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velocity of fluid passing through a plexiglass model of
a constricted artery, dramatically aiding Georgia Tech
researchers in the study of blood flow through diseased arteries.
This example of technology aiding biomedical research, is
characteristic of the dynamic benefits high technology can bring
to industry, education, research, medicine, agriculture, and
every aspect of our lives. The technological age is changing the
way we live. The changes are taking place very rapidly in many
forms—from personal computers to the space shuttle. This
special issue will look at some of the challenges of high
technology and how Georgia Tech is helping meet those
challenges.

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What Is High Technology, Anyway?

By Charles Seabrook

In this day of lightning fast computers and automobiles that talk to you, “high technology” is suddenly fashionable, and plain, old-fashioned technology seems to be out of vogue.

But exactly where “high technology” begins and run-of-the-mill technology leaves off has become a foggy area. “High tech” is being bandied about so much these days that its meaning has become muddled. Advertisers, for instance, ever eager to pick up on any catchy term that will sell products, now speak of almost any new thing—whizzing around the earth, blinking and buzzing robots and computers that weld, hammer and screw products together on an assembly line, and tiny microchips that can do the job of refrigerator-size computers 20 years ago.

High technology brings to mind IBM, Apple, Honeywell, hardware, software and Silicon Valley. It is the world of electronics and computers, from video games to computerized blood-typing systems in hospitals to hair-thin fibers than can carry hundreds of telephone conversations at the same time. It is the stuff of software, or a system of programming computers to make them do a number of tasks that boggle the human mind. High tech is hardware, or the actual plastic-and-silicon keyboards, transistors and circuits.

Many experts, however, say that high tech is more than whirring and buzzing robots, computers and electronic gizmos. The field of biotechnology—genetic engineering, monoclonal antibodies and the like—is just as much a part of high technology as the gee-whiz gadgets, experts say.

Dr. Thomas Stelson, Tech’s vice president for research, goes a step further than Webster’s definition of high tech. High Technology, said Dr. Stelson, “is anything that is new and probably more sophisticated. So you can take an old industry and apply new technological techniques, and it becomes high tech.”

He cites the textile industry, for example. “You can take an old industry like the textile industry, apply high tech automation techniques and it becomes a high tech industry,” he said.

Because nearly everybody has a somewhat different idea of what high tech is and what it is not, it is difficult to determine how many high tech companies a particular area might have. Research Atlanta, an independent nonprofit research group, for instance, says about 336 companies in metropolitan Atlanta can be classified as producing a high tech product or service. The Atlanta Chamber of Commerce, on the other hand, lists only 122 high tech firms in the area, most of them electronics manufacturers.

In Atlanta, high tech firms range from the 33-year-old Scientific Atlanta, which specializes in satellite communications and has a work force of 3,116 persons, to a nearly brand new outfit employing two persons who are trying to increase the durability of tools by altering atoms.

Despite the diversity of opinions over what high tech is, there is little disagreement that high technology already has changed our lives—and will continue to do so in the future—in ways we probably have little imagined.

Home computers, prime examples of high technology, are now a part of the

Charles Seabrook is the medical and science reporter for the Atlanta Journal and Constitution newspapers.
houses of several million Americans, for instance, helping solve a number of tasks. In sports, high technology is being applied more and more to help win the Big Game or the Big Race. Coaches use computers to figure a better way of running the fullback up the middle. Stock car racers, shedding their 'ol country boy image, have turned to computers to determine the best time to come in for a pit stop.

In the medical field, high technology is saving and improving the lives of countless Americans. Dr. James O. Mason, the new director of the U.S. Centers for Disease Control in Atlanta, would like to establish a center to study ways of applying high technology to disease prevention.

With high tech now the buzz word in industry and the wave of the future, every state wants a piece of the action. High tech is a clean, non-polluting industry for the most part, and it brings in a lot of high-paying jobs. Every state wants a Silicon Valley, like the place in Santa Clara County, Calif., that has become one of the leading high tech centers in the world.

Georgia, for instance, is fighting strongly for its share of the high tech market, and state officials have looked strongly to Georgia Tech for guidance and leadership. Tech, in response to the emphasis on high technology, has remodeled sections of the old O'Keefe High School to house Tech's Advanced Technology Development Center. Antiseptic white doors in the new center bear space-age names such as Pulsetek and Catronix, new firms that are working with Tech to develop high tech.

Earlier this year, however, Georgia's efforts to attract a major high-tech industrial venture fizzled out at the last minute. Georgia officials made a valiant effort to bring a 12-company venture called Microelectronics and Computer Technology Corporation to the state, only to lose the end to Austin, Texas, after a few million dollars of oil money sweetened the deal.

But that's only a temporary setback. There will be many other chances, and Georgia officials have vowed they will try even harder in the future for high tech industry.

Although Georgia does not yet have anything near to something like Silicon Valley, the Peach State is not lagging as far behind in the development of a high tech industry as it was 10 years ago, said Dr. Stelson. A principal reason for the catching-up, he said, is the development of the high tech research program at Georgia Tech.

"Engineering is critical (to high tech)," he said. "It's where you cement science to some product."

In addition, he said "high tech is an elitist business. Being second best isn't good enough. The competition will push you out."

Georgia Tech, Dr. Stelson added, is highly sympathetic to making Georgia a leader in high tech. "Over the years," he said, "half of our graduates have had to leave the state to get the jobs they sought. But that's actually an investment of sorts. Now, some of those graduates are in charge of companies, and some have brought their companies back here."

Dr. Stelson, comparing Atlanta to Research Triangle Park in North Carolina, another leading high tech industrial and research center, said, "I think we've probably done more and gone farther than Research Triangle. The fact is that Research Triangle has gone a lot further in packaging (public relations and selling itself as a high tech center)."

But should Georgia try to become another Silicon Valley, with its electronics based manufacturers, or try something different, such as high tech agriculture?

Dr. Stelson said that "I agree we shouldn't try to duplicate Silicon Valley. But I wouldn't sneeze at the chance to get a new $100 million electronics plant."

When the advantages are listed for Atlanta attracting high tech industry, Georgia Tech is right there at the top. Other pluses are the airport, non-union labor and the city of Atlanta itself, which consistently ranks at the top of the nation's most livable cities.

On the other hand, many officials have cited Georgia's weak secondary and public school system as a major drawback for attracting high technology to the state. Other disadvantages include a lack of trained workers and money problems with local banks that could supply capital.

State officials and business leaders are very aware of these deficits, however, and have set up plans and established goals to meet them. Gov. Harris, for instance, has set up a five-year, $30 million program—funding comes both from state and private sources—to gear up for high tech industry in the state. And the Atlanta Chamber of Commerce has set up a task force for the same purpose.

Georgia Tech, especially its Advanced Technology Development Center, will play a central role in these plans.

However, while Georgia Tech ranks among the nation's finest technical institutions, it faces a paradoxical situation these days. State financial support for Tech has slipped alarmingly in recent years. Class sizes have grown and equipment has deteriorated.

Dr. Pettit was asked in an interview with the Atlanta Constitution recently that, if he had 10 years, what would it take to put Tech where it needs to be? He replied: "It's no open-ended thing. We put in a budget that would first arrest the decay that is going on because of higher costs. We put in another level that would perhaps get us back to where we were several years ago. And we put in a third level that would move us up. It's very hard to say what you would need for the long haul. We could easily spend $6 million on equipment just to refurbish the instructional labs."

Dr. Pettit also said that while there is a tendency to look to high tech as a panacea for our economic trouble, we should not overlook other areas of technology. "I think Georgia could do with a more balanced spectrum of industries. We don't have a lot of smokestack industries. But if we had more electronics and computer-type industry, I think it would be very desirable. But it certainly won't solve our other problems. If we had an environment where small companies were being formed more easily, that's where a lot of employment is generated."
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High Technology

An Industry in Evolution

By Charles Harmon

The definition of high technology is a changing one,” says a very distinguished Dr. Melvin Kranzberg, “because one generation’s high technology becomes the low technology of the succeeding generation as new and better technologies come along.”

Kranzberg should know. He is Georgia Tech’s internationally recognized guru on the history of technology. In 1979-80 Dr. Kranzberg was National President of Sigma Xi, the honorary scientific research society which has some 130,000 members in more than 500 chapters and clubs throughout the world. He is the only historian ever to have headed this prestigious organization and one of only a few in his field to be elected to this scientific organization.

As chairman of the Humanistic-Social Division of the American Society for Engineering Education during the mid-1950’s, Dr. Kranzberg introduced the history of science and technology as a component of the humanistic-social stem of engineering curriculum. He was a pioneer in developing “general education” for the engineers and then in introducing what has been called the “contextural” approach to the humanities-social sciences element of engineering education.

Dr. Kranzberg’s authoritative views about high technology are often quoted in popular media, appearing in such publications as the New York Times, Newsday, U.S. News & World Report, and Christian Science Monitor.

The 65-year-old St. Louis, Mo. native is the prestigious Callaway professor of the History of Technology at Tech. Among the literal volumes of his resume, Kranzberg is listed as the founder of the Society for the History of Technology and editor of its journal, “Technology and Culture.” This particular phase of his life was recognized this summer when “Culture Technique,” a major journal of the French government-sponsored Center for Research of Technological Culture, dedicated the publication to Kranzberg’s efforts and published a series of his articles.

Kranzberg says that nowadays high technology is identified as another phase of automation with machines controlling processes which were formally done by machines with human control. He adds that high technology is also identified with the computer and the information revolution.

“One of the things I find interesting is that this represents an advance on the old Industrial Revolution. The classical eighteenth century Industrial Revolution took the burdens off the back of man, and the worker became a machine operator instead of being a handcraftsman who worked by hand with fairly primitive tools and machines. Now with this one (information revolution), the machine is already programmed through the computer to do the delicate processes.”

Kranzberg says that increasingly the worker today is no longer a machine operator, but a machine supervisor.

“He watches the dials and the machine does the work.”

The School of Social Sciences professor translates and looks to the future.

“The ‘steel-collar’ worker—the machine, the robot—will be doing the work. It will be programmed, have microchips, basically computers, inside the machine. So it represents really a change in the function of the worker.”

Kranzberg emphasizes that a study of the history of high technology reveals that high tech tends to be the top of the line technology during a particular historic period.

“After all, the steam engine was high technology 200 years ago. It had a great impact on production within a very short time, but at the same time it didn’t mean that everybody immediately threw away their old water wheels and turned to steam engines.”

One reason for the delay in the transition to steam power, Kranzberg says, was the ready use of water power with waterways packed with mills using water wheels and mill dams.

“They needed another source of power. They had run out of water power in a sense, but they didn’t throw away their old water wheels. They kept utilizing them.”

The transition to the steam engine was a slow one incorporating a full century. However, in such places as England the steam engine “had really revolutionized the whole nature of the technology even though it was not producing more hard power” immediately.

The Industrial Revolution did not begin with the steam engine, but the steam engine certainly contributed.

“You already had certain aspects of the Industrial Revolution, that is factory production, powered machinery, water power in the textile industry,” states Kranzberg. “They had mechanized the weaving and spinning processes before by a series of inventions in the early part of the eighteenth century, which took the textile industry out of home cottage production, (and) put it in large factories with large-scale machinery operated by water power, not by steam.”

Moving forward a couple of centuries to contemporary times Kranzberg analyzes the rapid development of modern day high tech and the very beginning of the computer phase and how it has evolved from “computers with vacuum tubes” when the emphasis was on bigness.

“We are not even sure what all of the consequences of this are,” says Kranzberg, who has observed the transition from the large Univac computers to the hand-held variety, all within his lifetime.
Therefore knowledge will be the chief going to be the ones who run society. Production will no longer be the major pot. Warns that we must not fall victim to increasingly doing, to the production of sleep in it. You can't drive it. "

"The application of computerized information will continue," says Kranzberg. "You're not going to be able to take all the people who have been engaged in manufacturing goods and put them into computer making and servicing." The result, Kranzberg says, will be some changes in the amount of working time put in, as well as further expansion of the service sector of the economy.

"The 40 hour week is not sacrosanct. You know in the nineteenth century people worked six days a week, and then they had legislation reducing it to five and a half days."

As a result of the reduced work week Kranzberg believe there will be a tremendous rise in leisure activities.

"More leisure time can be used up very easily, not just sitting around watching TV, etc. As a matter of fact, with the rise of education in this country, do you know that the attendance at art museums is greater than the attendance at professional football games? And that people are reading more books and magazines than ever before?"

As Kranzberg reflected on the history of high technology and its impact his attention turned to his home campus.

"Let's talk about Georgia Tech in relation to the whole field of technology and engineering. Look at what is taught, and how it is taught at Georgia Tech today. Compare it to how it was taught 50 years ago" or even at the very beginning of Tech. "When we started out we were indeed the trade school on North Avenue, because we were busy training boys to take part in the technology of that time. Well, the technology of that time has changed. So we are now training our students, not only boys, but girls too, to take part in this high tech."

Kranzberg says such specialized training is not confined to the Information and Computer Science School that has the computer and all of its ramifications.

"You go into every school, Civil Engineering, Mechanical Engineering, ISyE, etc., and all of them are involved in high tech as it applies to their particular field."

In Civil Engineering "they are using computers all over the place" for computer-aided design Kranzberg said.

"You know the old time civil engineer? The picture was a man in hip boots and mackinaw who goes out and builds a bridge. Now if you want a bridge built, you go to MIT or Tech and they will design it on a computer for you and you will have to go out someplace else to get the guy in the hip boots and mackinaw."

Kranzberg says that certain things which used to be an important component of an engineering education, such as draftsmanship, have been out-moded. Draftsmen now acquire their skills elsewhere such as at community colleges, but that too might die out as computer-aided design increasingly takes over the drafting function.

"And so we really have para-technologists. That's what the engineering technologists are. And they do the kinds of things which Georgia Tech used to train people to do."

The Georgia Tech engineer is going on to "this high tech kind of thing, computer-aided design, computer-aided manufacturing. That's the big push of the future. That's going to produce the 'steel-collar' workers. So this really represents a change in the engineering profession itself, and Georgia Tech is among the leaders in this field."

Kranzberg, the historian, is indeed optimistic about the future, not only of Georgia Tech but society as a whole. He sees high tech continuing to play that evolutionary role.

"People say 'machines have made man dependent on machines.' Baloney! Modern technology makes us more dependent on our fellow human being because every technology is so specialized and society is so complex that we need everybody else. For example, if the electrical workers go on strike and that system breaks down, nothing else can function. We are dependent on our fellow man as never before."

And he concludes, "That's why a Georgia Tech education is so important, for we are building the essential human resources of the future."

---

**Dr. Melvin Kranzberg**

"So when you get this miniaturization of the brain as it were, the directing force, this has all sorts of implications in terms of decentralization. You can sit at home and do your office work, and you can have a small plant producing goods. You don't have to be attached to a big, expensive office or factory."

There are those who say that society is changing to a point where industrial production will no longer be the major occupation. They say that with the production of information, the people who have control of the information are going to be the ones who run society. Therefore knowledge will be the chief basis for economic and other progress.

"That, I think is true only to a limited extent, because the point I keep making is that this information revolution is not sufficient by itself because you can't eat information. you can't sleep in it. You can't drive it." Still, says Kranzberg, the thing to do "is to apply that information, as we are increasingly doing, to the production of goods and material things which are necessary for human beings." He warns that we must not fall victim to the same sort of syndrome that the British did at the close of the nineteenth century, and let our own industry go to pot.

"Even though Britain still remained in the forefront in terms of thinking up technological ideas, they did not actually apply them to their own industry, and they were used abroad."

Although, as an historian, Kranzberg admits to having 20/20 hindsight not 20/20 foresight, he is still willing to look to the future of high tech advancement and its impact on society as a new century approaches.

"The application of computerized information will continue," says Kranzberg. "You're not going to be able to take all the people who have been engaged in manufacturing goods and put them into computer making and servicing." The result, Kranzberg says, will be some changes in the amount of working time put in, as well as further expansion of the service sector of the economy.

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For a few hours in May of this year, it looked as though Atlanta might take first place in the Microelectronics and Computer Technology Corporation (MCC) sweepstakes—a prize eagerly sought by 54 cities in 22 states. When the results were announced, Atlanta had to settle for second place in a competition in which it had more or less invited itself. And even though no cigars were ever passed out on North Avenue, the participation by Georgia Tech, the Governor's Office, the Mayor's Office and industry representatives wooing the largest joint research and development venture in electronics history did more to awaken Georgia to the realities of the high technology world, and to the role Tech plays in that world, than any episode in recent political memory.

