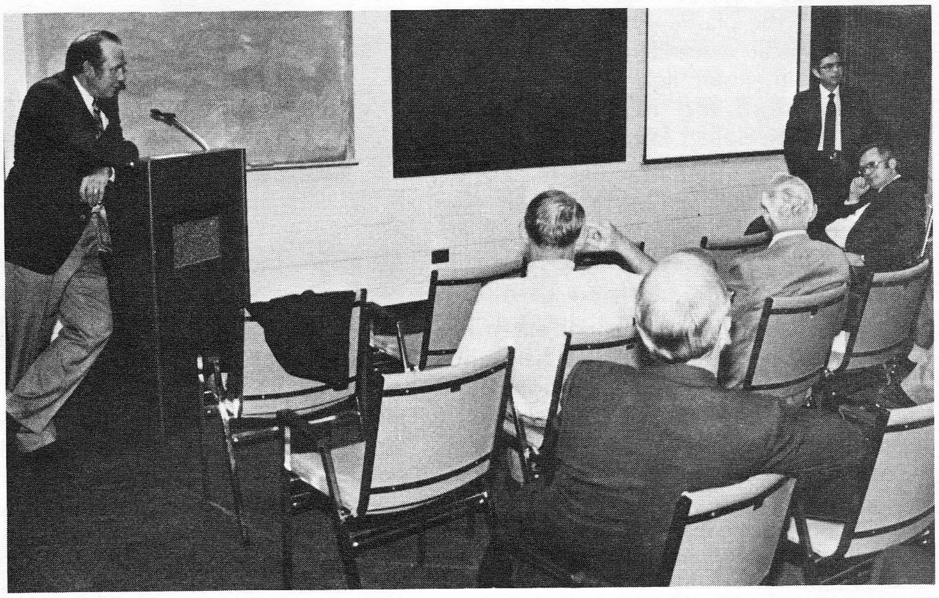
EES Report
ENGINEERING EXPERIMENT STATION • GEORGIA TECH

Tech researchers tour European labs

How do the United States, the Soviet Union and western European countries compare in technological achievement? With the impressions of a three-week tour of European laboratories behind them, three Georgia Tech electronics experts reported no large differences in quality of research. However, they offered these distinctions:

- Soviet technology is at least five years ahead of American research in certain high frequency millimeter wave signal sources;
- The Soviets still depend on U.S. computer technology;
- Scandinavian researchers are at the forefront in efforts to harness the power of ocean waves for energy; and
- West German laboratories excel in development of low noise receiver technology.



EES Director Dr. Donald Grace, left and standing, briefs Station laboratory directors on a tour of European microwave laboratories he made April 12 to May 3 with an American research delegation. Also making the trip were EES Associate Director Dr. James Wiltse, right and standing, and J.W. Dees, director of EES' Electromagnetics Laboratory.

"Of course, you have to remember that our observations were made on the basis of several visits to labs," cautioned EES Director Dr. Donald Grace. "All we could formulate were impressions."

Grace was joined on the mission by EES Associate Director James C. Wiltse and EES Electromagnetics Laboratory Director J.W. Dees. Dees and Wiltse organized the mission, which was made under the auspices of People to People International, an American-based group designed to bring together people in the same occupations from different countries. The American delegation consisted of microwave engineers and scientists. The group also visited labs in the Netherlands, West Germany, Norway and Denmark during the tour, which lasted from April 12 to May 3.

"The things that made the biggest impression on me were the millimeter wave carcinotron tubes," Dees said. "They literally had them in their desk drawers in the Soviet Union."

The carcinotron tubes provide a signal source for millimeter and submillimeter waves. Wiltse reported that Russian researchers claim to have built units operating at 2000 GHz. In contrast, Western laboratories have only been able to generate millimeter waves to 700 GHz. The labs which the group visited are doing basic research in this field. But millimeter waves are considered prime technology for future military applications and could drastically alter battlefield tactics (See separate story in this issue on millimeter waves) as well as provide better means of communication.

