance race of sorts — a race that he thinks Georgia Tech is well-prepared to compete in.

"I think there will be a bust period after this initial excitement because the applications will not come as easily as people are expecting right now," Erbil says.

"In a few years, there will be a plateau, and then again, a slow rise of many years [in developing superconductivity technology]. But until we come to that point," he adds, "there will be a lot of protection and competition, and restriction of flow of information."

Thomas says harnessing superconductivity will require a rethinking of what, in many cases, is fairly basic technology.

"I think Georgia Tech is good at doing that," Thomas says.

"And," he adds, "it's the sort of thing which requires a very good technological organization and cannot be supported only by a good scientific organization. It's got to have a broad technological base."

And so, this scientific and technological race of Olympian proportions might actually turn out to be more like the decathlon than the 500-meter speed skating race or the 400-yard dash. And, of course, in the decathlon, the best *all-around* athlete wins the gold only after proving himself in ten varied events testing his speed, agility, accuracy and, very importantly, his stamina.

Erbil and Thomas feel that it is important for Georgia Tech to continue to do basic research into this new class of materials, to support the technological applications being developed on other parts of the campus.

How to Fail in Management

By Hodges L. Golson

Learning what *not* to do plays a role in learning what *to* do. Several years ago, psychologists N.W. McCall and M.L. Lombardo published a study on the causes of executive failure. They identified a number of fatal flaws which lead to a person's eventual derailment as he moves up the organizational ladder. (As I recall, their initial research sampled males only. However, I suspect that most of this is equally applicable to females.)

The causes of executive failure they identified were:

- Insensitivity to others and abrasiveness.
- Coldness, aloofness, arrogance.
- The betrayal of trust.
- Overly-developed ambition.
- Specific business-related performance problems.
- Over-managing: the inability to delegate or to build a team.
- The inability to staff effectively.
- The inability to think strategically.
- The inability to adapt to bosses with different styles.
- Over-dependence upon advocates or mentors.

I hope it's not a reflection of a negative personality on my part, but I like the idea of studying what goes wrong to learn more about good management practices. I've kept these fatal flaws in mind over the past several years as I have interviewed managers for my clients. (My colleagues and I each conduct 300 to 400 psychological assessments with managers or potential managers per year for a wide range of organizations.) From this database, I've added to and modified the list to some degree. What follows is an outline for failure in management. If you really want to screw up, cover as many of these bases as possible. You don't have to do all of these things; one or two will usually suffice.

Incidentally, the first three items have special significance in the world of high technology. Technologists are at greater risk for suffering the consequences of these particular flaws than are managers in the larger population.