Of particular significance for Georgia Tech is the favorable attention its researchers and facilities got from political leaders, the press, the general public, and industry leaders. "Georgia Tech is Atlanta's shining star," is the way the MCC people put it when the results were announced. Obviously, Georgia Tech administrators and researchers who had put in long hours getting ready for the competition were keenly disappointed at the outcome. But they took heart from a strong second place finish, which put Atlanta ahead of heavy-weight contenders, like North Carolina's Research Triangle and even California's Silicon Valley. One very important reason for Atlanta's strong finish was Georgia Tech's recently formed Microelectronics Research Center.

Microelectronics, as a field of research, has been underway at Georgia Tech for fully a decade, but it was not until January, 1982 that the Microelectronics Research Center (MRC) was officially brought into being. The impetus for the Center came from several sources, one being President Pettit's experience in high technology projects with industry while he was dean of Stanford University's College of Engineering. Those cooperative efforts hastened the growth of California's Silicon Valley between Palo Alto and San Jose where today the "Silicon Valley phenomenon" involves a combined population of over 1.2 million people with a median family
income that exceeds $24,000 per year. President Pettit also was instrumental in the formation and growth of the Advanced Technology Development Center, another Georgia Tech operation that favorably impressed the MCC people.

A second development that led to the formation of the Center originated at the national level—at the National Science Foundation. Almost a decade ago, Dr. Henry Bourne, Jr., now Tech's Vice President for Academic Affairs, was an administrator at the NSF. Dr. Bourne, along with two of his colleagues, Jay H. Harris and Elias Schutzman, became convinced that the nation's scientists needed support in basic research in microstructures. In 1976, the NSF sponsored three workshops to discuss the issue, especially university-based programs to supplement industry. "The concept of centers to provide university-based microfabrication facilities serving the research community grew out of these workshops, and in July 1977, following extensive review and study, NSF announced the creation of such a facility at Cornell University," Physics Today reported in 1979.

Meanwhile, at Georgia Tech, a substantial basis for establishing a microelectronics research program was provided by the internationally recognized efforts of research teams in the areas of atomic and molecular collisions, physical electronics, material science, computer technology, and electronics-based systems. The field itself was developing rapidly and scientists from several disciplines were beginning to recognize that the scale of microscopic structures differed fundamentally from those of ordinary macroscopic structures. New subdisciplines were forming, concepts were being sharpened and the parameters of research were being defined.

By the end of the 1970's, researchers were talking about crossing the threshold into "new physics" as the size of systems reached the 1,000—100Å range. And in the mass media, publications like National Geographic began to introduce the public to terms like chip ("a small piece of silicon that is a complete semiconductor device, or integrated circuit"), EPROM ("Erasable Programmable Read-Only Memory; a type of memory in which stored information can be erased by ultraviolet light beamed in a window of a chip package"), RAM ("Random-Access Memory; a memory in which any piece of information can be stored or retrieved; its contents are only held temporarily") and ROM ("Read-Only Memory; a memory chip in which information is permanently stored during the manufacturing process").

Prior to the formation of the Microelectronics Research Center, most of Georgia Tech's research in microelectronics was conducted in the Physical Sciences Division of the Engineering Experiment Station, with substantial basic research also taking place under the aegis of Tech's academic departments. The formation of the Center has not meant a change in the basic staffing structure at Georgia Tech. In fact, the Center already has reached one-third of its projected staffing—32 professional people of an eventual 100—but these researchers remain in their respective administrative units. There are only two people on the Center's administrative staff: the Director, Professor John W. Hooper, and his administrative secretary, Mrs. Rosa Runner.

"There are 32 people are not necessarily full-time," Professor Hooper says of the staffing arrangements. "We may arrange with a metallurgist, for example, to work on a specific problem like corrosion of a ball bond; but after (s)he has helped with that problem, (s)he will go to some other metallurgical problem. We do not intend to have a permanent research staff."

Funding for the Center presently is in the $1.5 million per year range. About 70 percent of these funds come from government agencies, such as the DOD, and 30 percent from industry. This 30 percent compares with Tech's overall ratio of about 20 percent from industry. Nationally, the ratio is only 4 percent, but the national statistic includes liberal arts colleges that do not
Switched capacity filters are also studied at Tech.

Hooper feels that Georgia Tech has two strengths the Center can draw upon: its strong line organization, and secondly, the diversity of its researchers. "If a university were to start from scratch in some field of microelectronics, it would typically need $250,000 to $750,000 just to purchase an 'entry ticket'. Tech already has the entry ticket in several key areas."

Georgia Tech's Research Center hardware is state-of-the-art, and more is on the way, much of it donated by industry or acquired under various contracts. Conceivably, one possible problem down the road will be keeping abreast of rapid and costly innovations in the field. Obsolescent equipment has been a problem in other fields at Georgia Tech and in microelectronics at other universities. However, Hooper is encouraged by recent equipment grants to the Center, which during the past year exceeded one million dollars. Times have changed, Hooper feels, and industry is more sensitive to the research needs of universities than it once was. Tax laws are more realistic for donations of equipment to university-based research. He points out that a university research center is a wonderful showcase for industry's new equipment: "They want to show off the best that they have."

Hooper says that one computer company is talking to Tech about giving the Center a new computer that hasn't even been put on the market yet. His confidence about the Center's equipment needs also derives from the nature of the Center's mission. "It's possible to work with equipment that may not be state-of-the-art, in the sense of industry's most recent production model, because, in the research environment, equipment can be modified for research needs. Also, the Center's educational activity is primarily at the graduate level. We might need only one of a particular piece of hardware, whereas a teaching laboratory might need 100."

Obsolescence of equipment would be a problem if Georgia Tech were to install a base-line fabrication center capable of producing chips on a production quantity basis. He estimates that such a facility would require a $10-12 million front-end investment plus a million dollar up-keep cost per year. Because of those kinds of costs and the problem of obsolescence, the Georgia Tech Center has chosen not to go with base-line fabrication. Instead, Tech will develop programs including materials synthesis and characterization, device development and evaluation, theoretical studies and design. Most of the actual fabrication will take place under arrangements already in place with industry and government agencies. (Georgia Tech does fabricate discrete device sub-micron units, such as those in use in satellite communications systems.)

University-based research in technology has sometimes been criticized, not just for using obsolescent equipment, but for employing personnel who are not on the cutting edge of their respective fields. Critics point out that industry can readily afford to hire top talent away from educational institutions. "Presently, there is a supply/demand problem that's about 4 to 1," Hooper says. "This deficiency is greatest at the Ph.D. level. As you know, this business, like most businesses, is drawn by a few, key individuals. The salary problems Georgia Tech face are from key universities that are competing for the key people with a Ph.D."

"Timeliness is very important;" Hooper says. "There are a few schools that are ahead of us; for example, Stanford, MIT, the University of California at Berkeley, Carnegie Mellon, and Cornell. Cal Tech is prominent but is not as comprehensive as we are. Its main strength is in silicon structure and computer-aided design of chips. There
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are a whole range of schools that are our equal, or we are better than they. The North Carolina Microelectronics Center (NCMC) is one of the prominent centers. Presently, the university component of the NCMC is not our equal but they may overtake us because of North Carolina's uncanny ability to persist at a task and combine resources in innovative and cooperative ways."

As for physical facilities, the MRC centrally houses only those resources that would be needed by a multiplicity of users on campus. If there is to be only one user, the hardware is put at the particular research site where the research is based, not at the Research Center. Industry not only has contributed hardware, like the Center's highly sophisticated Harris Computer and the CALMA (GE) systems; they also are donating top research personnel for short-term assignments. The Research Center has user offices that are used by researchers who work on center-based projects. For example, a Lockheed Corporation engineer who is involved with the Center on a project comes to the campus two or three days a week and uses an office at the Center assigned to his project. Similary, a Cobb County, Ga. EES researcher has an office assigned for his use for one of the Center projects.

The Center's initial pride and joy, as far as hardware development is concerned, is the VLSI (Very Large Scale Integration) Design Area. The Center presently has the capacity—using the VLSI Design Area—of going from concept, to design, to computer tape, to the fabrication stage. When the fabrication stage is reached, Georgia Tech then goes to an external fabricator.

To give some idea of the complexity of the work that goes into place in this process, consider for a moment that approximately 5,000 transistors are located on the chip of a digital watch, and about 20,000 are on the chip of a pocket calculator. However, for a chip to be classified in the VLSI range, 100,000 transistors, or more, are compactly fitted on a single chip. Such a chip may require literally several man-years to design and fabricate.

Georgia Tech's hardware in the VLSI is valued in the one million dollar range, for which the Institute paid only about $150,000 in hard cash. Hooper says that only 4 or 5 schools are our equal in terms of design facilities, no other is better, and Tech is increasing rapidly.

Selected graduate students work on clearly defined problems at the VLSI Design Area; hence, the Center is not isolated from the teaching function at Tech. But its mission is primarily research. It provides a stimulus for materials and device research, theoretical studies, computer-aided design, algorithm development, etc. "We deal with the problem, 'How does one go from the tools that industry uses today to the tools industry will need tomorrow?" Hooper says.

What about the difficulties universities encounter in research because of proprietary interests? Professor Hooper indicated that some companies are almost paranoid about their research leaking out; in fact, some of these fiercely competitive companies are beginning to look for ways to cooperate. The impetus is admittedly fear of international competition, primarily Japanese.

One such venture is the Semiconductor Research Cooperative (SRC) which is rapidly becoming an important factor in microelectronic research. The SRC pools the resources of member companies—many of them small at present—and lets contracts for research with universities. Presently, Georgia Tech has one contract with the SRC on the order of about $100,000 per year. In addition, the Center is negotiating with the SRC for a "Center of Excellence" in the electronic durability area. Another instance of cooperative research is the previously mentioned MCC. The MCC is an in-house research organization but it is another example of several companies that are willing to pool knowledge.

Private industry recognizes that the university can be a neutral ground where companies can meet one another and address their mutual problems. In some cases, the respective companies don't even have to admit to themselves that they are cooperating with a competitor: the university serves as a broker of knowledge. "The companies in this industry are going to have to find ways of cooperating that are non-traditional," Hooper says. "At a center such as Georgia Tech's Microelectronics Research Center, we can do classified research, we can do proprietary research, and we can do traditional research. The classified and proprietary research will be done in EES with much of the generic research taking place in university academic units."

What role does Professor Hooper see the Microelectronics Research Center playing in Georgia Tech's future? "In microelectronics, we are an important part of Georgia Tech's interface with the outside world."
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Building a Reputation in the Computer Science Community

By Jeff Luck

In 1973, with the electronic calculator in its second year, the Bowmar Instrument Corporation introduced a new model with all the standard calculator functions (add, subtract, multiply and divide) and a percentage key for the low price of $100.

Two months ago in a newspaper circular, appeared an advertisement by a major toothpaste company, offering a calculator with all standard calculator functions, a percentage key, and a square root key. The price? Two toothpaste proofs-of-purchase and one dollar for postage and handling.

With that type of advancement in microchip technology and the expansion of the computer age, it's no wonder that the idea of a school of information and computer science conjures up in most adults the vision of a massive computer surrounded by terminals operated by wonderkids trying to access secret information.

Well, it's nothing like that. But Dr. Ray Miller, director of Georgia Tech's School of Information and Computer Science, points out, "Not a lot of us have grey hair."

The school, with a "young, highly qualified faculty," as Miller says, is committed to being one of the top in its field. Already they have had a start; the statistics bear that out. Among 57 Ph.D. granting schools in the United States and Canada, there was a net increase of 20 faculty members per year. "This may not seem like much," Miller says, "but this is in light of the fact that during the period from 1975 to 1980, in all the Ph.D. granting schools in the United States and Canada, there was a net increase of 20 faculty members.

"For a good undergraduate program, you need good research," he says. "They complement one another, rather than detract, as some people believe." Miller feels that the school should continue to emphasize the graduate program, training people that are needed to teach undergraduates.

One major program of the school has been to stress the concept of the Fully Distributed Processing Systems (FDPS). The design of systems where several computers work "separately but together" has been the cornerstone of the school's research. In a FDPS, the computers all do their own work, but are linked together for easy communication.

Working in distributed systems technology for the school is Dr. Martin McKendry, who is researching methods for keeping the problem solving functions of the computer network running continually.

"Right now, if you are using a computer and it fails, you lose your work," McKendry says. "We're working on a system so that if a computer fails, you won't even know it."

The method consists of breaking the job down to allow different computers to work on different parts. If one of the computers fails, another computer in the system starts it up from the beginning, and completes it.

"NASA is planning to send up a space-station and on that station the computers will have to be working on a full-time basis. Also, we've had some exposure to aluminum production plants that are so automated that, if the process stops, the aluminum-hardens and the entire plant has to be broken down and reconstructed," McKendry says.

"We're hoping to develop systems that won't break down for 20 years," he says.

Dr. Richard LeBlanc is also trying to take advantage of distributed systems. LeBlanc and his students are working on a monitor that will allow them to watch the progress of distributed programs as they work from one computer to another.

"The traditional approach to computer security has been to let a user work through a port that was accessible..."
with a password or a set of symbols. "The traditional approach has been to let the computer manage security," DeMillo says. "The problem is that the computer is such a powerful tool that there are many ways of breaking security. The military won't use it for just that reason."

In a distributed system it is possible to put a physical barrier between the different users and the system itself. "About four years ago, I suggested a way to use cryptography to scramble the information," DeMillo says. One of the results of his work in this area is a book of models of cryptographic types that can be applied for security purposes titled *Applied Cryptography, Cryptographic Protocols and Computer Security Models*, written by DeMillo in collaboration with four other cryptography and security experts.

"The only problem is that the technology needs some development," he says, "It's still relatively new."

To help students understand the ramifications of security and other legal areas that affect the computer industry, DeMillo also developed a course in computer law with Professor Pete Jensen. "It's the only course of its type that I know of in the country," DeMillo says.

"One goal we had was to give the student a minimum of computer law that they can use when they get out," he says. "The best analogy that we have for it is a course in business law. In the first class, which we held last spring, we covered everything from contracts for data processing to computer crime."

Another area which may give the school a "first" is the new program in Computer Networking and Communication Systems, being developed by Dr. Philip Enslow. "There is a growing area where computers and communications overlap," Enslow says. "We need people trained in that area."

Enslow admits that some of the motivation for starting the program was selfishness. "I don't know of anyone else in the U.S. that is teaching this, but in Europe there are a number of examples, in France particularly. I know that one of our corporate sponsors has gone to foreign consultants in the past because there was nowhere in this country that they could go for the information."

The advantage of being first in the area comes with a problem: no texts or models.

"The biggest problem is that some of these basic courses have not been taught before in an academic setting," Enslow says. "We're looking to industry to help us develop the curriculum."

Although Enslow stresses that this is not an attempt to create a degree program, he states that it is important to teach the area in an academic environment. "What people get in the field is training," he says. "The weakness is that these people never get to see the big picture. Then they have a tendency to underestimate in a given situation."

Even with that fault, Enslow is the first to admit that the faculty will have to come from industry. "We are talking about bringing company employees here as faculty as well as to do research projects."

"The most important thing, though, is to train the base," he says. "Then, we can move on to the research projects."

An area where several professors are combining their talents is in the area of chip design. Dr. Miller, Dr. LeBlanc, Dr. DeMillo, Dr. Vijayan and Professor Bruce Naylor are each working in the area of VLSI (Very Large Scale Integration). VLSI is used to put increasingly larger amounts of information on the same size chip.

Naylor is working with the idea of using automation in order to design chips more rapidly and at less expense. One of the biggest problems in chip design today, according to Naylor, is that with the amount of information being put on them, "the old techniques just don't work anymore. The answer
Dr. Ray Miller, left, director of the School of Information and Computer Science. Below, Professor Bruce Naylor.

is to use automation in the design process.

"But this leads to other things," Naylor says. "If we are going to have automation, then what is the human going to do? We want to give him something more intuitive.

"When a man designs a chip," Naylor says, "he thinks in terms of, 'I need an adder here and a subtractor here,' not in terms of 'I need some material here in order to make an adder.' With automation, he can request an adder, and the computer will do the rest."

This higher level technique should provide for very specialized chips at a very low cost.

"The man-hours needed to produce a chip drops as a result of the automation. Therefore, although the chips can't do as much, they don't have to because they're so cheap that when you are finished with them, you can literally throw them away."

Another area that Naylor is working in is in the area of three-dimensional graphics. The present technology that can produce animation and simulation using three-dimensional graphics can cost into the millions.

"In some areas, they have decided that the millions it costs to produce the images is worth it," Naylor says. "For example, flight simulators in aviation or the military seems to justify the costs. But if the technology were less expensive, you could use it in anything, entertainment obviously, but also in education.

"Any engineering that works with solids could benefit from this technology," he says.

While Naylor is working on making computers cheaper, Dr. Janet Kolodner is working on making them smarter.