The U.S. embargo on sales of high technology equipment to the Soviet Union underscored the Russians' continuing dependence on American computer hardware, the three Georgia Tech researchers said.

"A professor we met was complaining about the lack of some of the peripheral equipment he needed for a computer," Wiltse said. "He had bought a PDP-11 computer in the United States and now they won't sell him the external disc storage or the display or the printout equipment. He had to buy a French teletypewriter and things like that. So he was groaning a bit."

The lag in Soviet computer technology was reflected in an exhibit of significant scientific achievements of the country, Dees said. "Among other things, we saw displays of television sets and pocket calculators — things you'd see in drug stores in America."

Soviet laboratories presented the American group with notable contrasts. Grace said facilities were generally poor. Some buildings were over a

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Engineers help industry solve problems

What does an appliance manufacturer do when his products are being returned by his customers because of mysterious defects? A Georgia company faced this problem recently when clear plastic components on its product suffered severe discoloration. Management called Georgia Tech for assistance and three days later EES engineers came up with an answer: the plastic components lacked a chemical material to protect them from ultraviolet light rays. With this information, the manufacturer corrected the defect immediately.

"That's a good example of how we can help a business quickly when management is stumped by a tough, technical problem," said Eric O. Berg, Jr. of EES' Industrial Extension Division.

Georgia Tech's industrial extension staff has helped many Georgia manufacturers out of difficult positions since the program began in 1961. Today, a team of 22 technical extension specialists backed up by the research and academic staff at Georgia Tech, helps established companies as well as beginning businesses. Georgia Tech's assistance is not solely confined to engineering questions; the staff routinely handles problems involving most areas of business.

A staff engineer in EES' Industrial Extension Division performs a noise analysis test in a granite quarry near Macon. EES provides extensive assistance to Georgia industries with technical problems.

"We're generalists," explained Berg. "Most of us are engineers and we're problem solvers. Everyone in our division has had actual business or industrial experience."

Industrial outreach engineers help companies locate financial support and advise them on how to meet government safety regulations. They also offer energy conservation recommendations to industry along with suggestions for improving plant productivity. A good example of this work is a project sponsored by the Elberton Granite Association and the National Science Foundation aimed at increasing productivity and reducing noise pollution in the stone-cutting industry. Georgia Tech evaluated various cutting technologies and came up with a design using a water jet. The jet can cut through granite at reduced sound levels and at several times the speed of conventional methods.

Technical assistance comprises only part of the Georgia Tech industrial outreach mission. The program al

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Russian research quality rated highly

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century old and stocked with homemade equipment, but research quality was first rate. In a similar vein, Wiltse said that Russian research budgets were higher than those of the U.S. government, yet dollar-for-dollar returns may not be as great as they are in America. However, Dees added, "When they focus on one research area in the Soviet Union, they really plow in and get results."

The Georgia Tech researchers made their visit to the Soviet Union in the midst of a freezing of Russian-American government relations. In fact, much of the interest the trip generated in the American technological community dwindled after the Russian invasion of Afghanistan and the Olympic boycott movement. Why did the Tech microwave specialists continue with their plans?

"Because our trip was really an importing trip," said Grace. "The purpose was for our hosts to tell us about their activities. The Russians were so enthusiastic in briefing us on their technological accomplishments that there was no time left for them to even ask the Americans about their research."

All three men came home with warm memories of their excursion into the Soviet Union, largely because of the friendly reception given them by the Russian scientists. However, they said their visits to labs in western Europe were also rewarding.

"They were not in any sense behind us (in America) technically," Grace said. He was impressed with efforts being undertaken in Norway and Denmark to harness ocean wave energy for electric power. According to Grace, Scandinavian researchers have set up structures in the ocean which cause waves to focus into narrow points on the shoreline. At those points, the surf is unusually high and machinery exists to convert that power into usable energy.

