EES Report
ENGINEERING EXPERIMENT STATION • GEORGIA TECH

VLSI technology research effort growing at EES

EES RESEARCHERS work at a CALMA CHIPS 220 Integrated Circuit Station. This high resolution color graphics system is used in laying out integrated circuits. Georgia Tech has purchased a CALMA unit which will be employed extensively in the Station's VLSI circuit design research.

A simple comparison shows how much computer technology has evolved in the past 20 years. Today, a $100 microchip, ¼ inch by ¼ inch, holds more information than a 1960 vintage minicomputer which cost $50,000 to $100,000 and was as large as a standard office file cabinet. VLSI (an acronym for Very-Large-Scale-Integration) should broaden even more dramatically the gulf between computer technologies of today and tomorrow.

VLSI refers to advanced engineering efforts to design tiny computer chips with greatly increased numbers of integrated circuits. This technology promises computer users reductions in the expense, size and power requirements of hardware. At the same time, VLSI should increase the speed, reliability and calculating power of computer systems. "In the next decade," predicts Dr. Ken Perry of EES, "we will probably develop computer systems capable of processing information 100 times faster with one tenth the power needed today."

Of course, these developments will not occur magically. Intensive R&D programs are necessary, and Georgia Tech is one of the research institutions committed to building VLSI technology. EES is one of a number of research groups on the Tech campus which are working on VLSI through the new Georgia Tech Microelectronics Research Center. The Center's VLSI specialists have broad capabilities in designing low density chip families and in developing the tools and techniques necessary for general treatment of large complex systems. Moreover, a group of technology assessment experts at Tech are studying the serious societal questions posed by VLSI. Management specialists on campus also will perform cost-benefit analyses to determine the economics of investments in VLSI systems.

EES' major contribution to this effort will be the design and fabrication of custom integrated circuits. The Station already has begun a project for Fairchild Camera and Instrument Corporation to design a number of small- to medium-scale custom-made CMOS (Complementary Metal Oxide Semiconductor) integrated circuits. CMOS circuits are prime candidates for VLSI implementation, since they allow supply voltage to be scaled down, a prerequisite for reductions in circuit size. While the initital project will run for one year, this program is expected to last from three to five years. EES hopes this effort will provide exposure and training in VLSI design fundamentals for Georgia Tech graduate and undergraduate students, particularly those in the School of Electrical Engineering. In this way, Tech will help to expand the pool of engineers with VLSI expertise who are available for industrial work.

EES engineers involved in the Fairchild project will rely on support facilities on the Georgia Tech campus which are being improved dramatically by the Microelectronics Center. The most important improvement in VLSI-related equipment has been the acquisition of a CALMA CHIPS 220 Integrated Circuit Design Station, a very versatile and high resolution color graphics system used in layout of integrated circuits. The Center plans to upgrade Georgia Tech's VAX 11/780 computer facilities and set up a campus-wide network which links five large PRIME computers.

In the future, the Station intends to seek VLSI-related contracts from organizations whose information processing needs require greater speed and power but smaller hardware. Potential sponsors include the American space program, the military and the biomedical industry. To attract research programs, EES will emphasize its proven expertise in basic materials fabrication and characterization, especially for gallium arsenide and III-V and II-VI compound semi-conductors. Other strong capabilities at the Station include ion implantation, advanced crystallography, VLSI systems analysis and design methodology development. EES' long experience with electronics systems operating at microwave and millimeter wave frequencies also enhances its ability to do advanced VLSI research.