In her work with AI, or Artificial Intelligence, Kolodner sums up her work by saying, "I'm trying to organize large amounts of information. We're looking at how people do it and we're trying to get the machines to do it."

One of her programs, CYRUS, was started during the term of Cyrus Vance and keeps an up to date, day-to-day account of the activities of the Secretary of State. It has continued into the term of George Shultz.

"The memory has to organize events," Kolodner says. "If you ask the computer, 'Has Vance ever been to the Soviet Union?' it looks for diplomatic trips. If you ask it, 'Has Vance ever been to the Bahamas,' then the computer looks for recreational trips. Everytime that the computer receives new information, it reorganizes its memory."

Two other programs on which Kolodner is working are called SHRINK and NEGOTIATOR. The SHRINK program is designed to be a psychological diagnostician that learns from experience. Kolodner gives the program different cases and asks the computer for a diagnosis.

"We want to look at what changes take place as a person goes from being a novice to an expert," she says. "An expert changes his whole diagnostic process as he gains expertise."

The NEGOTIATOR also learns from experience. It has been programmed with different tactics for negotiating a conflict. "It takes a conflict in terms of the two parties and their goals," Kolodner says.

"For example, two sisters want the same orange. Splitting the orange into equal parts would seem to be the best way to resolve the situation. But if one sister uses the orange peel to cook and throws the fruit away, and the other girl eats the fruit and throws the peel away, then it's not such a good solution."

"The NEGOTIATOR can look back on this case, if it is ever faced with the same situation, and ask more questions."

Kolodner has gone full circle with some of her studies. "A psychologist at Emory and I are now doing experiments with humans using the observations from our studies with the..."
machines," she said.

To work in all these research fields, of course, the school must have the hardware. And the Georgia Tech School of ICS has a hardware list that reads like an acronym festival.

The school has a DEC VAX 11/780, five PRIME computers, three IBM Series/1's, a Hewlett-Packard HP 1000/45, an HP 9845C, and two Three Rivers Perq systems.

Equipment delivered during the last year includes: an Ikonas RDS-3000 Graphics Processor and Raster Display System; a Symbolics 3600 LISP machine and a Xerox 8010 Star Information System.

Probably the most exciting equipment in terms of instruction has been the Hewlett-Packard Classroom-Laboratory system, which went into use in late 1982. The classroom was made possible by a grant from the Hewlett-Packard Company Foundation.

Dr. Lucio Chiaraviglio, who is in charge of the project, says the system, composed of 30 student workstations connected to an HP 3000/44 system, is "dedicated to instruction."

"The main advantage of having a computer aided classroom is the strengthening of the feedback loops between the concepts and the exercises," Chiaraviglio says. "If the student is having to struggle with the system, then he may lose the basic concept he is trying to learn. With the computer aid in the classroom the instructor can keep the student from being frustrated by some little hangup and reinforce the concepts to be learned.

Even with computers on the desk, Chiaraviglio maintains that the phrase "computer-supported" is very important.

"The teacher still has to teach the student the basic concepts," he says. As for the idea of requiring students to have a computer in his room, there are some difficulties.

"It's easy to go to a student and tell him, 'Put a computer in your room.' What he has then is a powerful calculator and a word processor. To make personal computers more useful a network is required and this means offering high level computer network services which is very costly and difficult."

Cost is something that is mentioned by every member of the ICS school. Many faculty members grumble about being "underfunded for the mission we are being asked to accomplish."

As a result of the cash shortage and its conflict with the push for excellence, the school is starting to cut back on its undergraduate enrollment. "We've had a 20 percent growth per year in our undergraduate classes for the last seven years," Dr. Miller said. "If we were to let that go on, there is no way that we could obtain competent faculty to train all of the students."

Miller has a paradox—the school is one of the fastest growing and also one of the youngest. Funding is difficult to come by.

"I can see how we don't really appeal to the alumni, because we don't have a lot of alumni who have graduated from the school."

"But we do have a lot of Georgia Tech alumni who understand the importance of our school," Miller says. "And we need their support."
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High Tech Profiles

Catching the Vision

By John Dunn

From the entrepreneurs who catch a vision of what could be and have the grit to turn dreams into reality, to the astute money managers known as venture capitalists who make investments in innovative concepts, Georgia Tech has its share of graduates who are making an impact in the field of high technology.

In some cases, the companies directed by these men have roots in another era, but have kept pace with changing technology. Other companies have sprung up to meet the challenges and demands of a fast-changing, expanding industry.

The profiles of the Georgia Tech entrepreneurs, businessmen and venture capitalists featured here are representative of many alumni who have recognized opportunities and are achieving success in the world of high technology.

Brook H. Byers

Brook Byers has been a general partner of Kleiner, Perkins, Caufield & Byers, a San Francisco-based venture capital partnership since 1977. He currently serves on the board of directors of six high technology companies, including Hybritech, Inc., of which he was founding chief executive.

Before joining the partnership, he was vice president and a director of Asset Management Capital Company where he also concentrated on high technology start-up investments.

 Earlier in his career, Byers held management positions in two publicly-traded growth companies which were originally financed by venture capitalists. He was also a practicing engineer in telecommunications systems for the Federal Communications Commission. Byers is a contributing author to Guide to Venture Capital.

Byers, whose brother Kenneth is also featured in this article, grew up in Atlanta and was a co-op student at Tech, receiving his degree in electrical engineering in 1968. He was active in campus life, and helped found the campus radio station “WREK.” He also participated in cross country and track at Tech. He serves on the Ad Hoc Advisory Committee for Advanced Technology Development Center. Byers also holds an MBA from Stanford Graduate School of Business.

Kenneth G. Byers Jr.

Kenneth G. Byers Jr. founded Byers Engineering in 1971 to provide engineering, drafting and mapping services primarily to the major telecommunications operating companies across the country. Eighty percent of the firm’s business is with Bell Systems companies and the remainder is primarily with the top independent telephone operating companies such as General Telephone, United and Continental. The firm also serves some of the top cable television operating companies such as Cox Cable. The firm has 425 employees.

Byers, electrical engineering 1966, MSEE 1968, is the brother of Brook Byers, EE 1968, who is also featured in this article.

Ken explained that he founded Byers Communications in 1977 to provide conduit installation services in Atlanta. While its principle purpose is construction and installation, it has design capabilities also and in some instances has grown to be a competitor with Byers Engineering.

While Ken Byers is chairman and president of privately held Byers Engineering, he serves as chairman of the executive committee and director of Byers Communications, which is traded over the counter and is called ByCom. The president of ByCom is Morgan Q. Payne, electrical engineering 1965.

Byers has been actively involved with the Georgia Tech Alumni Association. He served as a member of the Board of Trustees, 1978-81, and is a past chairman of the Alumni Association.

James E. Blahnik

James E. Blahnik, a 1958 aeronautical engineering graduate, founded Technical Software Associates, Inc. (TSA) in 1982 after 20 years of working with systems and analysis, planning and project management—especially relating to advanced aerospace systems for National Aeronautics and Space Administration, the U.S. Navy and U.S. Air Force.

During that period, Blahnik participated in several national and international mission planning and analysis groups, including the Apollo Site Selection Committee, the High Energy Laser Net Technical Assessment Group, and the Search and Rescue Satellite Aided Tracking MCC Working Group.

TSA has offices in Atlanta and St. Louis, Mo. Comparatively small, the company has 13 employees—eight of whom are Tech graduates. The firm specializes in systems analysis/development, systems requirements and trade-offs, computer simulation, system test and evaluation, systems implementation, and training.

Most of TSA’s experience as a corporate team has been applied to the area of Command, Control and Communications primarily in the development of Search and Rescue Information Processing Systems (SARIPS) for the United States Mission Control.
Brook H. Byers
Kenneth G. Byers
James E. Blahnik

Charles R. Brown
Ben Dyer
John Hayes

Center at Scott Air Force Base. The USMCC is the focal point of an international network involved in the use of satellites to assist in global search and rescue.

Charles R. Brown

Charles R. Brown is president of Technology Park/Atlanta, a 350-acre office park designed to accommodate high technology industry.

After graduating from Tech in 1962 with a bachelor's degree in building construction, Brown worked in the field of architecture for a while before entering the commercial real estate field in Atlanta. He has been president of Technology Park for the past half-dozen years and is an outspoken proponent for high technology growth and development.

Technology Park/Atlanta was incorporated by a group of private investors in 1971 after studies recommended the establishment of some form of research park populated by firms using the kinds of skills taught at Georgia Tech.

Its purpose was to halt the "brain drain" of Georgia Tech graduates who left Georgia to practice their professions, to develop an endowment for Georgia colleges and universities, and to develop an identifiable community of scientific, research, and technological organizations in Atlanta and Georgia.

There are now some 50 organizations located at Technology Park/Atlanta in 25 buildings. About 3,000 people work in the park which is projected to account for about 10,000 other jobs in the metropolitan area.

The park has also been an economic success. When the Georgia Tech Foundation, Inc. in October 1981 sold the majority of its 60 percent ownership in the park—derived through gifts of stock by the original investors—the shares had appreciated about 400 percent. The sale reduced the Foundation's ownership to about 15 percent. Denver Technological Center, partly owned by European Ferries, a half-billion-dollar shipping company based in the United Kingdom, is now the majority shareholder in the park.

Ben J. Dyer
John B. Hayes

Since their college days at Georgia Tech, Ben J. Dyer and John B. Hayes, both 1970 industrial engineering graduates, have been crossing each other's paths. During their senior year, Hayes was president of the Student Government Association, and Dyer, the IE representative, was chairman of the campus government committee and director of the Commission for SAC-70, a major SGA project.

After graduation, Dyer and Hayes also served on the Alumni Association's Committee of Twenty and were instrumental in helping generate support for the establishment of the Advanced Technology Development Center at Tech. Dyer is currently treasurer of the Alumni Association and Hayes is a member of the Board of Trustees.

After a stint with AT&T, Dyer became president of King Hardware Company in Atlanta. Hayes travelled to Washington, D.C. to serve as an aide to Senator Herman Talmadge. In 1976 Hayes, who had returned to Atlanta to study law at Emory University, was assisting a group of Georgia Tech graduate students in the formation of a microcomputer software distribution company. He introduced Dyer to them, and the eventual result was Peachtree Software, Inc., a nationally recognized supplier of applications software.

"John was the matchmaker that brought all of this together," said Dyer. Hayes, however, left the firm to complete his Juris Doctor degree from Emory University School of Law in 1977. He later became vice president and general counsel for E-Tech in Atlanta.

In September 1983, seven years after stepping in to provide entrepreneurial leadership at Peachtree Software, and two years after it was sold to Management Science America (MSA), Dyer has stepped down as president of the firm to start up another high tech company. Not surprisingly, perhaps, his partner is John Hayes.

The firm Dyer and Hayes have established is COMSELL, an "incubating" company in the Advanced Technology Development Center at Tech.

"When we were working to get the ATDC established, I never imagined I'd have a high tech company getting started there," said Hayes. The company will remain at the ATDC only during the planning process.

COMSELL will apply interactive videodisc and microcomputer technology to specific vertical markets, Hayes said.

James C. Edenfield
Thomas L. Newberry, Ph.D.

James C. Edenfield, a 1957 industrial engineering graduate, and Thomas L. Newberry, who received his bachelor's, master's and doctoral degrees from Tech in industrial engineering, combined forces in 1970 to found American Software, Inc.

Edenfield is president, co-chief ex-
ecutive officer, treasurer and a director of the company. Dr. Newberry, who incidentally was awarded Tech's first PhD in industrial engineering in 1961, is chairman, co-chief executive officer, secretary and a director of the company.

Both Edenfield and Newberry formerly held executive positions and were directors of Management Science America before forming American Software, Inc.

The two started as the company's only employees, but by the end of the first year, they had hired another employee and sales revenues amounted to $120,000. The company now has 160 employees and at the year ending April 30, 1983, American Software had sales revenue totaling $16.09 million, almost double the $8.7 million of the previous year. Net earnings increased 415 percent in 1983 over the previous year.

Dr. Newberry was featured in the July 1982 issue of *Industrial Engineering* magazine as one of the 10 industrial engineers "who have the right stuff to make it to the top."

Newberry told the magazine, "Through the careful evaluation of costs and benefits, we've been able to build the company to its present size without any external financing, including bank borrowing. Our annual sales increases have averaged 50 percent, and we've made a profit every year since we started."

Fiscal 1983 also marked a 30 percent increase in the company's sales staff, and a 50 percent growth is projected for 1984.

**William M. Graves**

William M. Graves, one of the handful of men who helped found the company that is now Management Science America (MSA) in 1963, has been with the firm through the hard times and the good times during the intervening 20 years.

Graves is president, chief operating officer and director of MSA, the Atlanta-based company, a leading supplier of application software for microcomputers.

Graves controls all operations of MSA, with 1982 revenues of more than $100 million and more than 1,400 employees worldwide.

After graduation from Georgia Tech—he received a bachelor's degree in mathematics in 1960—Graves worked with the Georgia Tech Research Station.

In January, 1963, he and several other members of Operations Research, Inc., purchased the Atlanta office from ORI and founded the original firm of MSA, which then stood for Management Science Atlanta. From 1963-68, the company specialized in computer control systems for textile and garment industries. Graves became vice president in 1968, executive vice president in 1972, and president in 1979.

**Dennis C. Hayes**

Dennis C. Hayes is president, treasurer and founder of Hayes Microcomputer Products, Inc., Atlanta, one of the industry's leading telecomputing equipment suppliers.

Hayes gained experience in microwave transmissions, relay and electronic switching and computer programming, while in the co-op program at Tech working for AT&T Long Lines. A member of the class of 1973, Hayes majored in physics.

Hayes worked for Financial Data Sciences and later for National Data Corporation as a network management engineer with responsibility for managing the operations of NDC's nationwide communications staff.

In 1977, Hayes recognized the need for modems (modulator demodulator) converting computer signals to acoustical signals for use of telephone lines.

Hayes built his first modem on his dining room table in 1977. He told *Personal Computing* magazine in its February, 1983 issue, "I was frustrated by the lack of good available equipment to do the kinds of communicating people wanted to do on any level of computing. . . . The company actually started on my home dining room table, where we put the boards together. Before I knew it, it took over the whole house, and we had to move out. We moved into our first full-scale manufacturing facility in April, 1978."

The firm has now developed 300- and 1200-baud modems—the Smartmodem and Micromodem lines—as well as increasingly sophisticated computer-communications software to power telecomputing.

**John P. Imlay Jr.**

John P. Imlay Jr., chairman of the board and chief executive officer of Management Science America, Inc. (MSA) has already proven himself to be "something of a legend" in the computer software industry.

Imlay is credited with taking MSA from the brink of financial disaster and rebuilding it into the world's largest independent applications software company, headquartered in Atlanta.

A 1958 industrial management graduate of Georgia Tech, Imlay joined MSA in 1970 as chairman and CEO.

According to *Money* magazine, February, 1983, in 10 years, Imlay transformed the company which had a loss of $7 million on $9 million in sales in 1970 to one with 1981 revenue of $73 million and earnings of $5.5 million. His first move was to reorganize the company under Chapter X bankruptcy proceedings. He then slashed the staff to a bare 50, firing several hundred employees, and began developing a strong marketing and sales force.
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Imlay is a motivator, and his staff sales meetings also convey legendary qualities. The first year out of bankruptcy, Imlay had $1 million in cash delivered to the sales meeting as incentive for his sales force to reach a million dollar sales goal. At another meeting, he brought a live tiger to the session to emphasize the need for fearlessness and perseverance in reaching company goals.

In 1981, International Computer Programs, Inc. (ICP) named Imlay one of the 15 people who will influence the computer industry the most in the next five years. In 1982, Technology magazine cited him as one of the 100 people who was instrumental in promoting important technical advances during the preceding 12 months.

In 1981, MSA went public, and Imlay purchased another Atlanta firm, Peachtree Software, Inc., which produces software pages for IBM's personal computer. The firm currently has more than 1,100 employees.

Gene Milner

During its 50-year history, Lanier Business Products, Inc., of Atlanta, has found its success in keeping pace with current technology.

Lanier started out selling dictation equipment and has evolved with the market to feature word processing equipment and most recently, desk top computers.

Gene Milner, class of 1949, purchased interest in the partnership of Lanier Company in 1954 and became president in 1967. In 1977 Lanier Business Products was listed on the New York Stock Exchange and Milner was named chairman.

Under Milner's management, Lanier has grown from a volume of $12 million in 1966 to $183 million in 1979. In recent times it has enjoyed a sales volume exceeding $450 million.

