EES Report

Geoprocessing speeds mapping process

In Georgia, nothing illustrates the versatility and practical importance of high technology any better than computer-drawn maps of the state produced by EES. These electronic representations of Georgia can identify approximately 50 kinds of land cover on a color-coded video display. Information for this process is derived from Landsat, a U.S. satellite which has been scanning the earth's surface since it was launched in 1972. Over the past decade, the satellite has taken many highly-detailed images of Georgia which together illustrate dramatically the changes the state has experienced in the 1970's. Using the satellite data and other data sources, the Station has developed techniques useful for many practical purposes. These include the identification of long-term urban growth patterns, the study of farming trends, the search for appropriate sites for landfills or toxic waste dumps, the analysis of the effects of coastal real estate development on the marine environment and the location of natural resources in the state.

These valuable applications are just several examples of geoprocessing, an emerging research discipline at EES which puts computer technology to work solving problems with a spatial dimension. Traditionally, manually-prepared maps have stored and displayed geographic information. But this approach is inherently limited. Most maps are outdated by the time the data they represent are collected, analyzed and graphically displayed.

"Recent innovations in computer technology have provided for the automation of certain manual cartographic techniques and have markedly reduced the acquisition and production time needed to make maps," says Nicholas Faust, director of EES' geoprocessing program. "Moreover, computers can redraw maps to answer additional user questions or take a different view of the same problem."

Until last fall, EES' effort in geoprocessing was split among several research groups at the Station. Then, a major reorganization of electronics laboratories sent five professionals in this field to the Electromagnetics Lab, where a Geoprocessing Technology Group was formed under Faust's leadership. The group's composition is as multi-disciplinary as geoprocessing itself, with expertise in such disparate fields as geophysics, mathematics, geography, physics, city planning, systems engineering and electrical engineering.

Faust is primarily interested in focusing on research and development rather than on projects which call for a

Station designing energy integrated farm in Georgia

Engineers at EES are installing a comprehensive energy system at a North Georgia dairy, expecting that their work will give other large farms a reliable blueprint for moving toward energy independence. This demonstration is one of eight "energy integrated" farms sponsored by the Department of Energy (DOE) at locations throughout the country. The aim of the program is to show that American agriculture, which accounts for 2.5 percent of the nation's annual energy consumption, can thrive on non-fossil fuels provided that they are used with a high degree of efficiency.

The site of the research program is Aubrey Farm, a family-owned cor-
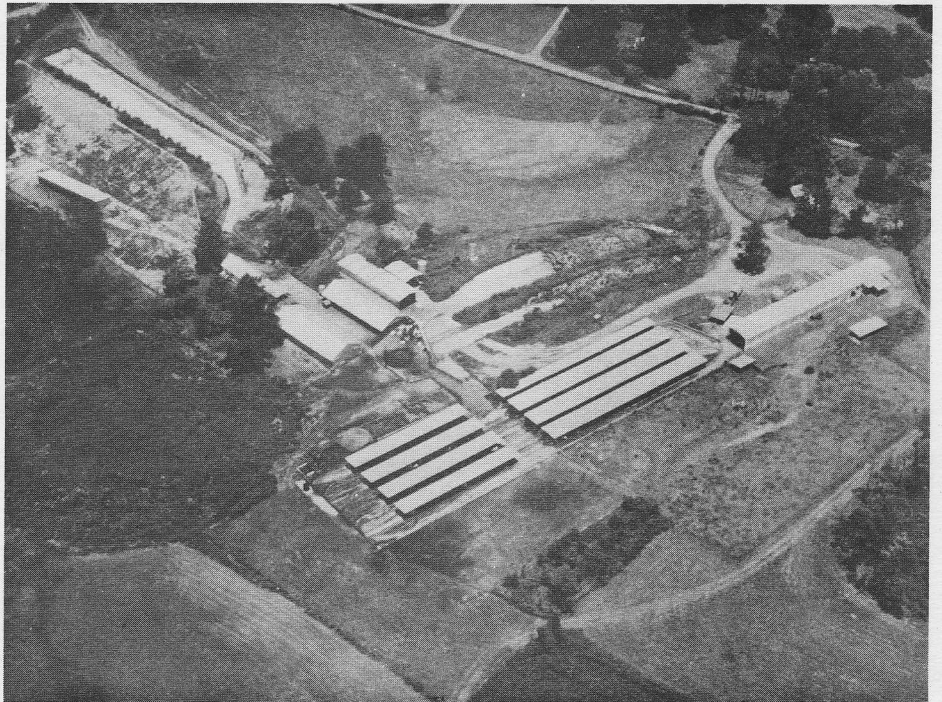
This aerial photograph shows the dairy operation at Aubrey Farm near Cartersville, Georgia. EES will design and install a comprehensive energy system here for the Department of Energy.