Energy forecast model assisting nation's utilities

by Anthony DeCurtis

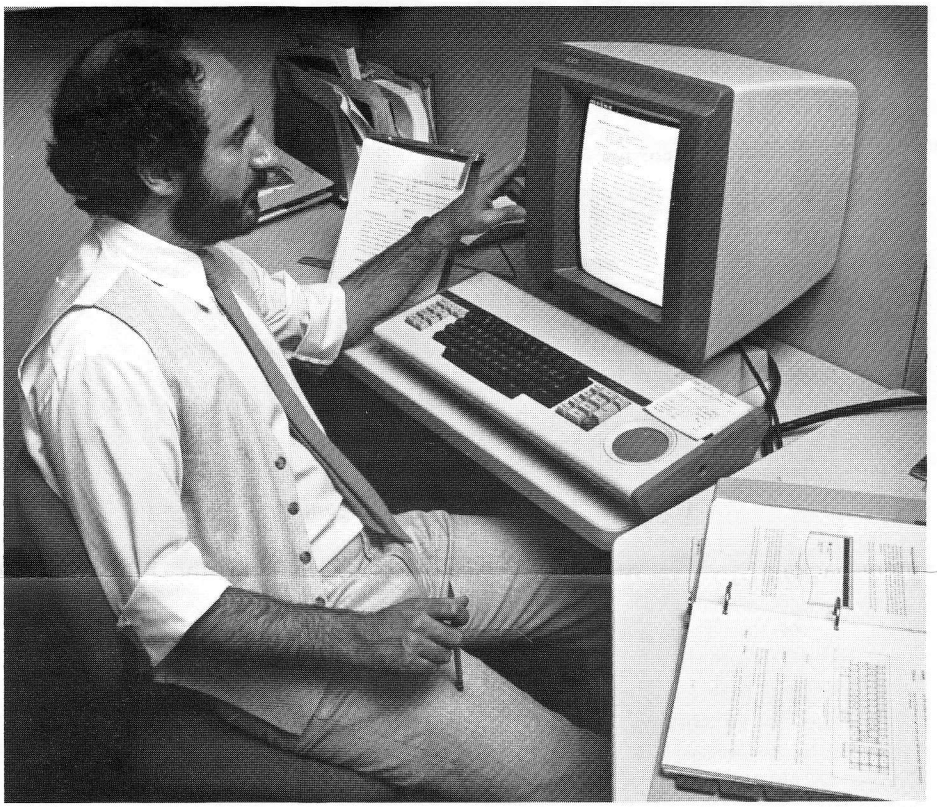
An energy forecasting model developed by an EES economist has become a paradigm for virtually all work done in its field.

In today's volatile energy market, utilities require increasingly detailed and specific forecasts to guarantee their ability to meet future community power needs. How will increased use of electric space heating affect generating capacity requirements or load factors in 10 to 15 years? How will customers react to prices in deciding which kind of energy burning systems to purchase? Will they opt for more efficiency or less in their energy systems? And will they use gas or electricity?

The Energy Economics Program at EES has used state-of-the-art end use forecasting models to help answer the complex questions facing the energy industry. The end use approach has proven extremely well suited to analyzing energy use at the detailed level required by the numerous energy-saving technologies and conservation strategies available today and being developed for the future.

The most distinctive component of end use forecasting is its ability to project the amount of energy consumers will require for specific purposes — space heating, water heating, lighting, for example — and for providing more comprehensive estimates of future energy needs in particular sectors of the energy market.

In 1976, Dr. Jerry Jackson of the Energy Economics Program designed the Oak Ridge National Laboratory commercial sector end use model that has served as the basis of almost all commercial sector end use modeling conducted to date at the federal, state, and utility service area level. Jackson used this model to help the Department of Energy evaluate the Building Efficiency Performance Standards, the schools and hospitals program, and the Federal Energy Management Program. He also used it to evaluate conservation programs and forecast commercial sector energy use for a variety of offices within the Department of Energy.



UTILITY COMPANIES have a pressing need to accurately predict future energy consumption patterns so that they can expand their facilities in a cost-effective way. One highly effective tool for charting future energy patterns is EES' state-of-the-art energy forecasting model.

Jackson is joined in the Energy Economics Group by Robert Lann and Bill Riall. Lann worked four years with the California Energy Commission, where he developed an end use modeling capability for the commercial sector to be used in the Commission's load forecasting system. Recently, Lann extended the commercial sector energy demand model for the New York State Energy Office, enabling it to forecast hourly electric loads for typical peak, weekday and weekend days in each of three seasons. Riall's areas of expertise include economic modeling of the market penetration of energy-related technologies, socioeconomic impact analysis of energy projects, end use energy demand modeling in the commercial sector, and data base and bibliographical development in energy analysis work.

Jackson, Lann and Riall are currently working on a number of modeling projects. For the Bonneville Power Administration (BPA), the Station is developing models of commercial sector space heating choices and floor space stock growth which will help BPA analyze future electricity use in the Pacific Northwest and evaluate conservation policy impacts on commercial establishments.

The Electric Power Research Institute is currently sponsoring a project for which EES is developing a commercial sector and peak forecasting model along with a survey methodology to collect data to support it. The Georgia Power Company and the Long Island Lighting Company are test-marketing the model and survey techniques in their service areas.

And in a project recently completed for the New York State Energy Office, EES assembled relevant data and analyzed trends in commercial space heating fuel choices and developed a life-cycle, cost-based microsimulation model to analyze future space heating fuel and efficiency choices. EES also designed a peak demand model for commercial electricity use, employing load curves derived for specific end use/building combinations for this project.

The Energy Economics Program's end use modeling techniques directly address the complexities of our nation's energy future. Sophisticated forecasting of this type is one part of the planning which is necessary to insure that energy's important contributions to our productivity and comfort do not diminish.