According to Financial World, Milner, who has continued to be a hard-driving salesman as well as chairman, established a no-tech strategy in a high tech market and built up an aggressive sales force. What Milner did was obtain word processing equipment from Lanier's 37 percent-owned Canadian subsidiary, Automatic Electronics Systems Data, Ltd. AES supplied the technology and Lanier sold it. The strategy worked extraordinarily well at first, and Lanier was an early leader. But when competitors introduced advanced word processors and then personal computers, Lanier was caught technology shy.

Within the span of 15 months, however, Lanier responded with the introduction of two new word processing units. In October, 1983, Lanier entered the market of desk top computers with the Lanier Business Processor which includes an optional package that allows it to run most IBM Personal Computer software.

Lanier has also announced that it intends to merge with Melbourne, Florida-based Harris Corp.

Milner served as a member of the Georgia Tech Alumni Association Board of Trustees from fiscal years 1980-83.

Charles A. Muench

Charles A. Muench, chairman and chief executive officer of Atlanta-based Intelligent Systems Corp., was working on his doctorate at Tech when he and others designed a color graphics terminal for use in the electric utility industry.

In 1973, he was one of the two founders of Intelligent Systems Corp., which now acts as a holding company for other firms that make microcomputer accessories and software, ink-jet printers and small office computer systems.

In October, 1983, Muench, a 1966 electrical engineering graduate of Tech, was named the Atlanta High Technology Venture Capital Conference's first "High Tech Entrepreneur of the Year."

Muench, who at various times has also served as vice president and secretary of Intelligent Systems Corp., has been responsible for research and development since the company's beginning.

The product line has expanded from color terminals to a complete line of color graphic desk top computers—including a color graphics workstation equipped with all hardware and software to prepare presentation quality color graphic visuals.

Intelligent Systems Corp. became a publically owned company on December 31, 1980. Two years later, the company acquired Quadram Corporation, a microcomputer accessory computer company, and in February, 1983, Intelligent Systems Corp. acquired Datavue Corporation of Seattle, Washington, a firm which manufactures and markets desk top computers and peripherals.

Morgan Q. Payne

Three years ago, Morgan Q. Payne became president of the firm that is now Byers Communications, Inc., a firm on the leading edge of the growing telecommunications industry.

Payne, a 1965 electrical engineering graduate, began his career with IBM and then joined the investment firm that is now Robinson Humphrey/American Express Inc. In 1979 he became a partner in Byers Communications Systems, Inc., BYCOM and serves as president.

The firm was founded by Tech graduate Kenneth G. Byers Jr., who had also founded Byers Engineering, a privately owned company. Byers Communications had been a privately held company until its merger with Redfern Foods, a public company traded over-the-counter, on June 10, 1983. Because the former shareholders of Byers emerged with controlling interest in the post-merger company, the transaction
Create computers that capture the mysteries of common sense.

The brain does it naturally. It wonders. It thinks with spontaneity--advantages we haven't been able to give computers. We've made them "smart," able to make sophisticated calculations at very fast speeds. But we have yet to get them to act with insight, instinct, and intuition.

But what if we could devise ways to probe into the inner nature of human thought? So computers could follow the same rationale and reach the same conclusions a person would.

What if we could actually design computers to capture the mysteries of common sense? At GE, we've already begun to implement advances in knowledge engineering. We are codifying the knowledge, intuition and experience of expert engineers and technicians into computer algorithms for diagnostic troubleshooting. At present, we are applying this breakthrough to diesel electric locomotive systems to reduce the number of engine teardowns for factory repair as well as adapting this technology to affect savings in other areas of manufacturing.

We are also looking at parallel processing, a method that divides problems into parts and attacks them simultaneously, rather than sequentially, the way the human brain might.

While extending technology and application of computer systems is important, the real excitement and the challenge of knowledge engineering is its conception. At the heart of all expert systems are master engineers and technicians, preserving their knowledge and experience, questioning their logic and dissecting their dreams. As one young employee said, "At GE, we're not just shaping machines and technology. We're shaping opportunity."

Thinking about the possibilities is the first step to making things happen. And it all starts with an eagerness to dream, a willingness to dare and the determination to make visions reality.

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is accounted for as a reverse purchase acquisition as though Byers had issued shares for the net assets of Redfern. Accordingly, the operating history of Byers became the operating history of the newly merged companies.

In August of 1983, Byers Communications acquired the majority interest in EnCom Systems, Inc., a newly organized Atlanta company specializing in system engineering and design services to the satellite communications industry.

BYCOM, listed on NASDAQ, provides systems integration and installation for cable television operators, common carriers and private networks. Services include engineering design, equipment selection and procurement, management, installation, testing, and maintenance.

**Parker H. Petit**

In June, 1970, Parker H. Petit's second son, a six-month old infant, died of Sudden Infant Death Syndrome, better known as crib death. It was a stunning tragedy that changed Petit's life.

Program manager at Lockheed-Georgia Co. at the time, Petit pronounced petite), who received his bachelor's and master's degrees in mechanical engineering at Tech, began working on a device to monitor the breathing and heart rates of infants. After consulting with some electrical engineers at Tech, and nine months of work at nights and on weekends, two products were developed—a respiration monitor and a heart monitor.

Petit quit his job and with four other men, pooled $60,000 to form Healthdyne in 1971. Then he struggled to ensure the new company would survive, including refinancing his home to raise money to invest in the company. It was 1975 before the firm became profitable.

Petit is chairman of the board, president and chief executive of the company. Healthdyne established three major product lines: the infant monitor, the oxygen concentrator and hospital products.

The Marietta-based medical high technology company has for the past six years reported 100 percent growth in revenues and profits through the year ending April 1982.

During the past year, Healthdyne took over much larger Narco Scientific Inc. of Fort Washington, Pa. and changed its fiscal year from April 30 to a calendar year.

Healthdyne is now emphasizing its home health care services division, an area that analysts predict to have much potential. The firm is now able to provide a full range of home health care services.

The home health care market totaled $5.28 million in 1981, and is projected to total more than $9 million in 1985 and $16 million by 1990.

**Glen F. Robinson Jr.**

Glen F. Robinson Jr. is chairman and founder of E-Tech, Inc., a company that develops and manufactures energy saving products. Its best known products are water heating pumps for commercial and residential markets.

Robinson, who received his bachelor of science (1948) and master of science (1950) degrees at Tech in physics, is also one of the founders of Scientific-Atlanta, Inc., one of the nation's major telecommunications and instrumentation companies. In 1951, Robinson and six other Tech engineers invested $100 each and founded Scientific-Atlanta. Robinson served as president of the company until 1971 and as chairman until 1978.

Robinson developed an interest in energy conservation and the technology of conserving energy, and in 1978 founded E-Tech, named for energy technology. And, as Robinson explained in an interview with the press, "I personally like the freedom of a smaller company, a private company."

Robinson also brought into the firm a top team of managers, engineers and sales representatives.

In 1981, Robinson was named "Entrepreneur of the Year" by the Georgia Business and Industry Association.

E-Tech has recently introduced a round pool heater to its product line. The company said the new pool heater can save 78 percent over electric resistance and 56 percent over liquid petroleum gas pool heating.

Robinson holds 24 patents in the fields of solar energy, antenna systems and energy management. He has published several papers in nuclear physics and antenna design.

He currently serves as chairman of the Georgia Tech Research Institute, is a trustee of the Georgia Tech Foundation, Inc., and is a former trustee of the Georgia Tech Alumni Association.

**E. Roe Stamps IV**

E. Roe Stamps IV is a partner in TA Associates of Boston, Mass., the largest venture capital investment company in the United States.

Stamps, who received his bachelor's degree (1967) and master's (1972) in industrial engineering at Tech, is responsible for risk capital financing for established companies, including leveraged buyouts and for the Direct Investment Programs.

In addition to his Tech degrees, Stamps received a master's degree in business administration (with honors, 1974) from Harvard Business School. Following graduation, he was employed by The Palmer Organization and later joined the First Chicago Investment Corporation where he became a senior investment manager. He then joined TA Associates.

TA Associates, established in 1967, has approximately $400 million in risk capital under management. The firm has 16 professionals including eight partners and officers in Boston, Mass. and Palo Alto, Calif.
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Norma Rae Doesn’t Work Here Anymore

By Gene Griessman

Albin Turbak, Georgia Tech’s Dean of Textile Engineering, and one of the nation’s leading inventors, sounds like a sawdust-trail evangelist these days. He is telling everyone within earshot that fresh winds are sweeping through the textile mills of America, blowing out lint, fumes, and the ghost of Norma Rae.

Turbak is finding to his disappointment that some people won’t listen. The textile industry has gotten bad press for years—some of it deserved—so the stereotypes of brown lung, low wages, worker exploitation, and labor strife still persist.

“All that is changing,” Turbak says, “thanks to new technology.” Indeed, several state-of-the-art textile mills are already in operation, and in many others, conversion will take place as soon as older looms and spinning frames are fully depreciated.

Even the sounds of the new mills are different. The clackety-clack of the weaving rooms has been replaced by hisses from jets of water and air in shuttleless, ultra-high speed looms that spit out fabric at velocities unhead of even 10 years ago. The old sounds soon will be old memories, like train-whistles in the night and calliopes.

The new looms squirt thread across the frame in a jet of water, or air, at a velocity of up to 600 “picks” a minute. Until about 10 years ago, 220 “picks” a minute was the norm. “It’s fantastic, it’s quiet, it’s clean, it’s a revolution,” Turbak says. “It’s an explosion of technology the textile industry hasn’t seen for the past hundred years.”

Millworkers, who used to be called “lintheads” by their “betters” now work in lint-free environments, thanks to a new device known as an “air vey.” A process known as open-end spinning has eliminated three stages in the spinning of yarns. And robots are coming too.

What these changes will mean for workers is better working conditions and higher pay—for those who survive the layoffs. Layoffs there will be; in fact, they have already begun. A report just released by a blue-ribbon panel of the National Academy of Engineering, and headed by one of Turbak’s colleagues at Georgia Tech, Dr. W. Denney Freeston, Jr., associate dean of the College of Engineering, predicts that as many as 400,000 manufacturing employees, mainly in apparels, could lose their jobs by the end of the decade. Everybody seems to agree that the textile workers who survive will be those who acquire new skills.

It is ironic that the textile industry, which was the first to automate—with the Jacquard loom in the early nineteenth century—also produced the revolts that gave us a name for an anti-technologist: a Luddite. The Luddites were English workers between 1811 and 1816 who smashed labor-saving textile machinery. The name came from Ned Lud, a feeble-minded man who smashed the frames belonging to a Leicestershire employer around 1779.

It is Catch-22 time for the textile workers: if the mills go with the new technology, there will be layoffs; if the mills don’t convert, many of them will have to close. The competition from textiles produced abroad with cheap labor makes the shift mandatory for American plants. The other alternative is trade barriers.

The United States, which once was the world leader in textile machinery, has now slipped behind Japan, Germany, Switzerland, and Italy in many fields. Turbak urges tax breaks and grant money from the states where textile employment is high, and from the federal government to spur research and development in the new technology. His idea is to take five cents from every dollar already collected from the textile industry and reinvest it in high-tech research. “If we don’t invest in research, we won’t kill the goose that lays the golden eggs,” Turbak laments, “we’ll just let the goose die of malnutrition.”
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High Tech Centers

Exploring, Coordinating Cooperative Research

By Jill C. Sewell and Pam Rountree

The diversity of research conducted at Georgia Tech is exemplified by its 17 centers of research, which Vice President for Research Dr. Thomas Stelson defines as “relatively small, flexible, exploratory units, whose primary function is to coordinate and stimulate cooperation in areas of interdisciplinary and emerging research.”

The centers work with Tech’s other organizational units—schools (and departments), which are organized along lines of academic disciplines in traditional form, and the eight laboratories of the Engineering Experiment Station, which are organized by functional objectives. The Centers are coordinated by the Office of Interdisciplinary Programs.

“The success of a center has as a primary goal the improvement of the schools and laboratories that relate to the center,” Stelson explained. “Because of their small size and flexibility, centers are created with far less resources and detailed planning.

“In short, research centers are the cutting edge of organizational development at the Georgia Institute of Technology.”

Tech’s centers of research are the Microelectronics Center, the Research Center for Biotechnology, and the Center for Research in Writing (featured individually in this issue), the Bioengineering Center, and those explained below—the Material Handling Research Center, the Technology Policy and Assessment Center, the Georgia Productivity Center, the Computational Mechanics Center, the Fracture and Fatigue Research Laboratory, the Center for Rehabilitation Technology, the Center of Excellence in Rotary Wing Aircraft Technology, the Center for Architectural Conservation, the Environmental Resources Center, the Georgia Mining and Mineral Resources Institute, the Health Systems Research Center, the Frank H. Neely Nuclear Research Center, and the Center for Radiological Protection.

The Material Handling Research Center

With a new laboratory equipped with approximately $600,000 worth of equipment donated by Litton Unit Handling Systems in Florence, Kentucky, the Material Handling Research Center is well underway. The equipment donation was arranged by Litton’s UHS subsidiary president, Gordon Palmer, Industrial Engineering 1957.

The center’s aim is to conduct basic and applied research in increasing productivity in the handling, storage and control of materials. Materials in this case refers to raw materials, work in process, and finished goods inventory, according to center Director Dr. John A. White of the School of Industrial and Systems Engineering. However, the scope of the center’s activities does not include bulk materials handling.

“With the increased emphasis on factory automation, warehouse automation, and logistics, it is apparent that innovative approaches to handling, storing and controlling material will be required,” White said.

Based on efforts supported by a National Science Foundation planning grant, the need within U.S. industry for an autonomous, university-based center devoted exclusively to those needs was determined. The center was established in October 1982, funded in part by a five-year, $700,000 NSF grant, with first year funding totaling $200,000. That funding is supplemented by its 23 member companies which pay annual membership fees of $30,000, as well as $200,000 in internal support from Georgia Tech.

“We believe that the presence of the Material Handling Research Center had a positive influence on IBM in its decision to award Tech the $2 million curriculum grant to support computer-aided manufacturing,” White said. “So, the benefits to the Institute are already being felt, because U.S. industry has recognized that Georgia Tech made a commitment and has strong capabilities in the areas of automation in manufacturing and distribution.”

The new laboratory equipment from Litton is housed in the School of Industrial and Systems Engineering’s new building on Ferst Drive.

The Technology Policy and Assessment Center

The Technology Policy and Assessment Center was formed in 1981 to undertake policy-related research involving significant social, economic and institutional elements, as well as technical and scientific components.

According to Dr. Frederick Rossini, director of the TPAC, the center “is a cross-disciplinary unit,” and includes faculty members from each academic college and the Engineering Experiment Station.

Because policy-related research in technology and science cuts across academic and professional disciplines, the center uses the interdisciplinary teams in its research work to get a clearer perspective for study of the many components of complex issues.

Two of Rossini’s goals for the center are to “generate interesting cross-disciplinary research projects and develop horizontal communication within the Institute.” He is interested in both the center’s “intellectual and research development.”

There are presently three major projects underway at the center. These are the Impact of Office Automation on

Jill C. Sewell is assistant director of the Georgia Tech News Bureau and managing editor of The Whistle, the Institute newspaper. Pam Rountree is contributing editor of The Whistle.
"Research Centers are the cutting edge of organizational development at the Georgia Institute of Technology."

Dr. John A. White, director of The Material Handling Research Center.

Office Workers for the U.S. Department of Labor, the Development of Strategies of Mitigating Earthquake Hazards to Existing Structures in the Southeastern U.S., and the Review of Performance of Interdisciplinary Research for the National Science Foundation.

Major areas of expertise being studied by the center are technology and impact assessment, technological innovation and diffusion of innovations, cost benefit analysis, socio-economic development, research and development policy and management, energy and environmental policy, technology and social forecasting, and interdisciplinary research processes.

The center is also interested in networking and involving graduate students in its research. Graduate students from the School of Social Sciences’ Technology and Science Policy Program, the Colleges of Architecture and Management, and the School of Industrial and Systems Engineering, have been involved in the center’s research. Several theses have been produced as a result of their work.

The Georgia Productivity Center

In 1975, the Georgia General Assembly designated Tech’s Engineering Experiment Station as the Georgia Productivity Center, thus making Georgia the first state to formally establish such a center to encourage business and industrial productivity.

Working through the Industrial Extension Division of the Engineering Experiment Station’s Economic Development Lab, the center’s mission is “to contribute to the economic development of the state, region and nation by providing assistance, education, and applied research for the improvement of public and private sector industry,” explained Center Director Rudy Yobs.

“The center acts as an umbrella over a number of service related areas within EES,” said Rich Combes, chief of the Industrial Extension Division.

Innovation, research and development, safety and environmental counseling, and human resources are the four major areas of the Georgia Productivity Center’s responsibilities. Through the Engineering Experiment Station’s eight area field offices located strategically throughout Georgia, the center’s work is...
carried out by approximately 110 full-time professionals and 35 full-time support staffs.