EES active in computer geoprocessing

repitition of techniques which the group has already developed in previous programs. Typically, a geoprocessing system designed by the Station is a three-leveled package. The first and most important level is the data base, with capabilities for data collection, manipulation, coordinate transformation, storage retrieval and display of geographic data. Level number two gives users the ability to do sophisticated analyses with data bases. The final level of a typical system allows users to do spatial simulations in order to answer "what if" questions.

Over the past decade, EES has undertaken a variety of Landsat-related geoprocessing programs. The first externally-funded work was a land-use mapping project done for the State of Georgia from 1972-74. Station engineers processed Landsat data of Atlanta and produced a color map showing the metro area on a 1 to 24,000 scale. Over the next three years, EES provided training sessions and demonstrations for various agencies in state government, showing them the potential uses of Landsat data in their work. In connection with this project, the Station did preliminary work to integrate satellite data into a proposed statewide geographic data base.

A subsequent research program focused on methods for using Landsat data to detect significant changes in land use. The sponsor of this work was the University of Georgia's Agricultural Experiment Station. Since 1978, EES' geoprocessing group has worked jointly with the University of Georgia's Department of Geography to present two short courses a year on new and innovative techniques for earth resources data analysis. Participants study basic photographic interpretation techniques and preliminary analysis of Landsat digital data at the University of Georgia. Then they go to EES and get experience in using the Station's advanced Image Analysis System for interactive processing of Landsat data.

Already, EES' geoprocessing program has gained national recognition for its research in remote sensing (Landsat) and geographic data base analysis. However, Faust believes that the group's distinctiveness is its versatility.