Solar electric application successful

In the 1970's, a series of energy emergencies helped to create widespread support for intensive solar energy research in this country. Since that time, the crisis atmosphere pervading the national energy scene has relaxed considerably, as available oil supplies increased and Americans adjusted to higher fuel prices. Consequently, interest and funding for solar R&D programs has lessened and only those technologies which appear ready for rapid commercialization continue to receive extensive government backing.

Researchers have found that solar energy systems which convert sunlight to electric power have the strongest potential for competing economically with conventional energy sources. As a leader in alternate energy development, EES has become increasingly involved in this area. Late last year, Station engineers helped to advance a significant new solar-to-electric application: a Stirling engine used in tandem with a solar concentrating device to generate directly usable electricity.

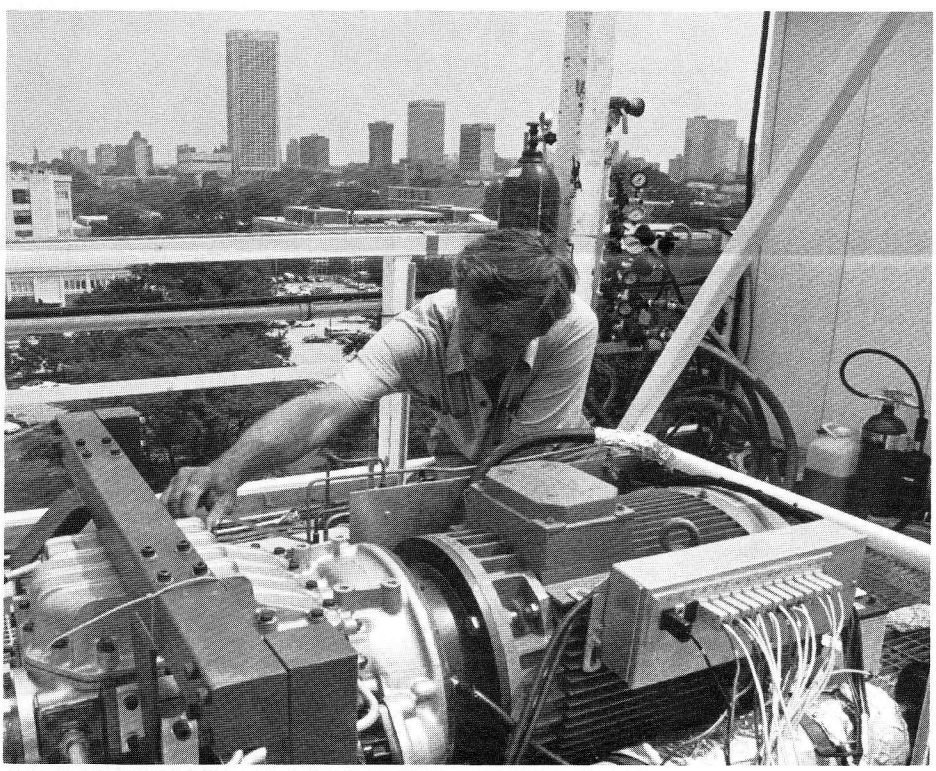
These successful feasibility tests took place at the Advanced Components Test Facility (ACTF), a solar experimentation site on the Georgia Tech campus which the Station operates for the Department of Energy. The testing program was initiated by United Stirling Inc. which brought its 4-95 Stirling Engine to Atlanta to be mated with the 325 kW (Thermal) solar concentrator at the ACTF.

The 4-95 engine-generator combination is a 20 kilowatt model using helium as a working gas in a completely closed cycle. In the EES tests, the engine was positioned in a tower seven stories above a field of 550 mirrors. These mirrors reflected and concentrated sunlight onto a series of tubes running outside the engine. As the helium passed through these tubes, it was heated to high temperature by the intense sunlight. The hot gas was then used to drive the engine's pistons which, in turn, powered the generator.

The Stirling solar application has received widespread exposure in technical and general media throughout the United States. The Solar Energy Research Institute of the Department of Energy considers this technology the most economically promising of its kind. EES engineers who helped United Stirling in its testing program agree. "With development, this application could be three times more efficient than photovoltaic panels in converting sunlight to electricity," reports Douglas Neale, a Station researcher who directed EES' participation in the Stirling tests. Photovoltaic panels contain clusters of small silicon solar cells, which convert sunlight to electricity. However, the power which they produce is low voltage direct current instead of alternating current and must be modified for use in conventional power lines.

Encouraged by the success of the Georgia Tech feasibility tests, United Stirling is proceeding with plans to market a Stirling Engine-based solar system which employs a generator and parabolic dish. The company believes that its system can function as a stand-alone facility (one dish) to supply the power needs for irrigation or desalination in remote villages. United Stirling executives also think that multiple engine parabolic dish arrangements may be deployed to create megawatt-sized systems which supply power to utility grids for peaking demands or the electricity needs of small communities.