The center's Industrial Energy Extension Service, Safety and Health Consultation Service and the recently implemented Hazardous Waste Consultation Service provide valuable guidance to Georgia business and industry.

Last year, the Industrial Extension Division provided technical assistance to companies in more than 900 cases, either by actual hands-on experience, or through information given over the telephone, says Robert Hawkins, assistant to Combes.

Until 1982-83, no funds were earmarked specifically for the Georgia Productivity Center by the legislature, and the center operated with funding from contracts and State funds allocated to EES for conducting field service. Now, in addition to federal and state grants, the Georgia Productivity Center receives $100,000 a year from the General Assembly. The work of the center currently includes four major projects:

- Productivity measurement and improvement projects—projects for small to medium-size businesses (under 200 employees).
- Specific evaluation of advanced manufacturing technologies for medium-size firms—the center goes into the companies to conduct an engineering evaluation in implementing such technologies as robotics, computer-aided design and manufacturing, and automated material handling.
- Production of bulletins on generic technological topics—the center has published bulletins on robotics, computers and other relevant topics, and is currently preparing information on automated process control.
- Workshops on productivity technology topics of general interest to Georgia industry—topics include robotics and computers, and one currently being prepared on automated process control.

The Computational Mechanics Center

Another of Tech's top centers for research is the Computational Mechanics Center, begun in December 1979, and directed by Dr. S. Atluri, Regents' professor in the School of Civil Engineering.

"The center was formed to become a focal point for research in the application of mechanics with the aid of high speed digital computers," Atluri says. "Basically, the center disseminates its research through a variety of archival publications, which will be made available upon request."

Among the center's projects are the study of mechanics of fracture in metals and composites; dynamic crack propagation and arrest in ship hull structures; behavior of components in the hot section of modern jet engines and control of large space structures, such as two square mile space stations; large antenna; and the analysis of fluid flow problems.

"The analysis of any structural or fluid system is fairly complicated," Atluri explains, "and cannot be accomplished analytically. So, the use of high speed digital computers is mandatory in analyzing or synthesizing a large system.

"The research in computational mechanics plays a fundamental role in analyzing and synthesizing systems and/or modeling manufacturing processes themselves."

The Computational Mechanics Center's research is funded by the National Aeronautics and Space Administration, the National Science Foundation, the Air Force Office of Scientific Research, the Office of Naval Research, the Nuclear Regulatory Commission, Wright Patterson Air Force Base, and other agencies.

It has a staff of approximately 20 people, including research and instructional faculty and graduate research assistants.

The Fracture and Fatigue Research Laboratory

The Fracture and Fatigue Research Laboratory was established in May 1978 and exists within the Metallurgy Program of the School of Chemical Engineering.

The laboratory, according to its director, Dr. Stephen D. Antolovich, "is primarily an interdisciplinary entity directed towards the solution of problems in fracture and fatigue of materials."

Faculty members from various academic schools and members of the Engineering Experiment Station are involved in the laboratory's activities.

The interdisciplinary research encompasses the behavior of a wide range of materials, including metals, polymers and composites.

Over $300,000 has already been awarded to the FFRL for research and equipment this year by industrial and governmental units. Sponsors include Oak Ridge National Laboratories, the U.S. Air Force, The National Aeronautics and Space Administration, and General Electric. Students working on these grants and contracts and educated in the FFRL and various academic units at Tech frequently take positions as research scientists and professors in prestigious laboratories and universities in the United States and abroad.

"The FFRL is already one of the three best academic fracture and fatigue research centers in the United States," Antolovich said.

Antolovich has also set several objectives for the program. These include:
The Hayes Challenge

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further developing the interdisciplinary nature of the laboratory and broadening the areas in which fracture and fatigue research can be carried out; providing a framework in which education of graduate students can occur at the forefront of science and technology; interacting broadly with industry and government agencies in solving practical problems; and further increasing its recognition as a national and international leader in meeting these goals.

The Center for Rehabilitation Technology

Approximately 14 percent of our population has some degree of serious disability, and at any given time, some 75 percent of our population has a temporary disability which requires aid, whether for a back strain, broken leg, sprained wrist, or other physical injury.

Because of these statistics, Tech created the Center for Rehabilitation Technology in December 1980. The center "brings the mainstream of engineering and architecture together to meet the needs of disabled persons in recognition of the increasing age of our population," explained Richard L. Martin, director of the CRT and professor in the College of Architecture.

"With the increasing age of our population, more and more people are in need of assistance to help them function with their disabilities," Martin says. "The general population is growing more aware of the needs of the disabled."

"The problems of being disabled are the problems of a majority, not a minority, of our population," he said. "And ones that we can expect as we get older. Disabled persons need technology, even more than the average person, whether it be a cane, a hearing aid, improved vision, a wheelchair, or special ramps.

"They need some type of physical improvement through the application of technology," Martin added. "The population needs it and we at Tech can provide it."

The Center for Rehabilitation Technology brings "an organizational focus" to the ideas and technologies for assisting the disabled. Through a combination of public and private funds, a core staff of six, some involved only on a part-time basis, administer the center. The staff is funded in part by the Georgia Department of Human Resources, while funding also comes from private sources on a project-by-project basis.

One of the organizations the CRT assists is the Roosevelt Warm Springs Institute for Rehabilitation. The center is a source of technical assistance and engineering services, and "working back through the CRT, Warm Springs will become an important cooperative institution for Georgia Tech," Martin said. Then Tech engineering interns will be able to use the facility for research projects.

One of the center's hottest concepts right now is Universal products—"those products and devices that serve disabled persons, but are also of benefit to able-bodied persons," Martin explains. Among these are the Universal House and the Universal Kitchen—"construction systems which allow a home or kitchen to be economically adapted to meet the needs of disabled persons, and serve the desires of able-bodied persons"; the Universal car—"a low-cost auto that can be produced simply in kit form, and can accommodate a wheelchair"; and the Universal Hotel—for which the CRT is developing a set of standards, using the 300-room Midtown Howard Johnson's on 10th Street next to the Tech campus as an on-going laboratory for accommodating disabled and able-bodied persons. The center hopes that one day its building standards will be recommended for use in all hotels.

The center has developed prototypes for the Universal projects, and through its private corporation, CRT Inc., headed by Bob Ferst, Mechanical Engineering, 1938, it seeks out individuals or companies interested in commercializing their products.

"We're not just doing these (prototypes) on an academic basis to have them just sit here," Martin stressed. "We want these things to get onto the market to be of direct benefit to people."

The CRT also serves as a clearinghouse of information for the disabled, relatives and friends of disabled persons, and businesses that want to know how to accommodate the disabled on a personal and business basis. With the implementation of its national information and consulting system, TechKnowledge, for a modest fee the center answers questions dealing with technology and disabilities. Questions should be directed to (404) 894-3476.

The Center of Excellence in Rotary Wing Aircraft Technology

The Center of Excellence in Rotary Wing Aircraft Technology was formed in July of 1982, and is "supported by the United States Army Research Office through an award of $5.8 million for five years," according to the center's director, Dr. Robin Gray.

The Tech proposal was ranked number one in the area of helicopter technology, and along with those of two other universities, was chosen by the U.S. Army for funding.

The Army's award will enable the center to produce more research in helicopter technology and more comprehensive training for engineers in the field.

In addition said Gray, "the award will pay for course, research and facility development, as well as facilities for testing and new equipment." Fellowships and research assistantships are also
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“The success of a center has as a primary goal the improvement of the schools and laboratories that relate to the center.”

provided for in the award.

The center will also be offering M.S. and Ph.D. degrees as part of its program. Degrees will be available in three areas: aerodynamics, aeroelasticity and structural dynamics.

Facilities and equipment to be used in the programs includes a laser Doppler velocimeter data acquisition system, a structural dynamic system identification facility, a nine-foot wind tunnel facility, and a 16-foot rotor-test facility, among others.

The Center for Architectural Conservation

In just 10 months, teams in Tech’s Center for Architectural Conservation have combed 1.5 million square feet, inspecting 1,000 buildings in 44 national parks from the Everglades to Maine, to Alaska, to Hawaii on a research project for the U.S. National Park Service.

The teams are “looking at all features of the buildings” leased by concessionaires—cabins, historic lodges, motels, restaurants and privies, “to develop a building inventory program for the NPS so it can identify and keep track of all of its property in national parks,” said John Myers, who directs the center. “We have been very fortunate to work with an agency like the NPS which is very progressive in managing its buildings.”

The information gathered is then put into a computer so that the NPS has immediate access to information on all of its properties. “The idea is that all information is in an electronic data base,” Myers said.

Legislation approved in January 1983, the Visitor Facility Fund, went into effect at the end of September and provides money for improving national park buildings. The law diverts concessionaires’ money back into the National Park Service for improvements, and will be in effect for five years, according to Myers.

Previously, money for building upkeep came from the NPS or concessionaires’ franchise fees. However, Myers said the Visitor Facility Fund is “a special fund over and above their regular operating budget.”

One of the center’s most important tools is the Mobile Resource Lab, a retrofitted, 26-foot, “very efficiently designed mobile architectural office” with an IBM personal computer and Motorola Data Link which can communicate with other personal computers. Teams using the van in their research stay out for four to six weeks at a stretch, and input their findings directly into the computer in draft form to the Park Service, which in turn makes its comments before the data is finalized.

Other computers involved in the project are located at the center on the Tech campus, in the Washington Park Service office, in the Southeastern Regional Office of the Park Service, and in a “typical national park,” Mammoth Cave, Kentucky.

The center’s staff is made up of approximately 10 research faculty and five graduate research assistants.

The Environmental Resources Center

The Environmental Resources Center was established in 1970 as the successor to the Water Resources Center, in operation since 1963.

The Department of the Interior provides funding and program guidance for water resources research to the Center, which manages individual projects at various schools in Georgia, according to ERC Director Bernd Kahn.

The water research program is developed in coordination with the state water resources management agency, the Environmental Protection Division of the Georgia Department of Natural Resources.

Water research projects for fiscal year 1983-84 include studies of the use of existing wells as supplemental municipal water supply and the effective use of cooling lakes and cooling towers in hybrid cooling systems, among others.

A second field of research is environmental radiation monitoring. The Center operates a laboratory that performs radioactivity measurement around nuclear facilities and in community water systems for the state environmental radiation protection agency. It also undertakes research concerning the movement of radionuclides in the environment.

The Georgia Mining and Mineral Resources Institute

The Georgia Mining and Mineral Resources Institute was formed in 1978 and was designated by the U.S. Department of the Interior, Office of Surface Mining in 1979. In 1982 the program was transferred from the OSM to the Bureau of Mines.

The GMMRI has placed its emphasis on stimulating “education and research for the mineral industries of the state of Georgia and the southeastern U.S.,” according to Dr. John Husted, director of the Institute. Enrollment in mineral engineering courses, said Husted, “has approximately doubled in two years” as a result.

This fall the program will fund three doctoral candidates with fellowships, one each in the Schools of Civil, Ceramic and Chemical Engineering.

In addition, there has been spending “in excess of $100,000 for new laboratory facilities and equipment,” said Husted.

Graduate research sponsored by GMMRI includes such projects as pit stability in kaolin mines and the improvement of recovery, quality and efficiency in production of low carbon steel in the electric furnace.

Faculty research includes the
microporosity of surfaces and the study of the structure of kaolin crystals and their relationship to obtaining aluminum from kaolin, among others.

**The Health System Research Center**

The Health Systems Research Center was established in 1969 by the Board of Regents of the University System of Georgia and is now a part of the School of Industrial and Systems Engineering.

According to Dr. Harold E. Smalley, the center's director, it was established as an interdisciplinary and interinstitutional program of health systems "research, community outreach and continuing education." The center is associated with a health related academic program begun at Tech in 1958.

The center closely interacts and collaborates with individuals, agencies and groups involved in the management of health care delivery. According to Smalley, the general aim of the center is to develop and apply strategies to improve the productivity of health services.

**The Frank H. Neely Nuclear Research Center**

A new method for treating brain cancer using radiation from the five megawatt nuclear research reactor in the Frank H. Neely Nuclear Research Center is one of the current research projects.

The reactor, completed December 31, 1964, and the adjoining laboratory building, were constructed "for the education of future nuclear engineers, the training of reactor operators for utilities in the Southeast, and for research into cancer therapy and other technologies," said Center Director Dr. John Russell.

Funded "partly by service to industry, partly by Georgia Tech for its educational benefit, and partly by federal grants," Russell said the center's researchers also radiation-test equipment for certification for use in high radiation areas in industry. They're also "just beginning a project to use neutron radiography to do basic work in measuring how pipes crack under stress." The pipes under study are the large, high pressure pipes used in industrial applications.

The Nuclear Research Center also works closely with the Medical Research Foundation (which is funded through the Georgia Department of Human Resources, other universities and private donations and is housed on the Tech campus) on other cancer therapies.

**The Center for Radiological Protection**

The Center for Radiological Protection was formed in 1977 to help coordinate research and training in Health Physics, according to its director, Dr. Melvin W. Carter.

Currently, the center is involved with research on a contract for the U.S. Environmental Protection Agency. "We are involved with the health and environmental effects of synthetic fuels," said Carter.

The center is also associated and works closely with the Environmental Radiation Laboratory which conducts research and provides support for faculty research programs for the School of Nuclear Engineering and Health Physics.
After years of rapid technological and scientific advancement, American society has now reached a predictable stage in its development: "Scientists and engineers can generate vast amounts of information because of high technology, but their ability to manage this information typically lags behind their ability to generate it," according to Dr. Joan Pettigrew. As the new director of Georgia Tech's Center for Research in Writing, Dr. Pettigrew bases her assessment on the extensive investigations and observations of researchers in several academic disciplines, in industry, and in government. Since its inception in 1975, the Center has worked to make this highly specialized information accessible and usable for both the business and the academic communities.

The Center for Research in Writing recognizes the importance of effective communication skills and is working to alleviate many writing problems. "We attempt to stay on top of the current research and to use that body of research to solve writing problems," said Pettigrew. Because the research comes from such diverse sources—cognitive psychology, business and industry, neuro-linguistics, military and government studies, and psycho-linguistics—it is not yet systematized. The Center aims to be a clearinghouse for this specialized information.

Once writers become aware of the results of various studies, they can begin immediately to use much of the available information. For example, Pettigrew explained, "most readers now do not read articles all the way through; we're all busy and usually skim or scan. We know that sentences longer than 22 words can be difficult for the average person to channel. We know that people remember what comes early in a document rather than what comes later." These considerations can be easily used to improve the readability of a document. To help students refine their writing skills in other ways, the Center investigates methods for managing information, designing more readable documents, developing software, and teaching writing and word processing simultaneously.

When an information-based society realizes that writing is not merely information delivery, but actually information management, the need for research in writing becomes apparent. To manage successfully the bulk of available information, efficient and proven techniques are necessary. Unfortunately, evidence compiled since 1970 by the National Association for Educational Progress indicates that many students are not adequately prepared in elementary and secondary schools to use basic skills in their writing. The highly-publicized decline in Scholastic Aptitude Test verbal scores of even upper-level students seems to verify these results. When these students enter college writing courses, their deficiencies become obvious and difficult to remedy. These circumstances convinced four members of the English Department at Brown University to create the Center for Research in Writing.

"What brought us together in the first place was our awareness that Brown students needed to be taught writing and that graduate students needed to be supported in the teaching of writing," Pettigrew explained. "After that, we branched out to local schools and the Rhode Island Department of Education. Basically, we're willing to consult with an individual or a group of individuals who have a writing problem and want us to help solve it."

The Center moved to Georgia Tech in 1982 when one of its founders and then co-director, A.D. Van Nostrand, became head of Tech's Department of English. Dr. Pettigrew began working with the Center during her doctoral studies in eighteenth century English literature at Brown and moved to Tech with the Center.

Although Brown and Georgia Tech have distinct personalities, Pettigrew discovered that the basic needs of their students are similar. In response to rapid change and the availability of information through computer technology, "it's going to be a necessity for all graduates to be able to communicate effectively.

"At one time, students did not need to have good communication skills until they started to climb the corporate ladder. But now, because of our information-based society, communication skills are important almost right away," explained Pettigrew.

Leaders in business and industry are keenly aware of the need for college graduates who are well prepared to work with a team not only in their specialty, but also in the use of language to communicate their ideas. "It's not unusual for a business to have a team of writers—a very sophisticated team with a graphics expert, an information specialist, a content-area specialist, and an editor. This is the business environment many of our students are going to have to deal with," Pettigrew observed. Often during job interviews, employers directly ask prospective employees if they can write well. Pettigrew believes that "the more prepared students are to deal with that question in sophisticated ways, the easier it will be for them to do with their lives what they'd like to do."