"A number of research organizations do one thing or another well in this field," he explains. "But our reputation is based on our combination of skills. We can take a project through all of its phases, from hardware fabrication to data base collection to programming. In other words, we develop complete systems and they're easy for operators without extensive computer experience to use."
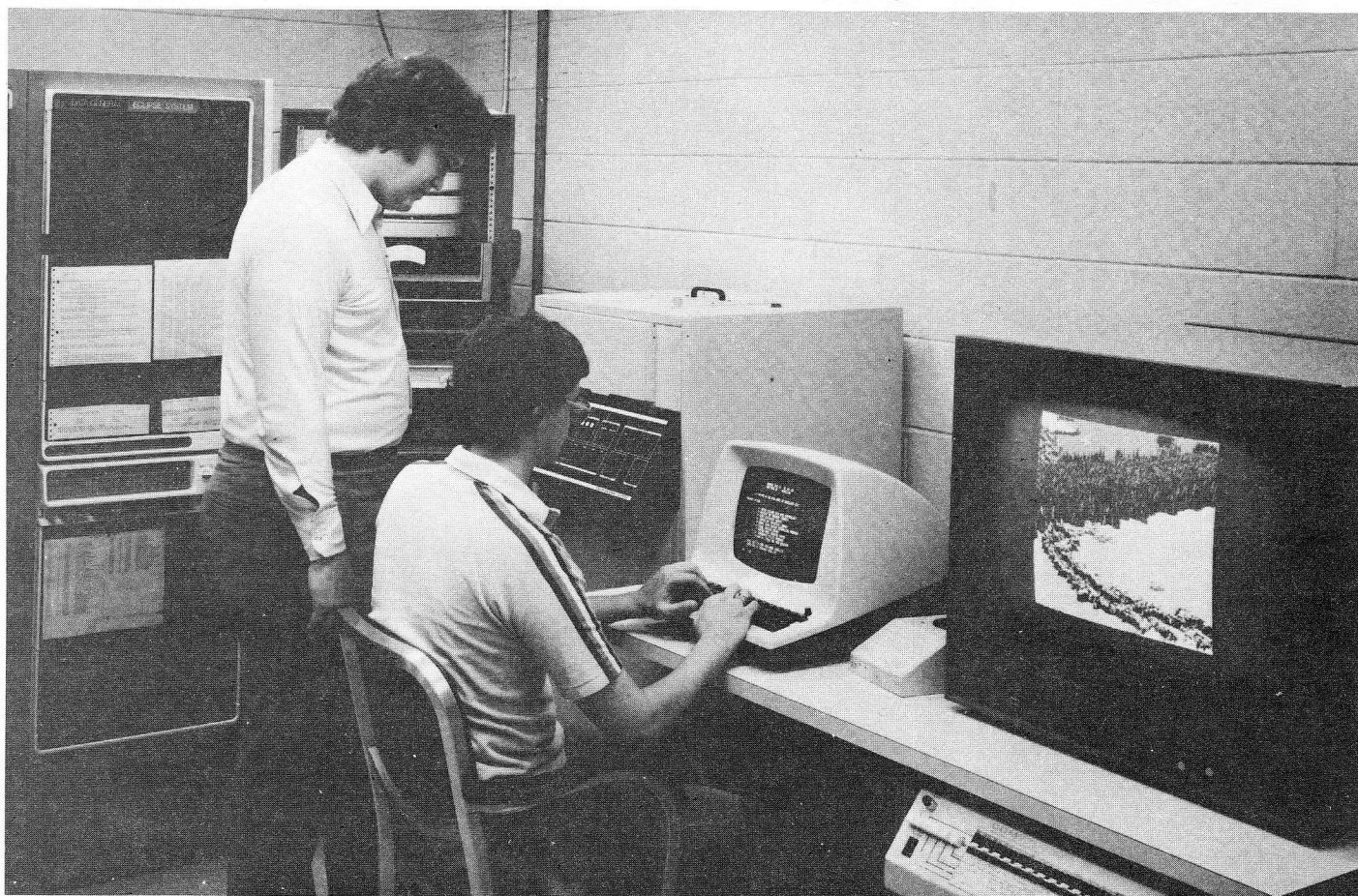
EES' Electromagnetics Laboratory has one of the nation's most versatile programs in geoprocessing, a research field which uses computer technology to solve problems with a spatial dimension. Here, researchers work with the Station's sophisticated remote sensing equipment.

Energy will be produced on farm

poration located 50 miles north of Atlanta, near Cartersville, Ga. The farm totals several thousand acres, of which 1,200 are devoted to crops and dairy operations. The remaining acreage is timberland. The farm's present energy needs are 25,000 kilowatt hours of electricity per month, 11,000 gallons of gasoline per year for trucks, 10,000 gallons of diesel fuel per year for farm machinery and 2,600 gallons of liquified petroleum gas per year to heat the farm's milking parlor and mobile home as well as to power the farm's irrigation pumps.

