GENERAL ELECTRIC

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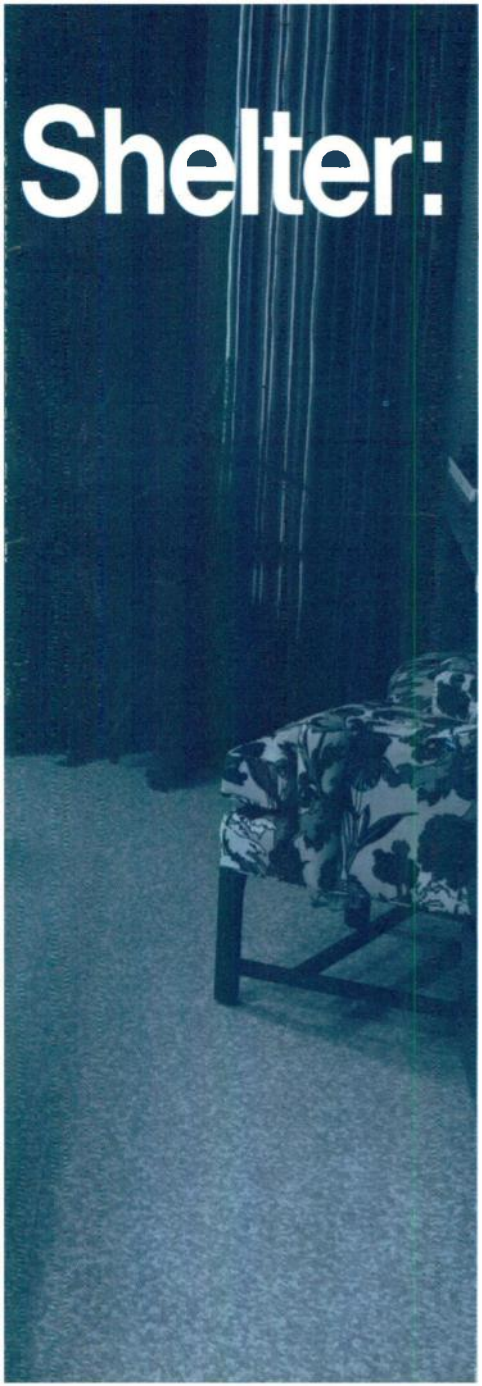
Monogram

1971

Shelter: Developing new technologies and industrial techniques to close the housing gap.



Shelter: an impending environmental crisis

The ever-widening housing gap in the United States is becoming a problem of increasing national concern. The consensus of government and industry experts is that during the Seventies an average of 2.6 million residential units must be built annually to eliminate the current shortage and accommodate future demands. Yet, recent family unit construction including mobile homes has been at least a half-million units shy of this goal.

Operation Breakthrough. A few years ago the Department of Housing and Urban Development (HUD) initiated a program called "Operation Breakthrough" to reduce or eliminate the constraints on our present housing system and to develop new and better means to provide housing on a national scale.

The objectives of "Operation Breakthrough" are to:

- Reduce the real cost of housing
- Produce quality homes in volume
- Reduce subsidization costs

Factory-built, modular townhouse has walk-through kitchen and adjoining family-dining area.

- Create a year-round housing industry
- Increase job opportunities for minority groups
- Encourage housing innovation
- Reduce one cause of urban tensions
- Help combat inflation in the housing market.

The Department of Defense and the Air Force similarly were interested in quality housing with an objective of providing a suitable career environment.

New technologies. At General Electric's Re-Entry and Environmental Systems Division conceptual studies for new ideas and new approaches for family housing were explored beginning in 1967.

Preliminary studies showed potential economies with the introduction of new materials, fabrication technology innovations, industrialization of the fabrication process, and the introduction of advanced management systems routinely used by government aerospace and defense contractors.

These cost reductions were to be achieved without sacrificing quality, livability, or attractiveness of the dwelling units.

General Electric was one of twenty-two contractors selected by HUD to produce housing as a part of "Operation Breakthrough". In December 1970, HUD officially broke ground at a site in Memphis at which GE will construct 48 modular garden apartments. These are being built in a factory near Philadelphia, Pa. and shipped to the demonstration project site in Tennessee.