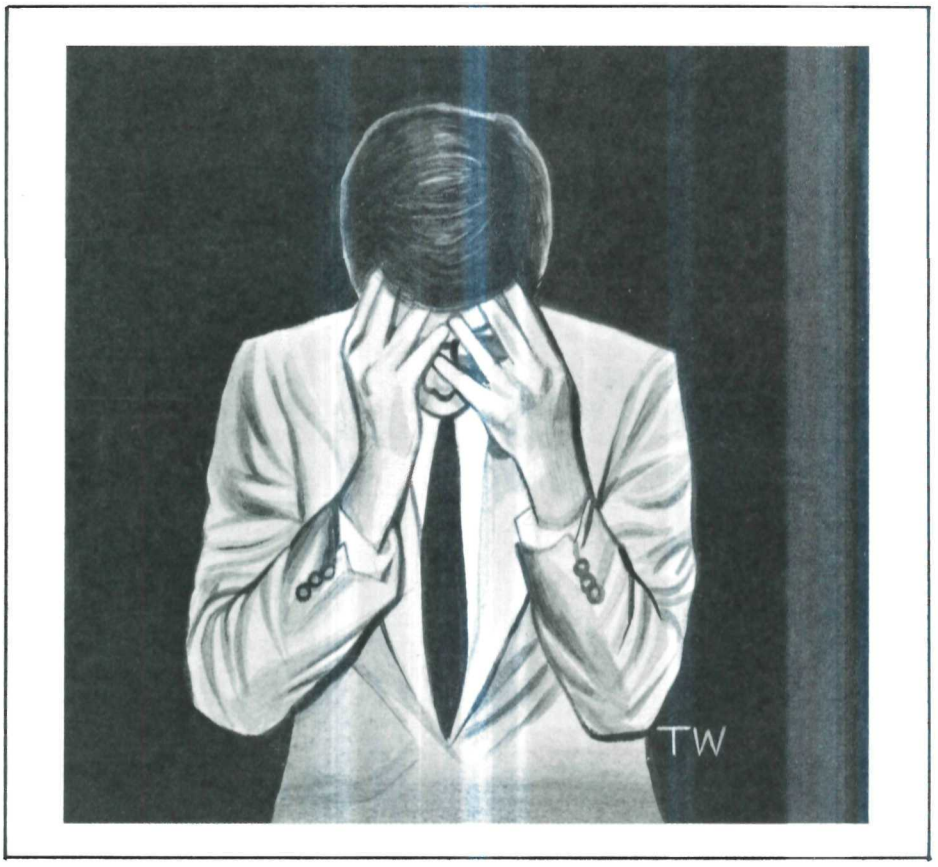
1. Have all the answers. Don't admit that you don't know. Bluff your way through.

Early in their careers, people are usually promoted because of their technical skill. However, few people can really stay current in their field when they move into management. (Actually, technology changes so fast that few people can keep up anyway.) People who don't admit a lack of knowledge or expertise, who don't find good people and rely on them, and who feel they have to have all the answers will not go too far up the ladder.

2. Manage tightly, inspect closely and delegate only what you have to.

Most people have trouble delegating when they first move into management and this is especially so for technical people. A related sure-fire way to fail is to approach delegation from the other end of the spectrum: MBWA. (Not "Management By Walking Around," but "Management By Willful Abdication.")

Dr. Hodges L. Golson received an undergraduate management degree from Tech in 1967. He is president of Management Psychology Group, P.C. The Atlanta-based firm provides psychological consulting services for organizations, focusing on management assessment, selection and development.



3. Hire in your own image.

This is a special subset of the ineffective staffing category. R.M. Belbin is an English psychologist who runs large-scale management simulations as training experiences for European companies. He discovered the "Apollo Syndrome" when he stacked the deck by concentrating a disproportionate number of exceptionally bright people in several of his teams. These "Apollo teams" were expected to run rings around the other teams, which were of a more random composition. However, the Apollo teams got their lunch eaten without fail. Belvin's explanation was that there were too many ideas in these groups, too many clever people to find fault with the ideas of others, too much analysis and too much intellectual arrogance and competitiveness. To generalize to the real world, he observed that the most effective groups were those with a great deal of heterogeneity and variety in the talents, traits and aptitudes of their members.

4. Don't worry about interpersonal skills. Managers are supposed to be tough-minded, hard-nosed, abrasive and even arrogant.

Dominant, abrasive managers can achieve remarkable results over the short run. However, over the long haul they will encounter direct as well as subtle resistance to their efforts and they will eventually self-destruct. When they are in danger of doing so, few people will come to their aid. The resistance is often underground, subtle and passive — but it is effective.

5. Always keep your next job in sight. Learn to play politics, avoid blame and sell upwardly. Be quick to rationalize and to project blame outwardly.

6. Don't worry about the long term. Keep focused on the immediate, here-and-now needs of the situation. Mortgage your future by making short-term, "earnings-per-share" decisions.

7. Focus only on the positive. Avoid bad news. If you do get bad news, shoot the messenger. Do anything you can to discourage subordinates from giving you bad news (e.g. by accusing them of being negative, not being on the team, etc.)

8. Pay an inordinate amount of attention to your image. Don't be caught without your three-piece dark suit, power tie, gold cufflinks, pocket hankies, pinky rings, Rolex, etc.