EES engineers expect to supply most or all of the Aubrey Farm's energy requirements with on-site systems fueled by renewable energy sources produced on the farm. The hallmark of the Station's approach will be to integrate thoroughly the various energy systems in use. It is difficult to describe how this integration will take form, but the schematic design accompanying this story shows the connections.
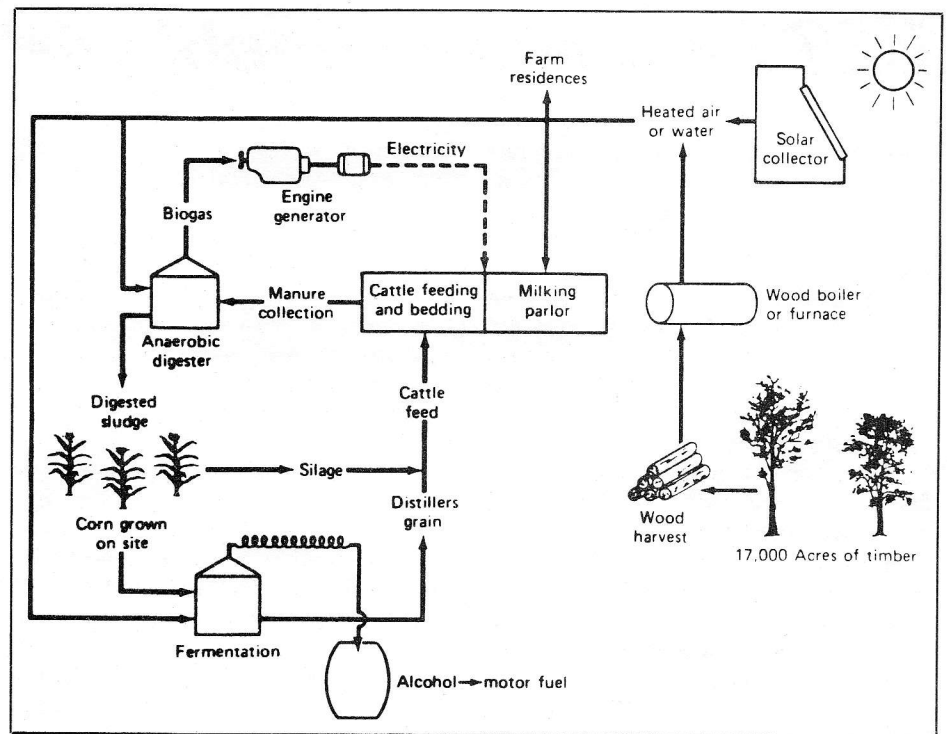
EES is evaluating the following concepts to generate energy on Aubrey Farm:

• Electricity will be provided by an engine generator which runs on

This diagram shows the integrated energy systems planned by EES for Aubrey Farm in Georgia.

methane gas produced by an anaerobic digester. This digester will produce methane by breaking down cow manure by anaerobic fermentation. Engineers will install waste heat recovery equipment on the engine/generator in order to heat water for other farm activities.

• Sludge from the anaerobic digester will be mixed with feed or used as a fertilizer.

• Wood cut on the farm will serve as a fuel in a boiler or furnace with the resulting energy used to produce alcohol or to heat farm buildings and residences. Solar collectors will heat water for the dairy operation.

• Corn grown at the farm will become the feedstock for a fermentation process which produces alcohol usable as a motor fuel. The distillers grain which is a by-product of this process will also be fed to farm animals.

• Farm energy surveys will lead to energy conservation practices which will cut energy needs to a practical minimum.

At present, the project work is focused on the design of the alternative energy systems. Tech engineers have spent the first six months of the program monitoring farm energy consumption patterns to fix design parameters. In addition, they have evaluated technology available from both U.S. and foreign manufacturers for use on the farm.

The Aubrey Farm program will last for four years and cost an estimated $688,500. DOE's share of this expense is $378,700, with the remaining $309,800 coming from state funds. EES personnel participating in the research program are members of the Station's Technology Applications Laboratory and Energy and Materials Sciences Laboratory.