Garden apartments. The GE-developed garden apartments consist of closed modules which fit together to form two-story buildings of contemporary appearance.

Architects Hugh Gibbs, F.A.I.A., and Donald Gibbs, A.I.A., have grouped the apartments so that entrance is through central, bi-level garden courts. Each court serves eight apartments, four to a story, so that each has an attractive, landscaped outside entrance with a maximum of privacy.

The living areas of each garden apartment have exposure on two sides, one of which is to the garden court.

Modular construction. The architects have employed combinations of module set-backs and exterior finishes in order to create the effect of basic structures wider than the 12 feet to which closed modules are limited for transportation reasons.

The building exteriors will be finished with low maintenance materials.

The GE development includes one, two and three-bedroom apartments.

A crane lowers into place the second-floor module of this factory-produced townhouse.

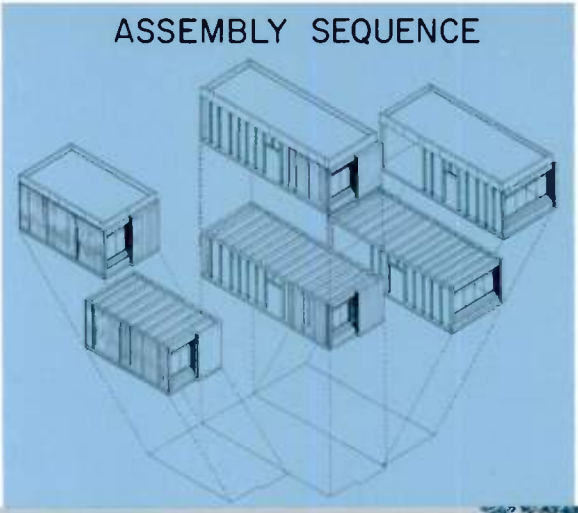
Rooms are arranged for spacious effect as well as practical use. Total areas are approximately 700 square feet for the one-bedroom units; 920 square feet for the two-bedroom units, and 1,050 square feet for the three-bedroom units.

Each apartment has its own individually-controlled electric heating and air conditioning system and hot water heater as well as connections for a washer and dryer.

Unique construction features include steel framing and cast plaster walls, and a central utility core for all plumbing and ducting.

Acoustical control is good, in part because of a four-inch space between the surfaces of the second-story floor and the first-story ceiling, and because apartments are separated by double walls.

The one-bedroom apartments consist of two factory-completed modules, and the two and three-bedroom apartments



Exploded view shows how closed modules fit together to form this garden apartment complex in Memphis, Tenn. Typical floor plans are shown below.

1 BEDROOM APARTMENT

2 BEDROOM APARTMENT

3 BEDROOM APARTMENT

are made up of three modules. The lengths of the completed modules vary from about 18 feet to 30 feet and the height up to 10 feet. The width will be 12 feet in all cases.

A 200-unit project. In addition, General Electric's Re-Entry and Environmental Systems Division is building a 200-unit project for enlisted personnel at George Air Force Base, California.

Basic to this project has been the development and operation of a prototype housing factory. A Company spokesman made particular note of the speed at which the factory was put into operation: "At the beginning of last August not a thing was in place. In the two-and-a-half months since then we have erected factory buildings; installed standard and special equipment; hired and trained the production staff; de-bugged the facility and brought it to a production-ready condition."

This factory is located at Apple Valley, Calif., approximately 15 miles from the building site.

Both government and contractor representatives indicated that the housing system showed definite promise. They noted that the first four townhouses produced in the factory were transported over the roads and quickly erected even in the adverse wind conditions that frequently occur in this area.

Variety stressed. There will be architectural variety throughout the project. Five combinations of low maintenance materials are used on four different dwelling units.

Additional variety is gained through the use of different combinations of individual dwelling units and varying building configurations.