The tool preferred by most of the corporate world for processing and distributing information is the computer. Accompanying the popularity of writing with computers is a set of new problems. This area is one in which the Center for Research in Writing is
especially interested. According to Dr. Pettigrew:

"We have to realize that the computer is not going to solve writing problems. The computer facilitates revising, but if the writer isn't sensitive to grammatical and rhetorical constraints, then the computer isn't going to say 'do that' to fix a particular problem. In the same way, buying the computer program, Visicalc, will not guarantee that you will become a good accountant. If you don't know the basic skills, no amount of typing away on a computer is going to teach them."

As students struggle to use the computer in their writing, the problem of inadequate training in the writing process becomes evident. However, not just the current students are deficient in writing skills; many of their teachers are also unprepared to teach writing. The Center for Research in Writing is working to address this problem directly through staff development programs.

"Basically," explained Pettigrew, "teachers are not given the training they need in college. As part of their training to be teachers, they are typically not taught how to teach writing. Many states do not offer any courses in the teaching of writing."

In addition to being inadequately trained to teach writing, many teachers receive very little support in their efforts to help students communicate. Overcrowded conditions, short class periods, and the required quiet classrooms all adversely affect the quality of writing education. Even the structure of elementary and secondary curricula restricts the teaching of writing. Traditionally, writing courses have emphasized grammatical correctness often at the cost of content and overall structure of the composition. While very few people would recommend discontinuing grammar instruction, studies of college-level writers show that "they focus on grammar too much, that they over-edit and lose their own train of thought." This behavior indicates that a balance has not yet been established between the need for writing to be grammatically sound as well as logically developed. Because the ability to handle both of these constraints is crucial to successful communication, students in college writing courses often feel that they are unprepared to compose adequately. Their composition teachers find themselves in situations "analogous to that of a calculus teacher trying to teach calculus without being sure that the students can add and subtract." The efforts of Dr. Pettigrew and her colleagues are helping teachers and administrators in many school districts across the nation to "accommodate both the freedom to compose and the responsibility for revising."

In the face of bleak assessments of the current system under which students learn to write, Georgia Tech may have reason for optimism with the assistance of the Center for Research in Writing. Dr. Pettigrew feels sure that "students are learning a great deal about writing here. Our question is what else might they need that we're not teaching them now."

One such need, in Pettigrew's opinion, concerns the misconception that being a scientist or engineer excludes a person from also being a skillful, talented writer. In cooperation with the academic departments, the Center hopes to integrate a high-quality technological education with effective communication capabilities. According to Dr. Pettigrew, "there are many people who do fine work in their own field that is highly scientific, highly technical, yet communicates extremely well. That should be our goal wherever the possibility exists." To achieve this objective, all disciplines will need an understanding of the creative process involved in formulating any kind of document.

"It's not useful to think in terms of technical writing versus creative writing —any act of writing is a creative act. We may have different purposes, and the content we're presenting may differ, but that doesn't mean that we don't have to bring our creativity to bear on the problem."

With the participation of all academic disciplines, the assistance of the Center for Research in Writing, and the financial support of many sources, perhaps one day the men and women of Georgia Tech will be able to revive the qualities of the Renaissance man as suggested by Dr. Pettigrew:

"The dream would be to create utterly literate scientists and to do away with the nonsense that there are scientists and mathematicians and then there are communicators; the latter group writes well and the others don't. We know that's not true; those poles just don't exist."
By all indications, the premature infant was doing as well as could be expected. Tim Carrigan, a Georgia Tech graduate student working on his master’s degree, was assigned to Grady Memorial Hospital in Atlanta where he was involved in an area of biomedical research. As he took measurements of the child’s blood flow to the brain by means of ultrasound instrumentation, he noticed an irregularity.

Carrigan was very familiar with Tech’s work in bio-fluid mechanics, research work which has been especially strong in the study of blood flow. He was equally familiar with Tech’s ultrasound technique and work that had been conducted on adults regarding blood flow in the carotid artery which carries blood to the brain. Because of that familiarity, Carrigan made what could be considered a startling observation. He concluded the child had a patent ductus arterious. Patent (open) ductus (duct) meant an open duct between the pulmonary artery and the aorta.

When a baby is in the mother’s womb, it does not need pulmonary circulation; the mother provides oxygenation for the child. The patent ductus (open duct) helps provide proper circulation while the child is in the womb.

“Normally when a child is born, this duct closes within a short period of time and that allows proper circulation,” explained Dr. Don P. Giddens, chairman of the multidisciplinary committee, bioengineering committee of the College of Engineering at Tech. Giddens has made major research contributions in the area of blood flow dynamics and development of the ultrasound diagnostic technique. “Sometimes the duct does not close but remains open as it did in the womb. Consequently, when the heart is trying to pump blood into the aorta, and to the rest of the body, it short-circuits back into the pulmonary artery—so you wind up not getting good circulation. Sometimes doctors can induce closure by drugs. Sometimes they have to go in and surgically tie off the duct.

“The problem in the past has been that a patent ductus is not usually diagnosed until it is fairly severe,” Giddens added.

When Tim Carrigan reported to the doctors that he believed the child had a patent ductus, they followed standard techniques to determine if that was the case. They found no evidence of a patent ductus. Afterwards, it became apparent by the usual clinical tests that the child did indeed have a patent ductus, and the doctors from the staff of Emory University Medical School became interested in the technique Carrigan used in reaching his conclusion.

“It was a classical case of serendipity in research,” said Dr. Giddens. “We were actually studying a problem totally different from the patent ductus but we had done the background work in carotid artery fluid mechanics and we had the instrumentation available. Most importantly, we happened to have a student working hands-on who recognized the problem.”

Carrigan, who received his bachelor’s degree in aerospace engineering at Tech in 1976 and master’s degree in December of 1981, is now a biomedical research engineer with Emory University. From these early studies have grown a close research collaboration between Georgia Tech and the Department of Pediatrics at Emory. Dr. Peter Ahmann, a pediatric neologist, and Dr. Giddens coordinate this joint effort.

“Using the ultrasound technique, plus our knowledge from adults on blood flow in a carotid artery, we came up with a technique for easily and quickly, noninvasively and cheaply, diagnosing the presence of patent ductus and following its progress,” Giddens said. “That’s been verified on numerous occasions now and, in fact, the people at Emory are so confident about it they now use it as a clinical service.

“It turns out that it was a very simple fluid mechanics situation, probably one of the simplest things we’ve ever done, and it may be one of the most useful,” he added.

Giddens is a Regents’ Professor in Aerospace Engineering. He received his bachelor’s (1963) and master’s (1965) from Tech in aerospace engineering and his doctorate in aerothermodynamics from Tech in 1967. He tells the patent ductus story as an example of Tech’s involvement in biomedical research and to illustrate how research in one area can pay dividends in another.

By definition, bioengineering is the application of engineering principles to biological and medical science—and/or engineering equipment for biological and medical science, such as designing artificial organs.

The fact that Tech has strengths in some areas of biomedical research is notable in itself. Most schools that have strong biomedical research programs also have hospitals. Tech, of course, does not. But Tech faculty members and scientists are involved with counterparts and doctors affiliated with Emory University Hospital and other hospitals.

While there is a Bioengineering Center at Tech, bioengineering and biomedical research are considered to be interdisciplinary programs from an academic standpoint.

Dr. Jack Spurlock is director of the Bioengineering Center, which emphasizes the application of the knowledge, techniques and approaches of the physical sciences, engineering, social sciences and management to the problems of the biological sciences, Dr. Spurlock is also director of Interdisciplinary Programs.

The Engineering Experiment Station, which performs 70 percent of all sponsored research at Tech, is also very active in bioengineering research. James
C. Toler, principal research engineer for the Electronic and Computer Systems Laboratory, directs the EES Biomedical Research Division where research has focused on cardiac pacemaker designs and the use of microwave signals to selectively heat diseased tissues, an area of research which could aid in the treatment of cancer.

On the academic side, Giddens said those departments which are most active in bioengineering research include, Chemical Engineering, Engineering Science and Mechanics, Aerospace Engineering, Mechanical Engineering and Electrical Engineering.

"It's a fluid structure, but it is fairly active," Giddens said. "There is some very well recognized research going on here."

While there is no academic department of bioengineering and Tech does not offer degrees in bioengineering, the Institute does have certificate programs for students at both the graduate and undergraduate level.

"This means a student can minor, if you like, in bioengineering," Giddens observed. "It isn't called a minor, but it's perhaps the equivalent."

Several members of the Tech faculty are involved in the area of biomedical research concerning bio-fluid mechanics, or blood flow, one of the strongest areas of research at Tech. While the faculty members usually conduct their research independently of one another, their common interests frequently draw them together to share findings and information. Among those most actively involved in blood flow research are:

- Dr. Giddens for the past dozen years has been conducting research in bio-fluid dynamics and also noninvasive ultrasound methods. A major focus of Gidden's research is diseases of the arteries.
- Dr. Ajit P. Yoganathan, associate professor in chemical engineering has conducted internationally recognized research in heart valve mechanics—fluid mechanics of both natural and artificial heart valves. He is an authority in the testing and evaluation of artificial heart valves and related cardiovascular devices. Yoganathan has also conducted research of pulmonary artery flows in children.
- Dr. Raymond P. Vito, associate professor, Engineering and Science Mechanics, has examined the mechanical properties of tissues, including arterial wall and pericardium (outer covering of the heart).
- Dr. John A. Brighton is director of the School of Mechanical Engineering. At Penn State, Dr. Brighton was involved in research concerning development of the artificial heart. He currently serves on the review board of the National Institutes of Health for evaluation of the artificial heart. His main research at present is blood flow.

A major target of Dr. Giddens' research is arteriosclerosis, the disease which causes hardening of the arteries and is one of the major killers in civilized societies.

"It is responsible for heart disease, most heart attacks, and most strokes," said Dr. Giddens. "It is the big killer by far in western civilization."

A study of certain factors which may influence arteriosclerosis is one of Dr. Giddens' major research projects. He has just completed a three year project in collaboration with the University of Chicago Medical School that was funded by the National Science Foundation, and has been informed the NSF will fund the project another three years.

"There are factors that may influence where the earliest fatty deposits in arteriosclerosis may occur in the arteries," Dr. Gidden stated. "Consequently, there is great interest in unraveling those factors and trying to see if it is coincidental or if there is a cause and effect relationship in terms of how the disease first begins and why it localizes in specific areas."

During the three year projects just completed, Dr. Giddens said certain factors which were thought to be associated with arteriosclerosis have been "pretty
conclusively eliminated.

"We are convinced and we think we have enough evidence to be convincing, that those factors don’t have anything to do with how the disease begins," he said. "One of the factors is high wall shear stress caused by blood flow. The other is turbulence caused by blood flow.

"We think we have narrowed the field of interest down in terms of looking at fluid mechanical factors to three mechanical effects that we plan to study over the next three years—those are low wall stress, oscillations in wall shear stress, and what you might call particle residence time (how long blood elements stay in the vicinity of the arterial wall in certain regions).

"We will see if we can firmly identify which, if any of these factors, are dominant. We will try to relate that ultimately to what goes on at the level of the cells that make up the arterial wall."

A second major project being conducted by Dr. Giddens and funded by the National Institutes of Health studies the effects of arteriosclerosis on blood flow patterns.

"Once the disease occurs, there is some distortion of the arterial wall as fatty deposits accumulate and grow," Giddens said. "We are interested in how those deposits affect blood flow patterns. Can they trigger turbulence, for example? And how does one interpret those blood flow patterns with regard to the state of the disease that caused it?

"This project is in the area of diagnostic methods associated with arteriosclerosis. We study basic fluid mechanics of disturbed blood flow patterns and we also study methods for deriving the information we’d like to get from noninvasive doppler ultrasound instrumentation."

Giddens said the research is being conducted in collaboration with the Imperial College for Science and Technology, London.

"Our early work in that area was among the first to demonstrate in animals that blood flow disturbances occur for relatively mild disease states in arteries. We described how turbulence evolved in an animal with arteriosclerosis, how other blood flow disturbance patterns evolved and how to use signal processing to extract that information. A lot of the commercial diagnostic methods that are now available in doppler ultrasound depend upon that type of flow disturbance work. We feel like in the mid-1970s we made some contributions in that area that tended to show the way for clinical people to use flow disturbance detection diagnostically. We’re now trying to refine that knowledge of fluid mechanics sufficiently so that we can make the diagnosis at earlier levels of disease.

Two years ago, Dr. Giddens began a major research project which involved monitoring blood flow in neonatal (newborn) infants, with a particular emphasis on premature infants.

It was through involvement in this project that Tim Carrigan was able to correctly diagnose a patent ductus in a premature infant, using the ultrasound technique refined and developed by Dr. Giddens.

Another area of research involves premature infants who have brain hemorrhage and factors that might cause or lead to brain damage, Giddens said.

"When we started doing the research, it was basically assumed by some investigators—particularly some Scandinavian investigators—that premature children who have brain hemorrhage do not have the ability to regulate their blood flow. We began to examine that hypothesis using the ultrasound instrumentation, and we found that many premature children do in fact have the ability to regulate blood flow. We don’t see a direct cause and effect relationship between hemorrhage and the ability to regulate flow to the brain, so we are now looking for other causes."

Giddens is the author or co-author of numerous research articles. One of the most important appeared in the mid-1970s entitled, "Measurements of Disordered Flows Distal to Subtotal Vascular Stenoses in the Thoracic Aortas of Dogs." It was an extremely well referenced work because it was one of the first papers that demonstrated how important blood flow disturbance research was and provided an impetus for the noninvasive diagnostic methods.

Another research work which he has co-authored was published in October of this year under the title, "Carotid Bifurcation Arteriosclerosis: Quantita-
tive Correlation of Plaque Localization with Flow Velocity Profiles and Wall Shear Stress."

"I think the significance of that article is that it probably represents the first careful correlation between fluid dynamic factors in the carotid artery and a quantitative description of where arteriosclerosis first forms. It makes it very clear that some of those factors thought to be important in arteriosclerosis are, in fact, not important."

Dr. Ajit P. Yoganathan, associate professor of chemical engineering at Tech, is one of the leading authorities in the testing and evaluation of artificial heart valves and related cardiovascular devices.

A native of Colombo, Sir Lanka, he received his B.S. degree in chemical engineering at University College, University of London, England, graduating at the top of his class. He received a scholarship to the California Institute of Technology where he obtained his Ph.D. in chemical engineering in 1978. He joined the faculty of Georgia Tech in 1979.

"The research work at Georgia Tech is aimed towards obtaining a fundamental understanding of the fluid dynamics associated with various heart valve designs, in hopes of improving their fluid flow characteristics and reducing the severity of complications associated with heart valve prostheses," Yoganathan said.

The studies at Tech are being conducted by Yoganathan in close collaboration with Dr. R.H. Franch, M.D., cardiologist at Emory University Hospital; Dr. E.C. Harrison, M.D., cardiologist at Los Angeles County-USC Medical Center, Los Angeles; and Dr. A. Chaux, cardiovascular surgeon at Cedars-Sinai Medical Center, Los Angeles. The work is being primarily supported by the American Heart Association, Georgia Affiliate, and the U.S. Food and Drug Administration.

"The development of an artificial heart valve is one of the most exciting advances in the modern treatment of heart disease," Yoganathan said. "These valves which may be constructed from biologic sources such as the pig and calf, or from metals, pyrolytic carbon, plastics and cloth, replace diseased natural valves and improve the ability of the heart to pump the blood in a forward direction."

Dr. Yoganathan added, "In the 22 years since the development of the heart-lung machine which made open-heart surgery possible, more than 700,000 artificial heart valves have been implanted in people whose own heart valves were defective. For most of those people, the quality of life has been improved and its length expanded."

However, he said, artificial heart valves are not free from problems. Of the nearly 50 different cardiac valves introduced over the past two decades, many have been discarded due to their lack of success.

"An ideal valve would allow blood to flow smoothly, not injure the blood cells that are passing by, not become infected, and last as long as necessary," Yoganathan observed, adding, however, that valves do not always meet ideal criteria. "In particular, the valves may traumatize blood components, releasing chemicals that may lead to clot formation and valve malfunction. The artificial valve can interfere with the blood's flow and durability, and in some cases, is less than desirable."

Professor Yoganathan and Dr. Franch have built a sophisticated artificial flow system—an artificial heart pump—with artificial valves that simulate the pulsating flow of blood through the human heart.

"The flow system is interfaced to a micro-computer system," Yoganathan said. "Using modern laser beam technology we are able to measure the flow velocities and stresses that are imposed by the artificial valve on the flowing blood."

Yoganathan said the system uses an instrument known as a laser-Doppler anemometer.