In all fairness, this in itself is not necessarily a cause of management failure, but it is often symptomatic of deeper problems. Unfortunately, image plays a major role in career development up to a point. John Malloy's books, and the endless parade of Dress-for-Success clones that followed them, attest to that. However, it's easy to overdo it. Peacocks aren't taken seriously. People who pay an inordinate amount of attention to their appearance and who always have every hair in place are often perceived as shallow, self-centered and abrasive.

9. Have a problem with integrity.

McCall and Lombardo's definition of integrity goes beyond basic honesty. The executive with integrity is the person who does what he says he will do, when he says he will do it and with the quality he promises. If he is not able to meet previous commitments, he lets everyone know in plenty of time. The person who overcommits, for whatever reasons, and fails to follow through will not be trusted and will eventually derail.

I can't guarantee that a person will be a good manager or executive by not following this list. However, the more of these points which are applicable, the greater the chances for failure.

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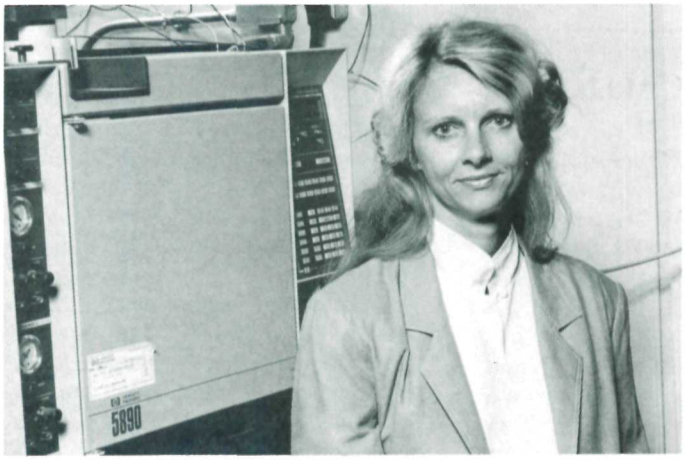
Shortage of Trained Technicians will Hamper Radon Control

Radioactive radon gas may cause as many as 20,000 lung cancer deaths a year, but a shortage of trained personnel and the absence of a central information clearinghouse hampers efforts to control the hazard, warns a Georgia Tech researcher.

The shortage of skilled radon technicians could lead to a proliferation of flim-flam artists who will prey on the cancer fears of homeowners, cautions Marilyn Black of Tech's Environmental Health and Safety Division.

"Control measures do exist and they are pretty effective," she says, "but the problem is training those who will do it." Radon testing is becoming part of real estate transactions, both for residential structures and for large office buildings, adding a new area for potential litigation, Black notes.

The Environmental Health and Safety Division, known for its work on indoor air pollution problems, gets at least five calls a day from building owners worried about the radon problem, she says.



Marilyn Black

Long-term inhalation of the naturally occurring radon gas, which enters homes primarily from adjacent soil and rocks, can lead to lung cancer.

The division has tested some two dozen large buildings for indoor air pollutants, and in most cases, radon levels were within guidelines established by the U.S. Environmental Protection Agency, Black says. However, some residential structures tested have had levels higher than the recommended exposure.

The good news is that compared to other indoor air pollutants such as asbestos and formaldehyde, radon is relatively easy and inexpensive to both detect and control. Black estimates that radon problems in most homes could be controlled for less than a thousand dollars.

"Radon gas ends up in enclosed structures, and the amount that's there depends on many factors, including the structure itself, the type of foundation on which it is built, the soil and the type of rock that is present," she says. Controlling the problem involves sealing off radon entry routes and ventilating spaces where the gas is likely to collect.

Radon is present "virtually everywhere," though the problem first gained widespread attention in the mid-Atlantic states situated over the Reading Prong, a geographical area of rock and soil with high radon concentrations. Georgia Tech researchers have also been instrumental in organizing The National Radon Association, a professional organization Black hopes will ensure high standards among those working in the relatively new field.