The complete project will occupy 37 acres of land on the base. Gross usable living areas for the types of units are: 1,045 square feet for the flats; 1,350 square feet for the three-bedroom townhouse units; 1,490 square feet for both the four-bedroom townhouses and the single family houses.

The units will be located along a winding central drive and in clusters around a variety of cul-de-sacs. The clusters will be arranged so as to surround and obscure driveways and carports.

Specialized sub-assemblies. The basic housing unit consists of 11 sub-assemblies. Construction features include:

☐ One-piece cast plaster walls and ceilings. These provide at less cost all of the advantages of hand-plastered walls, such as the solid feel and sound of a wall surface integrated into the wall structure. The seam visability and cracking of dry walls is eliminated at competitive cost.

☐ Honeycomb floor panels. Resin-impregnated honeycomb bonded between plywood sheets utilizes a stress-skin effect

Night view shows attractively landscaped, contemporary exterior of GE-built townhouse.

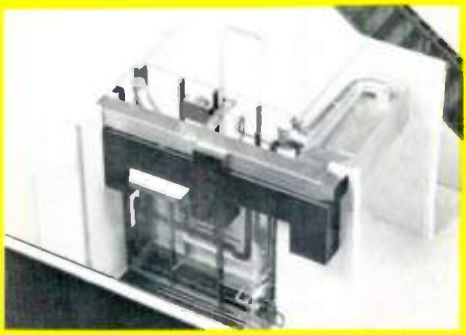
to provide light-weight strength, compactness and rigidity.

☐ Utility chase. All plumbing and heating pipes and vents, air conditioning and wiring are centralized into a virtual plug-in unit. Located centrally within the family unit, noise from use of the utilities is not transmitted into the adjoining housing units.

☐ Steel wall framing. Permits manufacturing speed and close tolerance control. Close tolerances in turn help assure ease of field assembly.

The housing factory receives such bulk items as gypsum, plywood, and hardware and sends out finished subassemblies which go together quickly in the field. The use of a factory allows optimum flow of labor and material. Location near the building site means reduced cost of shipping finished modules.

New technologies for home construction include a utility chase, **top**, which centralizes all plumbing, heating pipes and vents into a virtual plug-in unit. The cast plaster wall, **center**, consists of wire lath fastened to steel wall studs. The wall frame is then lowered into a mold containing a special formula plaster which sets around the lath. The floor panel, **bottom**, is a resin-impregnated honeycomb bonded between plywood sheets.



ERTS:

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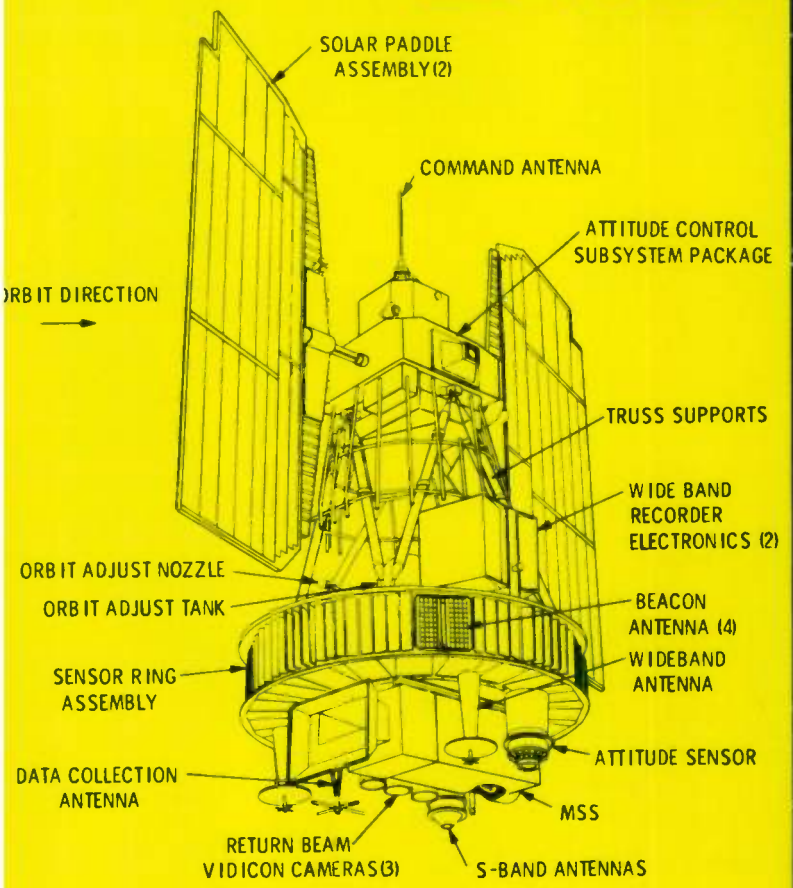
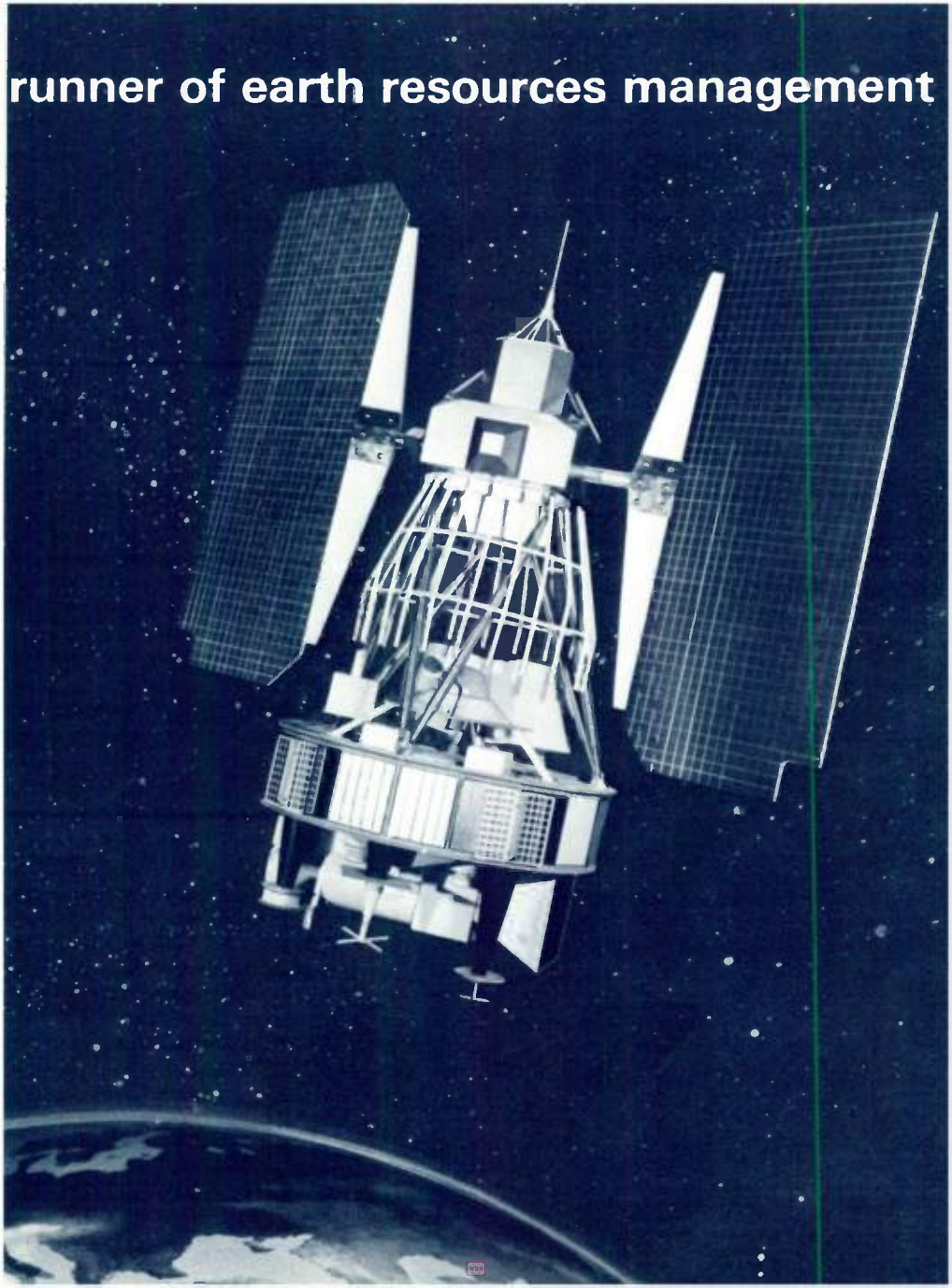