EES researchers believe that the Stirling solar application will have its greatest impact when used by large electricity consumers to "shave peaks" off their power usage. In Georgia, electric utility rates are set according to the single period during the summer when customers use the most power. Lowering peak usage of electricity can dramatically reduce a company's electricity bill.



THE STATION participated in a highly successful solar energy-to-electric power R&D program recently when a Stirling engine shown here was mated with the 325 kW solar concentrator operated by EES on the Georgia Tech campus. The current generated was directly usable.

EES REPORT

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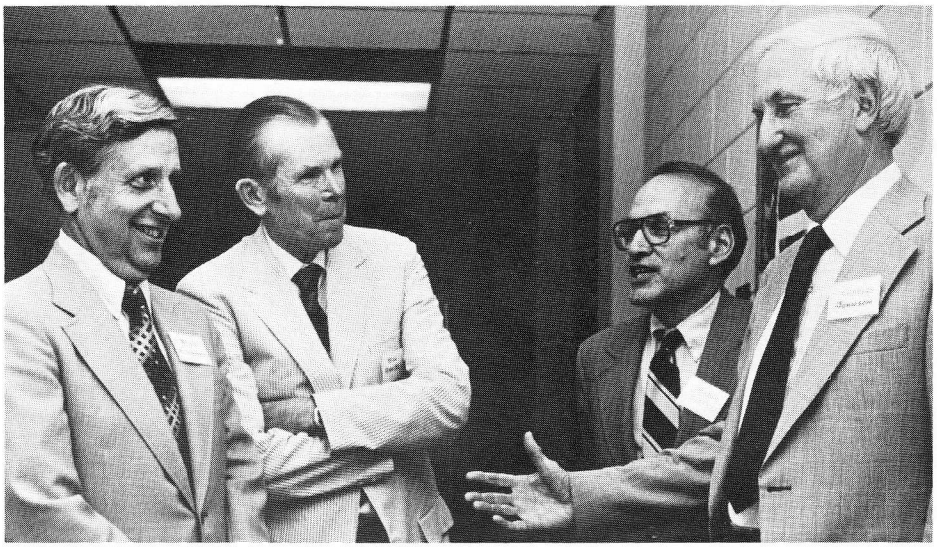
Advisory group helps EES chart future direction



THE STATION'S External Advisory Board recently met on the Georgia Tech campus to critique EES' operation and offer suggestions for improving research activities here. The Board is composed of a number of prominent members of the American research community, including (from left): William Leithauser, general manager of the Range Manufacturing Department of General Electric; William R. Rambo, former director of Stanford Electronics Laboratories; George Dieter, dean of the University of Maryland's College of Engineering; and Charles M. Johnson, manager of the Advanced Studies and Analysis Division of IBM.

Members of the External Advisory Board gave EES a good report card and a lot of advice during a two-day meeting at Georgia Tech in late May.

Dr. Charles M. Johnson, manager of the Advanced Studies and Analysis Division of IBM, said he was impressed and astounded with the number of contracts in the electronics laboratories. However, he suggested that the Station generate fewer proposals for larger contracts.

William R. Rambo, former director of Stanford Electronics Laboratories, said "Tech is broadly appreciated and sometimes hated by competitors in areas especially like millimeter waves where we (Stanford) are leaders." He said EES should concentrate on its strengths which he said include: 1) availability of the academic faculty 2) instrumentation and 3) demonstrated capabilities.

All the advisors stressed increasing the interaction with academic researchers. They noted that the academic side could benefit from the broad management skills available in EES.

William Leithauser, general manager of the Range Manufacturing Department of General Electric, said there appears to be a duplication of work and equipment at EES. He pointed out that the Station's millimeter program is being done in various laboratories, and that each lab has its own computers. Dr. Donald Grace, director of EES, added that Associate Director Dr. James Wiltse is heading a committee to study the use of computers in EES from an overall basis.

Leithauser suggested that when engineers are laid off in one lab for lack of work they might be retrained at minimal expense for work where it is needed in other labs. This might be preferable, he said, to hiring a new engineer. He also suggested recruiting among depressed industries where layoffs are occurring.

George Dieter, dean of the College of Engineering at the University of Maryland, said he found good morale in the resources labs and he was impressed with creative programs underway in the Energy and Materials Sciences Laboratory. Dieter said he was pleased to see EES examining growth possibilities in manufacturing technology and materials handling, but suggested the pace might be accelerated. Dieter said there is no other engineering university which has a research center the size and magnitude of EES.

EES' External Advisory Board annually reviews the past and present status of the Station, and recommends methods by which EES may achieve its development goals.

For Advisory Board members who missed this session, another meeting will be held on October 19-20.

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