Superlattice May Hold Key to Better Solar Energy Cells

The best solar photovoltaic cells can convert only a small fraction of the sunlight striking them into electricity. Conventional cells use only one semiconducting material, which is able to absorb energy from only a small part of the solar energy spectrum.

To increase conversion efficiency, Georgia Tech researchers are developing a solar cell with composites of several semiconducting materials that together are sensitive to a wide range of solar energy.

Georgia Tech microelectronics specialists have won a one-year, $100,000 grant from the Solar Energy Research Institute to develop a variably spaced superlattice that could not only minimize energy loses, but also amplify the electric current generated from sunlight without shorting across the interface. Researchers in Tech's Electromagnetics Laboratory believe that a superlattice device made of mercury cadmium telluride and manganese cadmium telluride might possibly improve photovoltaic conversion efficiency to approximately 45 percent.

Success in this program would mean a dramatic improvement in existing technology. Currently, solar photovoltaics provide approximately 20 to 25 percent conversion efficiency, while the average commercial system yields around 6 to 12 percent.

Superlattices in themselves are relatively common — they are electronic devices composed of two or more thin-film layers of different material, arranged in a sandwich of alternating layers. Since some of the layers are less conductive than others, they serve as an insulator to current flow under certain conditions.

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When the electrons emerge from the superlattice into adjacent semiconductor material, they are sufficiently energized that they excite other electrons out of the valence band and into conduction. This doubling of the electron population is known as impact ionization which, in effect, magnifies the electron current generated in the top layer to twice its value in the bottom layer. This happens at the same time that the electron voltage is halved.

"Even if this device works, it'll be hard to get the production costs down, because growth processes are expensive," says Summers. "But in 10 to 20 years, who knows? Superlattices are new technology, and further research may reduce the costs."

Superlattice technology may be the key to solar energy.

New Chemical Laser has Potential for Space Applications

For 20 years, scientists have been searching for chemically powered visible lasers. Now, physicists at Georgia Tech have developed what are believed to be the first two chemical laser amplifiers which operate in the visible spectral region.

The new laser amplifiers could have applications in space or in any environment where electricity to operate conventional lasers is not readily available, says James Gole, who heads the research group that developed the lasers. Conventional lasers require large electrical current to generate the molecular changes that produce the laser effects.

Gole points out that these chemical lasers, developed in Tech's School of Physics, also make more efficient use of energy than electrical lasers.

"When you calculate how much energy you can channel into a system with a chemical reaction versus what you have to put in with normal electrical means, you are much better off with the chemical approach," Gole says. The Tech group has succeeded in producing both continuous and pulsed visible laser amplifiers running solely on the energy produced by chemical reaction.

Although the Tech researchers had been searching for a visible chemical laser on and off for a decade, the discovery of the continuous laser amplifier came as an offshoot of research on chemical reactions being done for the National Science Foundation.

"We recognized that we had observed the earmark of stimulated emission when we studied these chemical reactions," Gole explains. "We probably would not have recognized that very easily if we had not been familiar with the chemical laser work."

Chemical lasers operating in the lower energy infrared spectral region already exist, but Gole says visible lasers — once developed to their full capacity — will be easier to focus and operable with simpler equipment.

The group, which also includes Stephen H. Cobb and J. Robert Woodward, is now attempting to convert the amplifier systems to laser oscillators. The two scientists discovered that Georgia Tech lasers produce green light, but Gole reports that additional research underway on similar chemical systems indicates the promise of blue and violet light.

"The number of approaches that have been taken in attempts to make this laser would probably take about seven pages to list," he says. "There have been many possibilities, but until now, they all had some flaw."

Tech Builds System to Test SDI Kinetic Energy System

Engineers at Georgia Tech have completed construction of a kinetic energy weapons testbed for the Strategic Defense Initiative.

Georgia Tech project director Cecil Alford says that the testbed's performance exceeds that of other systems because of a unique parallel-processing computer.