SOLAR PADDLE ASSEMBLY(2)
COMMAND ANTENNA
ATTITUDE CONTROL SUBSYSTEM PACKAGE
ORBIT DIRECTION
TRUSS SUPPORTS
WIDE BAND RECORDER ELECTRONICS (2)
ORBIT ADJUST NOZZLE
ORBIT ADJUST TANK
BEACON ANTENNA (4)
WIDEBAND ANTENNA
SENSOR RING ASSEMBLY
ATTITUDE SENSOR
DATA COLLECTION ANTENNA
MSS
RETURN BEAM VIDICON CAMERAS(3)
S-BAND ANTENNAS

runner of earth resources management



This infrared photo of agricultural and forest land in Louisiana near the Mississippi River was taken from an Apollo spacecraft. The Earth Resources Technology Satellites will have regular monitoring capabilities (color simulated).

Next year science and technology will achieve a new milestone in putting the space frontier to work for the benefit of mankind. A new type of satellite will join the communications relaying and weather observation satellites that are presently orbiting earth.

Called the Earth Resources Technology Satellite (ERTS), this family of continuous monitoring observers will provide man with his best tool for effective management of the earth's resources on a global scale.

Earth Monitor. Special sensors on the first two satellites to be launched will provide data of agricultural, geological and oceanographic significance. Among the various potential benefits of the information collected will be more effective utilization, improved classification of earth surface features, and shoreline analysis.

Earth resources satellites are an extension of aerial photographic surveying.

As early as 1858 a French photographer made excellent aerial photos from balloons in the vicinity of Paris. With the advent of the airplane, which provided a better platform for mounting the camera, the field of aerial surveying was born.

Advances in cameras, lenses, and films moved aerial surveying from a curiosity to a science. The introduction of color film for aerial survey work about 1935 and of infrared film in 1943 further enhanced the value of aerial photography.