Laboratory facilities in both Norway and Denmark were exceptionally fine, Wiltse said. In contrast to the Soviet labs, equipment here was ultra-modern and lighting was excellent. Some laboratory floors in the facilities toured were made of hard wood, even in machine shop areas.

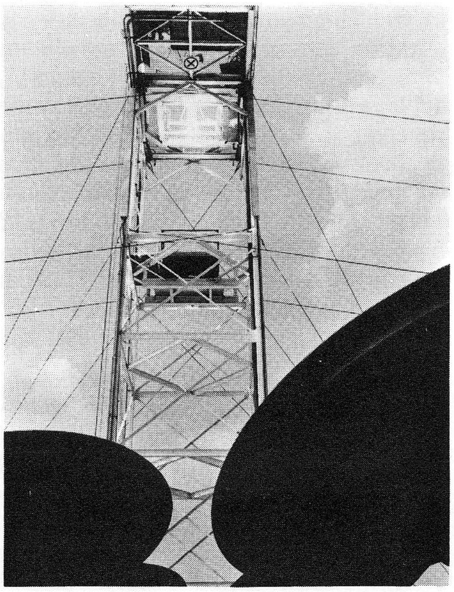
Dees found the millimeter wave technology at the Max Planck Institute in Bonn, West Germany, to be superior. This equipment is used in low noise receivers for radio astronomy applications. "The West Germans are equal to if not ahead of us in low noi receiver technology," he said, "part cularly in areas of sub-harmonic mixers and cooled front ends of receivers in the 100 to 600 GHz range."

Solar reactor might produce syngas

Of all problems facing solar engineers, perhaps the most difficult involve storage. How does one collect and retain energy from the sun? For some years, Georgia Tech researchers have worked with systems for storing this energy as heat in fluids and solids. These systems face two problems: 1) the storage time is limited by the ability to insulate against heat losses and 2) it is impractical to transport the energy and the storage medium from the energy collection point to the sites where the energy is to be used.

Nature, however, has inspired additional answers to the storage problem. One is the ability of simple chemical compounds to hold tremendous amounts of solar energy in chemical form for long periods of time. Trees use the sun's rays to produce chemical compounds which form wood. The same process occurred in the formation of oil and coal, and today that energy is released after thousands of years of storage.

EES researchers hope to build a special solar reactor which would make use of this principle. The reactor would employ heat from the sun to link carbon and water into combustible chemical compounds. The result of this union would be syngas, a mixture of



A solar reactor on the tower at Georgia Tech's Advanced Components Test Facility glows with light reflected from solar mirrors. The reactor is undergoing tests to see if syngas can be made efficiently in it.

carbon monoxide and hydrogen which could be substituted for scarce fuels in numerous industrial and residential applications.

Syngas could be used directly as a fuel for heating or cooking. Manufacturers also could convert it into synthetic gasoline, alcohol or natural gas for broader applications. The hydrogen compound in the fuel could serve as a raw material in the production of farm fertilizers. And with minor chemical changes, syngas could be changed into methyl alcohol, one of the principle raw materials in plastics. At present, two-thirds of America's methyl alcohol is made from oil.

What are the elements of the process which Georgia Tech proposes for the manufacturing of syngas? One promising possibility is to mix steam and coal in a cylindrical reactor, then expose the contents to intense sunlight beamed from a field of solar mirrors. A temperature of 1800 degrees fahrenheit would be required for the syngas reaction to proceed.

The type of reactor envisioned is known to researchers as a fluidized bed reactor. Georgia Tech is already working with Westinghouse to determine the feasibility of this type of reactor for solar applications. In such a reactor, a bed composed of a carbon-based material, such as coal or sawdust, is agitated — or fluidized — by steam rising up from the base of the reactor. The agitation is necessary so that the solar energy being beamed into the reactor will heat the different particles in the bed at the same speed.

One problem with this type of reactor is that the rate at which the steam is released into the bed must be changed as the temperature of the bed rises. For this reason, EES researchers are considering a reactor design for agitating the bed with a mechanical stirring device.