"With this type of anemometer, crossed laser beams strike particles in a stream of fluid flowing through a channel, and the light is scattered from them at a slightly different frequency than from the original source. From this displacement in frequency and the angle at which the laser beams pass through the system, calculations may be made of the exact velocity of the flow at a given point."

An understanding of the velocities is important for several reasons, he said. "Jet effects can, for example, damage the walls of the aorta. High shear stresses can damage blood cells, and regions of low flow can lead to clot formation. Under adverse circumstances endothelial cells of the aorta may be sheared off and scar tissue developed. Red cells may be fractured, allowing hemoglobin to leak out into the blood plasma... When the various problems are considered, the value of the research goals of learning more about shear and velocity fields along with pumping pressures becomes more apparent. This research effort will lead to better and
longer lasting heart valves in the future for the many patients (young and old) who suffer from valvar heart disease. The improved heart valves will also help in correcting many of the congenital cardiovascular problems observed in young children.

The Biomedical Research Division of the Engineering Experiment Station was established in 1976. Two of the principal motivators for creation of the division were James C. "Jim" Toler, who was working with cardiac pacemaker designs, and Dr. Cliff Bifrdette, who was working with the Emory University School of Medicine researching the use of microwave signals to selectively destroy diseased tissues while not damaging normal tissues. Toler, who has been a research engineer at Tech since 1966, was named chief of the division. He received his master's degree in electrical engineering from Georgia Tech and his bachelor's degree in electrical engineering at the University of Arkansas.

Toler had been working as an environmental test engineer performing tests on the electronic systems of airborne missiles and had coincidentally scheduled a job interview in the space division of Chrysler Corporation at Huntsville, Alabama the day the Soviet Union launched its first Sputnik satellite in 1959. He became a member of the team of scientists and engineers that helped build the U.S. space program and joined the National Aeronautics and Space Administration in 1960. Toler was a special assistant for electromagnetic compatibility for the Saturn/Apollo program when he came to Tech.

During the relatively short period of time since its founding, research work in the division has received major recognition. The research work on pacemakers has continued, and the division now does the design evaluation for essentially every major pacemaker manufacturer in the world. And the research work concerning microwave heating has continued with results that allow diseased tissues to be destroyed by selective heat treatment.

"Over the last few years, our research has more or less evolved along four separate lines," said Toler. "One is the characterization of tissue electrical properties; two, development of electronic instrumentation for beneficially treating disease; three, the biological effects of exposure to microwave environments; and four, development of specialized instrumentation for biological purposes."

In order to develop a method of selectively treating diseased tissues by microwave heating, Toler said it was necessary to know the electrical properties of tissue.

"In the case of microwave heating, we had little knowledge about the electrical properties of tissue," Toler explained. "Yet those properties govern, to a very large extent, how effective we are able to use microwave energy to heat tissue—whether it's to heat all tissue or to selectively heat certain designated tissues."

The division has developed a small antenna that can be used on living animal systems to measure the electrical properties of different tissue types.

"In normal tissue, we measure the electrical properties of bone, muscle, blood, brain, skin, fat, etc. And then we measure the same sorts of tissue under conditions of disease. We call that the 'in vivo' (within the tissue) measurement probe. It has been adopted by most of the research labs in the country now."

Knowing the values of different electrical properties, Toler said it is now possible to predict before the fact how an electromagnetic wave will interact with tissue, how much of the electromagnetic energy will get converted into heat energy as the wave propagates through tissue, which tissues will get hotter than other tissues, etc. "Without that knowledge, in our opinion, much of that type of research is strictly trial and error research; there is no basis for knowing before the fact what is likely to happen," he said.

Researchers found that many diseased tissues, especially tumorous types of tissues (cancerous tissues) have electrical properties that differ from normal tissue. Diseased tissue was found to absorb more heat than normal tissue.

"We are exploiting that fact now in some programs that we have, and we're developing electronic equipment for cancer treatment using heat," Toler said. "Because diseased tissue absorbs a little more heat than normal tissues, we can realize a temperature differential and use that as a treatment technique."

The Biomedical Research Division is developing a system of equipment referred to as hyperthermia (high temperature) equipment for use in cancer treatment.

"It involves exposing diseased tissues to microwave signals and heating up those diseased tissues," Toler said. "But, since normal tissue doesn't get quite as hot as the diseased tissue, then the normal tissue survives."

Toler explained that on a centigrade scale, normal tissue is about 37 degree C. If it is heated by only about five degrees, 42 degrees, "We begin to be reasonably efficient in killing tissue—any kind of tissue. By the time we get to 43 degrees, we're quite efficient, and 44 degrees we're super efficient in killing tissue.

"We are able to take advantage of this knowledge of electrical properties of diseased and normal tissue in such a way that we can expose the two tissues to microwave fields and realizing a temperature elevation in diseased tissue of say five or six degrees, that is 42 or 43 degrees centigrade, while heating the surrounding normal tissue to 40 or 41 degrees and it survives."

The role that engineers can perform in the area of biomedical research is significant, according to Dr. Don Giddens.
Biomechanical Research

An Engineering Challenge

By Dr. Raymond P. Vito

Biomechanics is a sub-specialty of bioengineering which deals with the application of the principles of mechanics to problems in the biological and medical sciences. The field covers a lot of ground. Indeed, problems in such diverse areas as design of orthotic devices, measurement of the mechanical properties of body tissues and mechanical modeling of various organs could all be classified as biomechanics.

In what follows, I would like to briefly describe some biomechanics research, conducted at the School of Engineering Science and Mechanics, in which I have been involved. I will describe three problems, two of which I would classify as fundamental research while the third is very much applied. My goal is to provide some idea of what biomechanics research is in practice and thereby impart some appreciation of the engineering challenges involved.

Radial keratotomy is a surgical technique which has great potential for treating myopia (nearsightedness). The surgery evolved from the accidental discovery in the 1950's that a man, whose cornea was severely cut by glass fragments, was able to see without his glasses once the fragments were removed.

In radial keratotomy, the surgeon makes eight symmetrically placed radial slits in the cornea of the eye leaving a central, circular "clear zone". The result is a somewhat flattened area in the center of the cornea and hence increased refraction (bending) of the light as it enters the eye. Thus, the image, which previously formed in front of the retina (myopia) now forms on the retina. In some cases, the correction can be such that glasses are no longer required.

The surgery is simple, inexpensive and appears to be safe. So what are the problems? There are potential medical problems which will not be discussed here. They are the subject of a five year national study funded by N.I.H. and headed by Dr. George Waring of Emory University. There are also problems which may benefit from some engineering input. Specifically, what are the mechanical factors governing normal corneal shape and how are they affected by surgery? At present, no one really knows why the surgery works, and the results can be variable. Occasionally, the cornea becomes non-spherical after surgery resulting in astigmatism or blurring of the image. Some researchers, particularly in the U.S.S.R., claim that by using different slit patterns on the corneal surface, both astigmatism and myopia can be corrected.

My colleague Dr. Don Vawter and I, in collaboration with Dr. Waring and with support from N.I.H. are attempting to deal with some basic questions about the biomechanics of the cornea. We have conducted a variety of mechanical tests in an attempt to measure the mechanical properties (stress-strain law) of human corneas obtained from cadavers. Such information is of fundamental importance in understanding normal corneal shape and possible ways of changing it. We are also trying to construct a mechanical model of the cornea using our experimental data in conjunction with finite element methods. These are numerical techniques in mechanics which can accommodate both the complex geometry and nonlinear material properties of the cornea.

Finally, we are working on an instrument which uses infrared interferometry and a microcomputer to measure the corneal shape both in the lab and in patients. This instrument-
tion is unique and will allow us to perform mechanical tests using intact corneas and to see how well our mechanical model works. Ultimately, this instrumentation could be valuable in the clinic. For example, it could be used to monitor the variation of the results of the surgery with time. This is now done by periodically measuring the central curvature of the cornea. Our instrument will give the shape of the entire corneal surface. This may be important since surgery of the periphery of the cornea is being used to alter its central curvature.

I'd like to turn now to a discussion of a different problem, specifically, the mechanics of the arterial wall as related to the initiation and proliferation of arteriosclerosis.

Arteriosclerosis is a complex disease, one with which we probably all have some familiarity but also one which no one totally understands. Its causes are largely unknown, but, because the disease and its complications (primarily stroke and heart attack) are a leading cause of death, there is a keen interest in understanding all factors which may be important in the disease process.

Arteriosclerosis is usually a disease of old age; in time we all develop "hardening of the arteries" to some extent. However, there are many factors which correlate with the premature occurrence of arteriosclerosis, among them: cigarette smoking, diet, and exercise. The one factor most directly associated with arteriosclerosis is high blood pressure. If left untreated, high blood pressure can lead to early death from stroke or heart attack.

This fact has intrigued mechanical engineers since the early 1970's. Increases in blood pressure must, by the laws of mechanics, result in increased stress in the vascular wall. The question is, how can this influence the disease process? There is no simple answer, but one can pose some questions which can form a basis for research.

One may ask, for example, what are the stresses in the vascular wall? To answer this requires both measurements of the mechanical properties of the arterial wall and a mechanical model simulating the arterial geometry and loading. This sounds deceptively simple until you realize that the arterial wall has a very complex structure. It contains muscle cells and several layers composed of varying amounts of two kinds of oriented fibers each having drastically different mechanical properties. The wall is therefore non-homogeneous and the presence of the fibers makes the mechanical properties directionally dependent. Add to this the effects of age, sex and disease state, all of which affect the wall structure, and one can begin to appreciate the problem!

Given the large number of important variables, measurements of mechanical properties must also include measurement of arterial wall structure. How can this be accomplished?

In my laboratory, I have developed a microprocessor controlled mechanical testing device which permits one to subject an arterial segment to stretching and pressure loadings simulating those experienced in-vivo. Since the device is programmable, a variety of tests can be conducted.

To make measurements of the microstructure, standard histological slides of the tissue are prepared for microscopic examination. The various constituents of the arterial wall are stained different colors, and, using an image digitizer and a minicomputer, measurements such as areas and orientations of the constituents, can be made.

The data on microstructure may be coupled to the mechanical data in a model to give stresses in the wall and, perhaps more importantly, correlations between mechanical behavior and disease related changes in structure.

Recent experiments and calculations have shown that one layer, the outer or adventitial layer, can give rise to unexpectedly large stresses in the vessel wall when the blood pressure is elevated.

The design of leg braces for paraplegics is a problem that came to my attention through Dr. Carl Fackler, a pediatric orthopaedic surgeon who is on the faculty of Emory University. Dr. Fackler works with children who have spina bifada, a common birth defect (one in 1000), which is often accompanied by lower body paralysis. Braces currently in use in Atlanta are quite primitive. They are heavy (about 15 percent of the user's body weight) being made of steel and leather and have little capability for adjustment. This last problem, coupled with the fact that children grow quickly, results in very significant costs.

We have come up with a novel design which uses lightweight materials. The result is an improved brace at reduced cost. This project has been supported by the Spina Bifada Association, and there are a number of very enthusiastic undergraduate students involved. We have completed a prototype and hope to test the brace in a new clinic currently being set up at the Scottish Rite Hospital. Georgia Tech is considering the possibility of patenting the design.

This has been a very gratifying project as it offers the chance to use engineering in a way which could greatly benefit these severely handicapped children. After all, isn't this what bioengineering is all about?
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Making the World a Better Place to Live

By Kathleen C. Moak

In the laboratories of the Cherry Emerson Building synthetic oil is being manufactured, new life forms are being used as fuel and genes are being spliced and restructured.

All of this may sound a bit futuristic and mysterious, but it is neither to the researchers in the Applied Biology Department at Georgia Tech. These are everyday occurrences in the Emerson Building labs and just part of the department’s ongoing biotechnological research.

There is a major emphasis on research in the Applied Biology Department, even at the undergraduate level, and it ranges from the aforementioned gene splicing, to investigating the production of plant and animal biomass, to the biological production of antibiotics, methane and hydrocarbons in the laboratory, and almost everything in between.

“Applied biology includes every function, every process, everything that involves a living thing,” said Dr. Thomas G. Tornabene, academic director of Georgia Tech’s Applied Biology Department and director of the newly-created Research Center for Biotechnology. “It is taking a biological system and ‘applying’ it to today’s needs to solve a problem in order to make the world a better place to live.”

The difference between biotechnology and bioengineering may seem to be a gray area, but Tornabene defines biotechnology as using the biological process to generate the products that will fulfill needs of society, such as making antibiotics or lubricants. Bioengineering is applying engineering principles to biology or medicine, as in the construction of an artificial limb or heart valve.

By any definition, it translates into a lot of ground to cover in research.

The major divisions of the department’s research cover three processes: genetic engineering, fermentation and immobilized cells. With the establishment of the Research Center for Biotechnology this fall, the biotechnology programs at Tech will receive an even bigger boost.

As departmental research has been decentralized for some time, the Center is the much needed official recognition and coordination of all the biotechnology efforts at the Institute. “This will simplify the logistics of the interdisciplinary efforts at Tech. President Pettit saw the need for the Center and has supported its establishment. The labs are being pulled together now,” Tornabene said in early September. “It is important that alumni know this exists because most engineers are already involved in biological systems.”

The Center unifies several ongoing programs in applied biology, biochemical engineering, environmental engineering and genetic engineering. Research will concentrate on the conversion of wood and waste materials to usable products, the biological production of petrochemicals and fertilizers, and scaling-up the manufacturing processes for health care products.

It will utilize the faculties of various schools, Applied Biology, Chemical and Civil Engineering, Chemistry, EMSL-EES and Physics, and will be located on the first floor of the Emerson Building which already houses the DNA and fermentation laboratories. Construction has begun on an immobilized cell and enzyme lab there and planning has begun for a mass spectroscopy lab.

The goal of the Center, according to its establishment proposal, is to “create the technological and human resources basis for a biotechnology industry in Georgia.” The Center’s founders believe this will come about through research that will increase the economic potential of Georgia’s natural resources.

Ultimately, the Center is intended to be a base for commercial products and processes that will help attract new high technology bioindustries to Georgia. Active support for Center-related group projects is expected to be initiated by December of this year with the initial proposals going out to industry by May, 1984.

Tornabene has been working in these areas for almost 25 years and is recognized as an authority on microorganisms’ synthesis of hydrocarbons. He earned his Ph.D. in biological chemistry from the College of Natural Sciences, University of Houston, then taught at Colorado State University for 13 years in the late 1960s and during the 1970s. Currently, his research centers on the production of algae and bacteria for the biosynthesis of lubricants and fine chemicals with commercial potential. His five-year goal for the Applied Biology Department is, simply, to make it the best in the Southeast and comparable to the best in the nation.

Much of Tornabene’s work has been directed toward the development of alternative energy sources. In his years of research on the subject, he has made a number of discoveries. One of these is...
the biogenic production of fossil fuels, that is, that fossil fuels were produced biologically by living organisms.

It has always been understood that oil was created from decomposed plant and animal deposits as a result of time and underground pressure, but the question "how?" has remained without a conclusive, definite answer. Tornabene's discovery substantiates the theory that microorganisms biologically converted organic deposits from plants and animals (fossils) into specific kinds of hydrocarbons (oil).

"We were excited to find hydrocarbons synthesized by microorganisms and that the hydrocarbons were identical to those found in fossil fuel deposits," Tornabene said in an interview with the Denver Post.

He has identified diverse bacteria which generate chemicals that resemble petroleum components, common inhabitants of human skin, methane-producing bacteria and unusual bacteria that grow in hot acid water. Production by the methanogens generally is 14 percent by cell weight, but Tornabene is working to biologically increase production to 80 percent.

In February of last year the department announced in a news release that "a unique strain of bacteria routinely makes hydrocarbon compounds whose chemical structures are strikingly like those found in fossil fuels." Tornabene has classified these as a third division of living systems and calls these organisms "archaebacteria."

It was also discovered that they must be put under "environmental stress" to produce the needed results. The process is called "downshocking" and essentially involves placing the organism in unfavorable surroundings. While trying to stabilize itself in its new environment the organism over compensates and makes compounds such as oil.

These types of archaebacteria were discovered about five years ago during Tornabene's research on synthetic oil. They were classified as a new life form because they fit into neither of the traditional two classes of life forms, those with sophisticated cells (plants and animals) and those with simpler cells (bacteria). This third form resembles bacteria but their cellular composition, genetic and metabolic characteristics are different.

Tornabene said that although they are found widely in nature, they are particularly a primitive type of microorganism which makes hydrocarbons similar to those in petroleum. They may even be related to the process that converted plant and animal remains to oil millions of years ago. Able to survive in extremely harsh environments, much like those that existed in archaic stages of the earth's development, they will also grow under extremes that can be simulated in the laboratory.