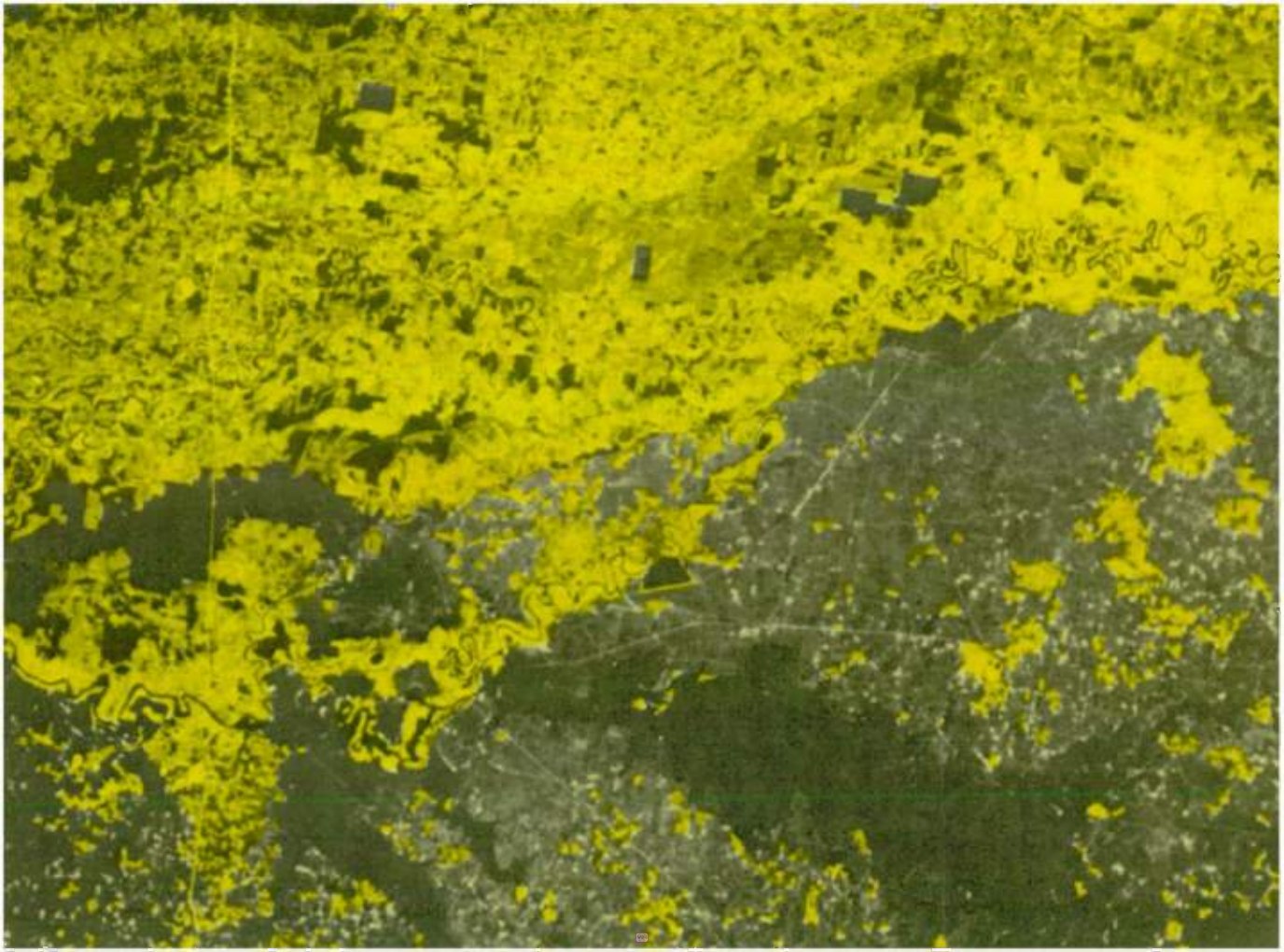
The first photograph of the earth taken from space was made in 1959. By August 1964 the Nimbus weather satellite was routinely returning photographs of the earth's cloud cover.

Polar Orbit. The earth resources satellites to be launched in 1972 and 1973 are unmanned satellites with sensory payloads orbiting the earth in a circular, near-polar orbit. Data, collected on command, will be transmitted to special ground stations for processing, analysis and action.

The ERTS spacecraft being built by General Electric utilizes the flight-proven Nimbus basic design which also was built by GE.

The sensor complement for ERTS A/B will consist of three TV cameras, each viewing a distinct part of the color spectrum and capable of discerning objects as small as approximately 200 feet; a multi-spectral scanner to measure visible and thermal energy radiated from the earth; and a data collection system to receive data collected by instruments located at remote sites on the earth's surface.

On-board sensors for the Earth Resources Technology Satellite program operate over a wide range of wavelengths



including visible, infrared and microwave. Sensors in the visible and near infrared will be carried on the first two spacecrafts in the program. Subsequent satellites may carry a combination of these and other units.

How They "See". The earth emits reflected and radiated energy into space, including wavelengths which cannot be perceived by the human eye. For example, in the "near-infrared", which is just a little too red for the eye to see, some vegetation is even brighter than the green reflections which the eye registers. This near-infrared information can be particularly valuable to farmers and agriculturists.

Studies underway at several universities indicate that it is possible to identify different crops and to distinguish between healthy and sick crops, using visible plus near-infrared information. TV cameras with special filters and tubes are able to sense this near-infrared information.