At present, Georgia Tech is one of the few U.S. research organizations studying this concept intensively. EES has begun discussions with the Department of Energy which may result in the construction of a solar reactor of this kind in Georgia.

Industrial outreach serves Georgia

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works to bolster local economies in Georgia. Staff engineers help communities to get industrial parks, advise development groups on strategies for attracting industry and then help Georgia cities to sell themselves to companies as sites for relocation.

To carry out these extension activities, Georgia Tech maintains eight field offices in the following cities: Savannah, Gainesville, Rome, Douglas, Carrollton, Augusta, Macon and Albany. These offices provide resident field engineers who have the advantage of being familiar with local needs and who can call on back-up support from Georgia Tech's extensive technological resources.

While most of the short term industrial outreach assistance is provided at no cost to the company, extended assistance programs are usually done on a contract basis.

In the near future, EES' program in industrial outreach will place growing emphasis on helping Georgia industries to remain competitive through increasing their productivity. The potential benefits of applying new manufacturing technologies including microprocessor controls and robotics will be offered to engineers and managers through seminars, technical bulletins and demonstrations. Companies will be able to obtain the assistance of EES engineers in assessing these advanced technologies from U.S. and overseas sources and in relating them to their particular needs.

EES REPORT

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Millimeter waves to change war tactics?

Twenty five years ago applications resulting from millimeter wave research were a curiosity in the electronics field but today Pentagon officials regard the resulting technology as one of the factors which could radically change battlefield tactics in the 1990's.

Millimeter waves make it possible to provide radar tailored for battlefield conditions. Millimeter wave radar units can be made smaller than common lower frequency radar, and are therefore much more portable. They also penetrate rain, fog or dust with more effectiveness than standard visual devices and identify and single out targets, such as tanks, with extremely high accuracy and resolution of detail.

Georgia Tech researchers are helping the Department of Defense develop several military uses of millimeter wave technology.

One application is a missile guidance system known as a "beam rider." Under development in Tech's Electromagnetics Laboratory, this system would locate enemy targets such as tanks with a beam of millimeter waves. A missile would then be launched, follow the path of the beam and destroy the tank.

A passive radiometer being designed in the Electromagnetics Laboratory is another approach, with a significant change from the beam rider concept, achieved by placing a millimeter wave receiver in the nose cone of an explosive missile. The missile would thus be guided by a built-in system which homes in on natural radiation emitted by the target, rather than by an independent guidance system. Such a system has good accuracy but is limited in tracking range to, usually, less than ½ mile.

A more expensive radar system under development in the Radar and Instrumentation Laboratory could give these so-called "smart" missiles longer-range accuracy, up to around three or four kilometers. This active system is built into the nose cone of the missile and allows it to seek out and destroy a tank after it has been fired from a launcher.

Military analysts believe weaponry with such sophisticated guidance systems could aid in offsetting the Soviet Union's tank advantage. For this reason, the Defense Department has sponsored increasing levels of research in millimeter wave development during the last several years. Contracts have gone to institutions like Georgia Tech, which has 25 years of pioneering experience in this field.

"Funding for the program at Georgia Tech has grown consistently over the past four or five years," says Dr. E.K. Reedy, director of EES' Radar and Instrumentation Laboratory. "Half of our lab's research and development business is tied to millimeter waves, either directly or indirectly."

The Engineering Experiment Station is one of the nation's leading research organizations in investigating "what the world looks like through the eyes of a millimeter wave radar system,-- according to Reedy. The investigation includes numerous tests, known as calibrated radar reflectivity measurements, which make it possible to develop the "smart electronics" in a missile seeker to distinguish a tank from other objects.

Millimeter wave technology is still in the developmental state and EES researchers are optimistic about future growth in applications. Nevertheless, work on the technological forefront has created problems. In many instances, EES researchers must make some of the components they need for millimeter wave systems because many of these items are not yet made by manufacturers.

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