"Fossil fuels aren't renewable, but their synthetic substitutes are," Tornabene told The News and Observer in Raleigh, N.C. With the know-how to produce the substitutes the next step is economic feasibility.

It will be possible, one day, to use the organisms to produce oil, but it will not be the one single answer to our energy problems, according to Tornabene. When the process is affordably marketable, industrial production will come. But industrial production does not mean that by the year 2000 we will be driving cars powered by synthetic oil grown on remote bacteria farms. What it does mean, however, is that bacteria farms could be producing enough synthetic oil to be used as oil substitutes in petroleum-based products such as paint, lubricants and solvents. Already the oil companies are interested.

"The idea is to use the bacteria to produce synthetic raw materials for
some petro-chemical based products. What we can do is get lubricants and filler products," he said.

Tornabene has been studying other organisms that produce synthetic petro-chemical substitutes such as different species of algae.

Photosynthetic microorganisms (algae growing on waste water) feed on the waste water with the aid of energy from the sunlight and can make industrial waste waters usable. To increase algae production of chemicals, however, the strain must be stopped in the middle of its growth cycle and subjected to environmental controls.

"We could grow these, make petro-chemicals and clean up the environment. We're trying to get rid of agricultural and industrial pollution by algae and bacteria, first by degrading them so they are non-toxic and secondly, by scavenging chemicals from water. We can't just use one part of a system and discard the rest," he observed. "We have to find ways of using it all."

With the key to hydrocarbon production in hand, researchers can splice genes and insert the ones they desire—laboratory manipulation of those keys—in order to modify the bacteria so they make more petro-chemicals than normal. This speeds up production of synthetic oil, making it cheaper in the long run.

"You have to use a cell's normal biochemical machinery to force it to make a product," Tornabene said. "We can control cells to make specific petro-chemicals but very few cells do it. It's a secondary product but we can use it for alternative fuel sources and lubricants, or as potential cancer drugs and nutrients. We have to learn how to increase and control that pathway. We want to unravel the specifics of biochemical mechanisms and apply that technology to very specific needs of commercial importance."

Gene splicing is applied in agriculture to yield crops that are less susceptible to insect infestation, can resist pesticides and herbicides ad have a lower mortality rate. Just last spring The Washington Post reported that the first crop of plants to be genetically engineered by man were planted in laboratories in the U.S. and Europe "marking an early milestone in a new kind of plant research, a combination of genetic engineering and other relatively new techniques that could revolutionize parts of agriculture."

Another instance where biotechnology influences food production involves algae as feed for shrimp larva. The algae enhances the life of the larva. "People say, 'What do I care about shrimp larva? How can that affect me?'" Well, this makes the shrimps' mortality rate 20 percent rather than 50 percent. When you go to the market to buy shrimp that will make a difference," he said.

This technological exploration for commercial application has led to the laboratory manipulation of plasmids (an extra small bit of DNA that causes genetic expression, which can be chemically cut and spliced).

"We're not making a new cell or creating a new thing, we're just amplifying something that already exists or giving it an added capability. This is all part of genetic engineering. We take the cell that's easiest to work with, single out one expression and inhibit others.

"Genetic cell manipulation is just making the cell do the function you want it to do. There are many things a given cell can do, many paths it can follow. It already has the expression for that process, we're trying to make the cell follow the pathway we want. We're trying to control a biochemical pathway, not make stronger supercells or super-humans," explained Tornabene.

It is not always easy, as in the case of the growth hormone, somatostatin. It took 500,000 sheep brains to extract enough of the hormone (five milligrams) to analyze its structure. Once it was identified, a bacteria system was controlled by genetic engineering processes to produce five milligrams of the hormone from one gallon of meat broth in about three hours.

Another facet of Tornabene's work is the taxonomy of bacteria. In addition to the study and discovery of organisms, Tornabene has been categorizing them and has revised the taxonomy of two important classes of bacteria through fingerprinting of the cells by chemical analysis. "We have re-identified over 200 organisms by cell fingerprinting. We're analyzing cells and looking for their places in the ultimate scheme of things," he said.

Part of Tornabene's job is explaining exactly what his department is about, which includes trying to dispell the misnomer that all biologists are leaf collectors and bird watchers. At Tech, biology is approached pragmatically and fundamentally with technology and application in the forefront.

"In 1960 the department was formed with specific instructions to build a program that relates to the overall mission of Georgia Tech," he said. "What we have now is a restructured program with emphasis on applied biology, and we award degrees in Applied Biology. This is not just a biology program.

"We have a true interdisciplinary program whereas a school like UGA has several different departments that are restricted to specific biology principles: agriculture, botany, microbiological genetics, horticulture, etc. We are one centralized department and we don't have the burden of the narrowness other universities experience because of the multi-departments that are interrelated," he said.

Tornabene is a believer in cooperation between academic disciplines—engineers and biologists working together.

"For instance," he said, "suppose you're working on a project involving a sewage disposal. The engineers together with microbiologists and chemists are capable of constructing a system where sewage will be converted to clean water, fuels and commercially important petro-chemicals, with little or no undesirable by-products, including noxious odors, and we'll save the city money and save the environment at the same time."

At Tech this interaction between engineers and biologists will be a result of the Biotechnological Research Center.

Georgia Tech is one of a few institutions in the U.S. and the only Institute in Georgia that offers degrees in Applied Biology. Tech offers the only undergraduate program in chemical engineering in the state and competes nationally in the number of graduates it produces, in addition to bachelor's, master's and doctorate degrees in applied biology, chemistry, and chemical engineering.

As a result, Tech is the recipient of support from major firms in chemical, pharmaceutical and petroleum industries and a number of the faculty serve as consultants to these industries.

The exploration of applied biology on the fringes of our future is exploration into worlds in which we have never been, but live amongst daily. Biotechnical research will continue to enhance our lives, making them longer, more pleasant, and safer while bringing scientific industry, discovery, and renown to Georgia and to Georgia Tech.
Giving a Boost to High Technology

By John Toon

The setting is the former principal's office in the old O'Keefe High School, a fortress-like structure that until the mid 1970s taught Atlanta's youth reading, writing and arithmetic. Shag carpeting covers the floor. Faded beige drapes hang from the windows, and four state surplus desks are jammed into space planned for one. On one of those desks sits a Terak computer, and behind it, Georgia Tech graduate Tom Koehler.

In the next room—the school's former infirmary—Dr. Charles Pearson and a secretary work. When he needs to communicate with Koehler, he rings a bell.

Such was the Catronix Corporation one year ago as it struggled for success as one of the first companies in the Advanced Technology Development Center (ATDC), a state-sponsored program designed to assist technology-based small business.

Today, Koehler, Pearson and 17 other employees work in a spacious 6,700 square foot office in one of Atlanta's most prestigious new buildings, Renaissance Square. Catronix Corporation, a few years ago only an idea in a computer addict's mind, has joined Atlanta's high technology community, with a promise of big things to come.

The company's story begins in West Germany with Tom Koehler's fascination for computers. In high school, as he readily admits, "the other people would go out and drink beer, and I would sit behind the computer."

Later, while in college struggling with tedious mechanical engineering drawings, Koehler realized he could put the computer to work on the drawings, and through trial and error, he learned the algorithms for making that happen.

To protect his idea, Koehler formed Tecgraph, a fledgling company he brought to Atlanta when he enrolled at Georgia Tech for a master's degree.

With the encouragement of a Tech professor who saw the idea's potential, Koehler began to develop a computer-aided technology system particularly applicable to solids modeling. The system would permit sophisticated modeling on 16-bit minicomputers, at much less expense than other available systems.

In early 1981, Koehler found out about the Advanced Technology Development Center, at that time also very much a fledgling operation. He applied to the program and was accepted.

ATDC assists more than 30 technology-based small businesses, offering them assistance with business planning, marketing and the location of venture capital—through two annual meetings with financing firms. Through its "incubator" space in the old O'Keefe High School and the use of state surplus furniture, ATDC can cut office costs for the small companies, while getting them access to a whole support network of accountants, attorneys, business consultants and Georgia Tech faculty members.

The Center also provides a linkage to the facilities at Tech and other University System institutions, giving small companies access to Tech's computer center, machine shops, specialized electronic test equipment and extensive library. The ATDC can call on the technical expertise of the more than 1,000 faculty members in Tech's $80 million a year research program.

The idea is to improve the success rate for technology-based start-up companies, which traditionally have been somewhat volatile. And while boosting these companies' chances of success, the ATDC also hopes to put them on the fast growth track, to increase jobs and capital investment in Georgia's growing high technology community.

Admission to the ATDC program comes after tight scrutiny from a review panel composed of experts from the technology, business, finance and accounting communities. About a third of the applicants have been turned down and invited to reapply after additional planning or study.

While ATDC is temporarily headquartered in the O'Keefe Building, it is constructing a new 83,000 square foot headquarters/incubator building at Tenth and Greenfield Streets, also on the Tech campus. When completed, the new building will accommodate 30-40 start-up companies, as well as research and development or new product development teams for established high tech companies.

Through ATDC contacts, Koehler got help with marketing and business planning, areas until then largely
foreign to the self-confessed "computer addict." One of those introductions was to Dr. Charls Pearson, a Tech faculty member who was planning to retire from the institution to devote full-time to investment planning.

"The greatest thing ATDC did was get Tom and me together," recalls Pearson, now the company's secretary/treasurer.

The two agreed to join forces and incorporated as Catronix Corporation. Their first office was in the 64-square foot closet of Koehler's apartment, but the venture moved to the O'Keefe Building when that became available. ("It was not the Marriott, but it was a place we could start," Koehler will explain.)

When the software development work outgrew the Terak computer system Catronix owned, ATDC was able to arrange for the company to buy time on the VAX-780 computer in Georgia Tech's Engineering Experiment Station, allowing the development work to proceed full-speed ahead.

"That saved us a lot of money because we didn't have to buy a VAX," Pearson explained. "In a time of tight cash flow, it helped us have access to powerful resources."

Catronix Corporation gained other help through the ATDC, hiring Georgia Tech students to help with programming, and leasing additional space on the ground floor of O'Keefe. In early 1983, the company obtained its first round of financing, enabling rapid growth to some 19 employees.

On September 13, Catronix Corporation moved into its brand new facility in Renaissance Square. President Robert T. Duncan expects to have 50 persons on his staff by year's end.

Similar stories remain to be written among the other technology-based small companies associated with the ATDC. In all, the companies are responsible for more than 150 jobs and a surprising capital investment.

The first graduate of ATDC's incubator, Chalk Board, Inc., now employs 30 persons out of its office in north Atlanta. Chalk Board produces a line of entertaining/learning software, and a new peripheral product designed to replace the keyboard for using the software on personal computers.

The device, dubbed "PowerPad," provides a touch-sensitive surface which allows users to issue commands and make responses by simply touching a particular place on the board. The Power Pad also turns into a drawing board, a piano keyboard and a game board with the appropriate overlay and software cartridge. Company officials believe the device will make computer use easier for children and those not accustomed to using the machines.

The company entered the ATDC incubator last spring, and moved out into its own space in July after only eight months in business. While in the incubator, Chalk Board used ATDC's contacts with the business community and found the low-cost on-campus office space "invaluable" to its fast growth track. Chalk Board's products will be marketed through toy and chain stores nationwide.

One of ATDC's newest firms is Sales Technologies, Inc., which provides an integrated computer system using hand-held computers—linked to a front-end processor—to help consumer goods companies improve the efficiency and effectiveness of their field sales organizations. The system collects, transmits, processes and reports sales and marketing information to help speed order entry, provide timely sales management reports and obtain marketing information previously untapped by headquarters personnel.

The company joined ATDC in mid-July after taking part in the first Seed Capital Conference, which was designed to get start-up companies together with venture capital financing. Through the conference, Sales Technologies gained financing from Noro-Moseley Partners, an Atlanta-based venture capital firm.

Sales Technologies was attracted to the ATDC incubator program because the ATDC's location on the Tech campus would help the new company gain access to consulting expertise from the Georgia Tech faculty and facilitate hiring part-time student workers as well as full-time personnel as the company grows.

"It's the proximity to campus," explained Chuck Johnson, one of the company's founders. "When you can get a part-timer and he only has to walk two blocks to work, its attractive to him."

The ATDC has also put Sales Technologies in touch with influential experts in the Atlanta business community, helping it obtain the technical expertise and support needed to fully develop the system.

The company now has five full-time employees and one part-time student. It is actively recruiting new employees from Tech, Georgia State University and the University of Georgia to help with two contracts already underway, and hopes to employ 10-12 full-time people—along with a number of students—within six months.

But the creation and nurturing of small business is a long-term process. The initial output of jobs and capital investment, while impressive, cannot provide the jobs the state needs now. So to increase the immediate reward, ATDC also operates an active industrial recruitment program aimed at spreading the word of Georgia's economic advantages among established high tech companies who might consider relocation or expansion to the state.
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Toward that end, ATDC produces audio-visual programs and issues reports on state resources. Included is information on the existing 800-company high tech community that already provides jobs to more than 56,000 Georgians.

To assist in getting that information out, ATDC also publishes a quarterly newsletter, fields questions from interested publications, and takes part in national trade shows.

Other small companies in the ATDC small business development program run the gamut from computer equipment, software and computer peripherals to biotechnology, instrumentation, ion technology and millimeter wave technology. In all, the more than 30 technology-based companies in the program employ more than 150 people.

Among the newest of ATDC companies is STRATEGIC TECHNOLOGIES, INC., which is producing a full-function portable microcomputer known as the "PC Traveler." The briefcase-sized device, which weighs in at about 26 pounds, offers 8 megabytes of disk storage, a full-size gas plasma display screen, detachable keyboard (compatible with the IBM PC) and an 80-column impact printer. The device, which can process information up to 10 times faster than the IBM PC, is one of the most powerful and compact microcomputers on the market.

The ATDC is also helping the giant Lockheed-Georgia Company market the test instrumentation technology it originally developed for airframe manufacture. GETEX division of the company has located an assembly facility in the ATDC incubator for its capacitance hole probe, a device designed to quickly and efficiently test the quality of rivet and fastener holes. Coupled to a minicomputer, the probe can make, record and analyze 192 separate quality measurements in a few seconds.

A small company with a solid track record of computer system installations as far away as China is ERDAS, INC., an acronym for Earth Resources Data Analysis Systems, Inc. ERDAS designs and produces turnkey image processing systems and services for the mineral exploration, forestry and engineering communities. The ERDAS systems perform automated mapping using information obtained from satellites and aircraft, which is then merged with geologic, topographic and economic information for geographical applications associated with resource management and development. Despite its small size, ERDAS has over 20 installations of its system on four continents.

At a time when many companies are cutting their corporate travel budgets, an ATDC company known as FARESCAN, INC., has developed an automatic electronic system designed to help corporate travel departments find the lowest cost fare to a given airline destination. The system provides immediate access to unbiased, published and unpublished, low fare data and flight information; offers several alternatives to the business traveler; and then issues the ticket through a licensed ticketing agent. The system can reduce travel costs 20-30 percent.

One of Georgia's major entries into the growing field of biotechnology is HYBRIDOMA SCIENCES, INC., which produces monoclonal antibodies using hybridoma technology. Monoclonal antibodies are made by fusing antibody-producing cells with immortal cells. The resulting cell, called a hybridoma, is a biological factory than can be maintained continuously, producing a specific and consistent source of antibody. The antibodies have a wide range of medical diagnostic and therapeutic applications.

Two ATDC companies last winter were the only Georgia recipients of Small Business Innovation Research grants from the National Science Foundation. ION TECHNOLOGY, INC., uses the ion implantation technology developed for the semiconductor industry to improve a wide variety of surface properties of materials. For instance, the procedure can be used to improve hardness, fatigue, fracture toughness and conductivity of metals, increasing the useful life of tools and other items.

The other, MILLIMETER WAVE TECHNOLOGY, INC., is involved in the development and production of a radiometric system for detecting ice on aircraft, a low-cost satellite reception antenna for home use, and microwave and millimeter wave systems and components for military applications.

With telephone rates continuing to rise, many companies are looking toward alternative means of data communication. SCIENTIFIC COMMUNICATIONS, located in the ATDC incubator, is developing equipment that will use existing cable TV systems to provide an alternative. Previous uses of cable systems have required extensive modification, but the company has devised a solution that will not require the modification.

Successful industrial recruitment and small business development efforts demand the infrastructure to support high technology growth. Companies must have a supply of skilled workers, be able to obtain the services they need, and have financing available.

Toward that end, ATDC Director Jerry L. Birchfield chairs the state's High Tech Advisory Council, which provides direction for Georgia's system of vocational-technical schools. The center has also been active in bringing public and private leadership together to work out a strategy for growth, an effort that bore fruit with creation of the Georgia Research Consortium last spring.
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