The computer was developed under contract for the U.S. Army Strategic Defense Command in Huntsville, Ala., and will be used to test and evaluate the performance of kinetic energy weapons systems.

In a parallel-processor computing system, a number of computers are linked to perform complex tasks. The Georgia Tech parallel-processing computer will be used in evaluations of the guidance, control and signal processing algorithms of these weapons. It also will perform real-time tests on the inertial measurement unit as well as the signal, guidance and control processors.

The parallel-processing computer has attracted the attention of a group of investors interested in producing a commercial product. This group has formed a company, Advanced Cybernetic Technology Corp., and negotiated a license agreement with the Georgia Tech Research Corp. pursuant to terms and conditions of the contract from the U.S. Army Strategic Defense Command.

The agreement is the first commercial spinoff under the contract, but other research and technology developments are being discussed with outside interests.

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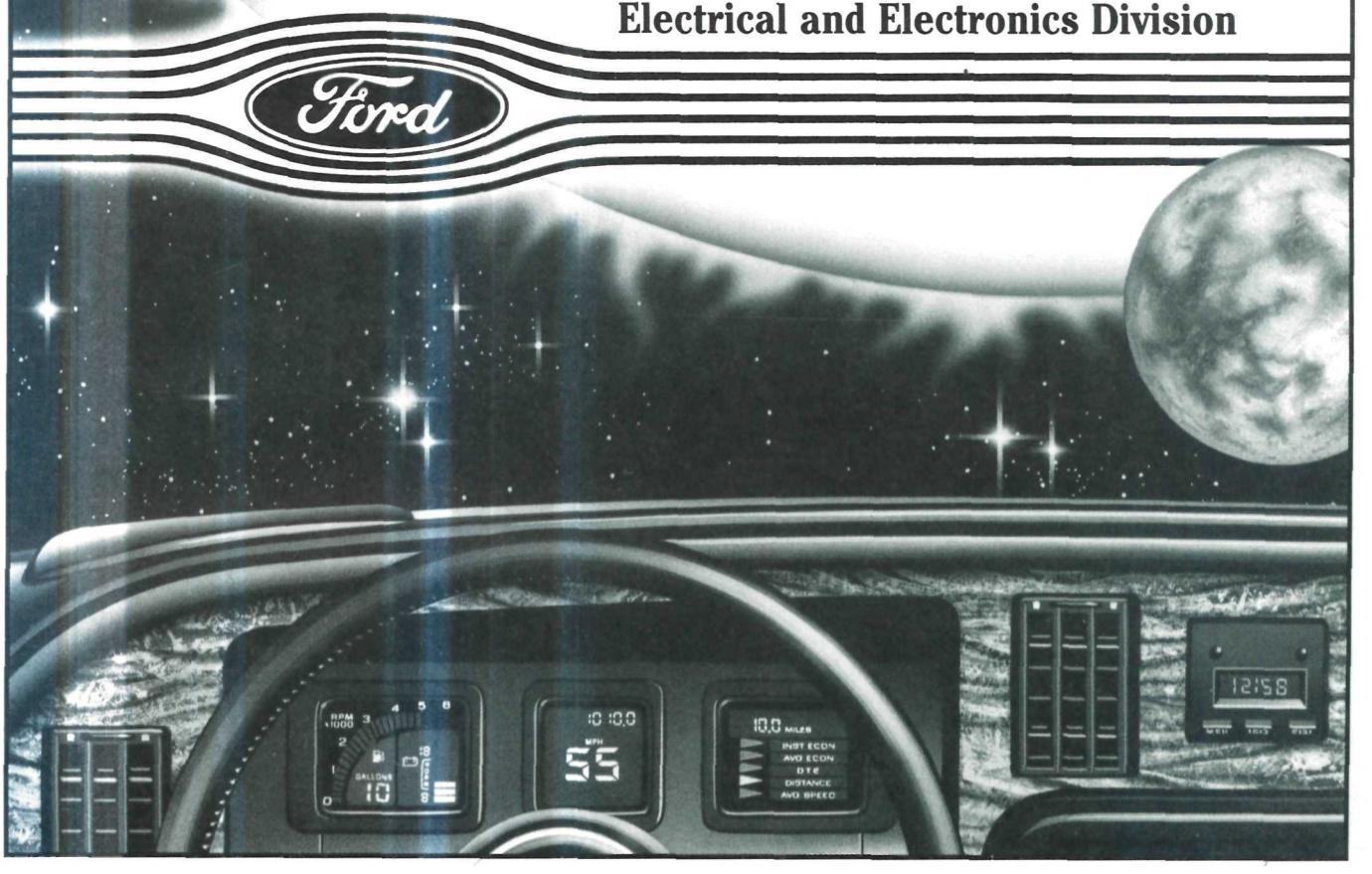