Corporate Liaison Program underway

EES is participating in a Corporate Liaison Program which will make Georgia Tech's resources more readily available to businesses and industries, particularly those which are technology-based. This Institute-wide effort is designed to assist participants with problem-solving, to help them establish working relationships with Georgia Tech faculty and staff and to give them aid in opening new avenues of commercial development. Moreover, members of the program will receive continuing information on the latest research developments at Tech.

Members of the Corporate Liaison Program are asked to contribute $20,000 or more per year to the Georgia Tech Foundation, a tax-exempt organization. A campus liaison officer will be assigned to each member. He will ensure that the com-

pany's contacts with Georgia Tech are as productive as possible.

Specifically, the liaison officer is charged with:

• Visiting the company and discussing with management and technical personnel their topics of interest;

• Expediting responses to all inquiries;

• Bringing to the attention of member firms new developments of interest;

• Identifying faculty and staff, at Georgia Tech or other universities, whom the member company may wish to use through sponsored research programs, consulting arrangements or programs of continuing education; and

• Making all arrangements for visits to campus by representatives of member firms.

EES helping to simplify defense systems

In recent years, America's defense systems have grown increasingly complex while the availability of skilled personnel has declined. For this reason, the Department of Defense is giving greater emphasis to studies of human factors which insure that the operational requirements of defense systems mesh better with human information processing capabilities. EES is contributing to this effort through two major programs in basic and applied research. These contracts are being administered by the Station's Systems Engineering Laboratory (SEL), under the leadership of Lab Director Robert Zimmer and W.E. (Bud) Sears.

The Air Force Human Resources Laboratory is sponsoring the first of these contracts. Through this program, SEL's Psychological Systems Group developed an operational computer model which simulates and matches human performance in tracking, the principal activity involved in piloting an aircraft or driving a car. One of the model's strongest features is its reliance on existing knowledge of human mental processes. With further development, this characteristic should enable the model to describe more complex kinds of human behavior. These include decision-making, communications in command and control systems, and multiple-task, multiple-cue functions such as piloting an aircraft. This program involved the close collaboration of two experimental psychologists, Lee Davenport and Dr. Joanne Green, and two engineers, Harold Engler and Sears.

Last year, the Psychological Systems Group won another major contract, this one with the Air Force Aeronautical Systems Division. The purpose of the program is to investigate the visual and mental processes involved in tracking signals on radar displays so that this information can be used to design more effective countermeasure techniques. The first stage of this research will be to develop hypotheses about the cues used by human operators in tracking, based on a survey of current radar operating techniques and a review of the psychological literature on visual information processing. These hypotheses will be tested experimentally with human subjects by systematically varying visual information in a task designed to generalize to operational scenarios.

SEL expects to continue making important contributions to psychological science and applying the results to defense systems development. Dr. Ted Doll will lead the contract development effort for the Psychological Systems Group. One area in special need of further research is communication in command and control. In programs of this nature, Doll's group offers strong experience in performance measurement, modeling and simulation. These capabilities qualify the group to assess individual and team performance, to model communication networks and to optimize human-computer interaction in command and control systems.

The Psychological Systems Group also is planning to pursue basic research to determine the efficiency with which people can process information in one rather than both cerebral hemispheres of the brain. This research could help defense specialists in designing more effective visual-motor tasks.

Another area of potential research involves human engineering analysis to improve the visual and auditory cues for operators of radar warning receivers. These receivers warn pilots when they are being illuminated by radar which is being used to aim anti-aircraft artillery and to guide surface-to-air missiles. Present information systems can overload pilots, especially in combat and multi-threat environments. Research efforts will apply the existing body of knowledge about human information processing. The major result will be human factors design recommendations which facilitate communication between the radar warning receiver and the pilot. The recommendations may include advanced visual displays and a synthetic voice warning system with a large repertoire of responses. These communication devices will be simpler, less confusing and less demanding of the pilot's time.