A Moral Question

By Cindy L. Harden

In 1960 the mayor of Nashville, Ben West, was asked the following question by Diane Nash, a young black woman who had been a leader in the sit-ins at Nashville's lunch counters: "Do you feel it is wrong to discriminate against a person solely on the basis of their race or color?" Without hesitation Mayor West replied that yes, he did believe it was wrong. Later, when commenting to reporters, he said that it was a moral question put to him as a man and that he had to answer as a man and not as a politician. His answer hurt him politically but won blacks the right to be served at lunch counters in Nashville.

In 1988 we are still faced with issues that pose moral questions. Do we believe that it is wrong to deny men, women, and children a safe and affordable place to live? Most of us would answer yes to that question, but, unlike Mayor West, we have not taken public actions to back up our beliefs. How many times in a day do we pass a homeless person and turn our heads? Do we honestly believe a person must choose between living on the streets and living in a shelter, sharing a room with hundreds of others? And, anyway, what can we do about it? After all, we didn't cause their homelessness. Or did we?

In the past couple of years the issue of homelessness has become increasingly newsworthy and "fashionable." The American Institute of Architects has launched a major program, "The Search for Shelter," to confront the problem and develop solutions, and "Hands Across America" was a media event designed to rival "Live Aid." While these initiatives are laudable, they have a minimal effect on the problem. "The Search for Shelter" has the financial backing of the Jaycees to provide funds for a few projects, and "Hands Across America" has distributed only $18 million dollars, most of which has been used for emergency shelters and soup kitchens. At a relatively conservative estimate of $15,000 per person this amount would provide housing for 1,000 persons — if it were used for permanent housing.

In New York City alone, 11,000 individuals are living in shelters and 6,000 families are living in shelters and welfare hotels; these number don't include those living on the streets or in abandoned buildings which, according to advocates providing outreach services, could number more than 40,000. The New York City Housing Authority estimates that 35,000 families are illegally doubled up in public housing. There are estimated to be two million homeless people nationwide, and given the numbers of those living on the edge of homelessness — two million families paying more than 50 percent of their income for rent and three million families doubled up — the future projections are indeed terrifying.

While architects, engineers and others may have participated in programs aimed at solving the problem, many more — even some of the same professionals — may have indirectly increased the number of homeless people by involvement in projects that displace or ignore existing low- and moderate-income residents in the path of development. As professionals with a sense of social responsibility, we are often faced with the necessity of deciding what is right. Should we work on the development of a shelter because that is the best solution we know of, or should we work to develop innovative and sensitive permanent housing solutions? Do we volunteer to work in a shelter, or do we lobby for federal spending that will make shelters obsolete?

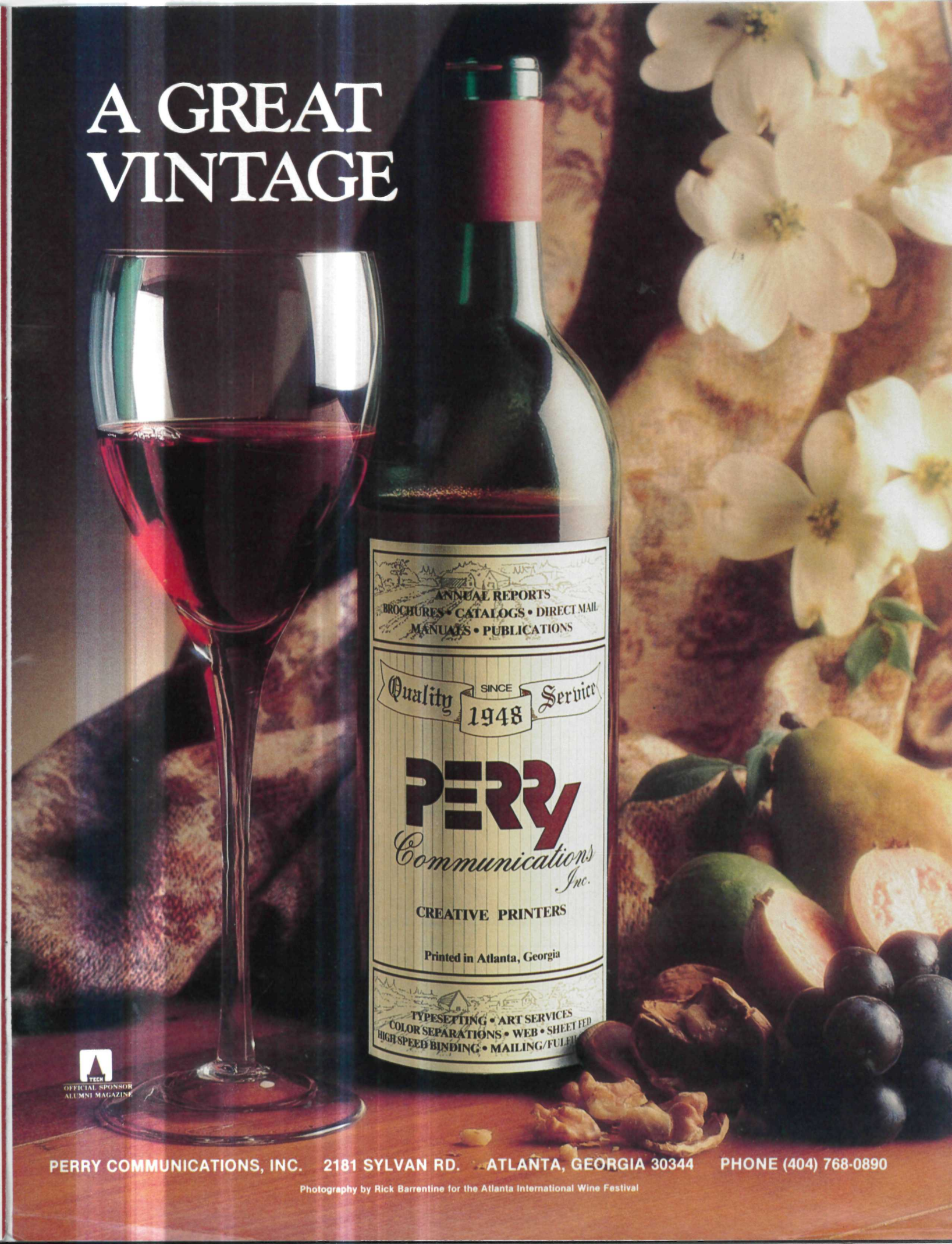
To answer these questions now and in the future we must educate ourselves and our children about the causes and effects of homelessness so that we have a moral basis, not just a financial one, for decision-making in both our professional and personal lives. If a project we're involved in will result in the displacement of low-income residents, we should have the courage and the imagination to offer alternative solutions to our client or, ultimately, to decline to work on a project. Or, if we live near a site proposed for low-income housing, we must make the moral decision to support its placement in our community despite our personal fears.

Nor can we defer these moral choices to the future. We must act immediately to confront these issues of homelessness and develop programs that will not only prevent homelessness, but will offer safe and affordable housing to all. This includes not only housing for traditional families, but also those families and individuals whose needs dictate special design features and social services.

We must act now, because homelessness affects us all. In New York City, armories formerly used for after-school recreation and physical education programs are now shelters; nationwide, church basements formerly used for youth programs are now used for emergency shelters, school systems are burdened with an ever-changing population of homeless children living in welfare hotels, and our future looks bleak as a whole generation of undereducated and psychologically damaged homeless children grows up. Our children may remind us of the moral dilemma when they ask us to explain why a person is huddled under a cardboard box on a cold night.

Do we believe that it is wrong to deny men, women and children a safe and affordable place to live? This is a moral question; as people of conscience, we must answer it with actions, not just words, or be doomed to walk down a street past the homeless — feeling and seeing nothing.

Cindy L. Harden, BS '76, is architectural director at the Pratt Institute Center for Community and Environmental Development, located in Brooklyn, N.Y.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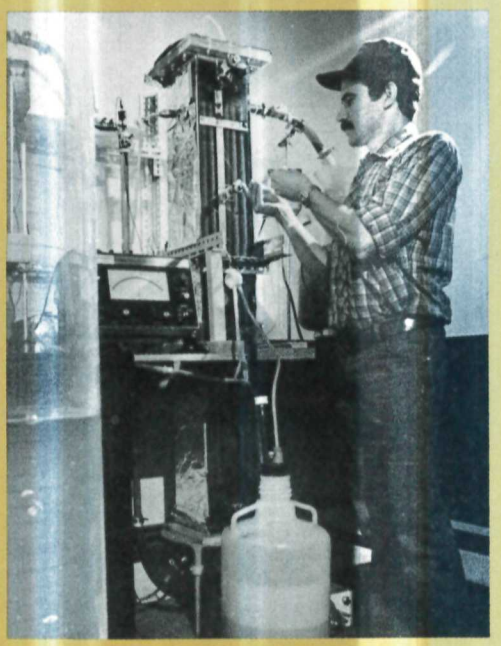

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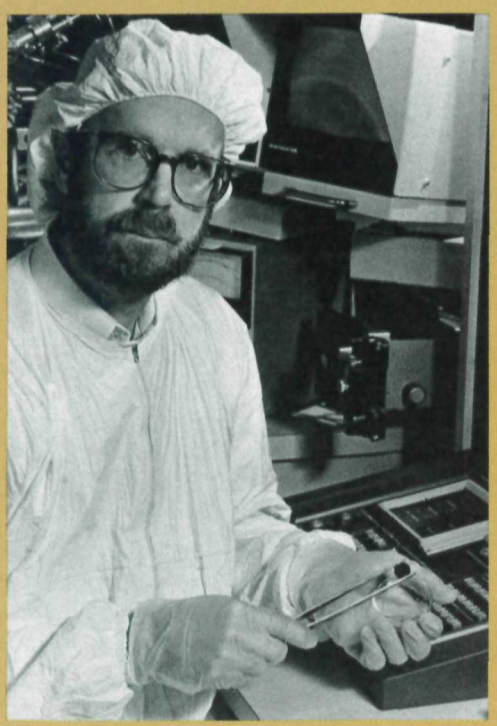

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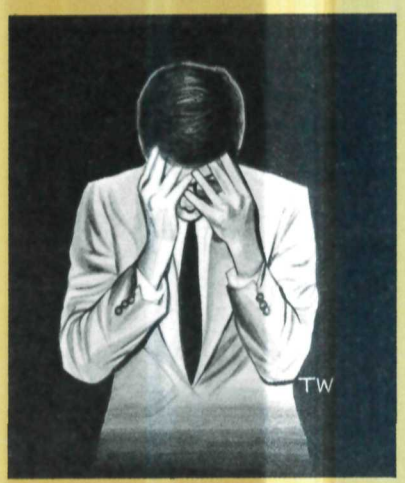

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