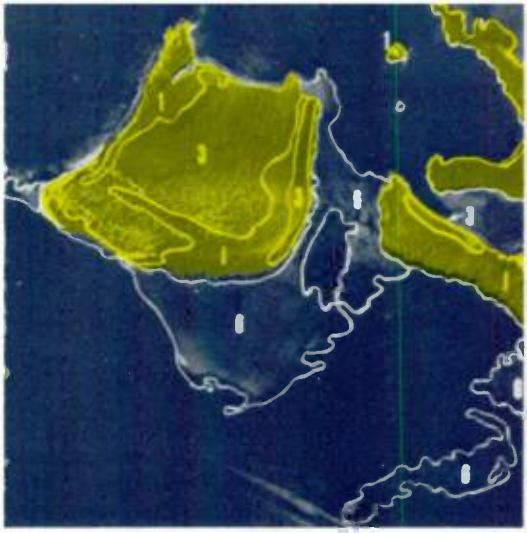
At slightly longer wavelengths, the thermal, or heat radiations of the earth, can be sensed. Ocean currents, rivers, lakes and even subsurface streams can be observed because they are at different temperatures than their surroundings. Hydrologists are particularly interested in this kind of information.

Thermal anomalies also may be of geological interest, possibly indicating mineral deposits. Infrared sensors use sensitive thermal detectors capable of measuring ½-degree temperature differences, even from space altitudes.

Microwave sensing is also important to earth resources management. All materials emit heat radiation. A passive microwave radiometer could receive the microwave radiation signals emitted from the earth, even through clouds. The information in these signals can be used, for example, to establish soil temperature and soil moisture conditions.

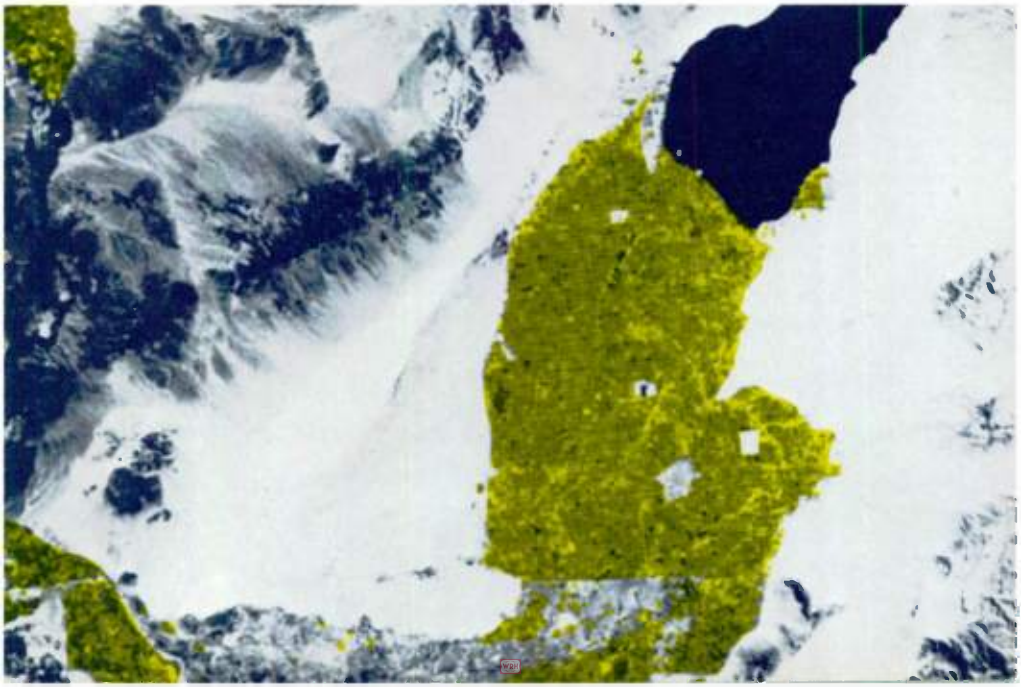
Radar is a special kind of microwave sent out by a radar antenna. Part of the radar signal bounces off the target and back to the antenna. A simple radar scatterometer would send a radar beam to earth where some of the energy will be reflected back to the satellite and measured. The nature of the returned signal is an indication of surface roughness. Ocean sea-state measurement is a possible use of this sensor, but it also has potential for topographic mapping.

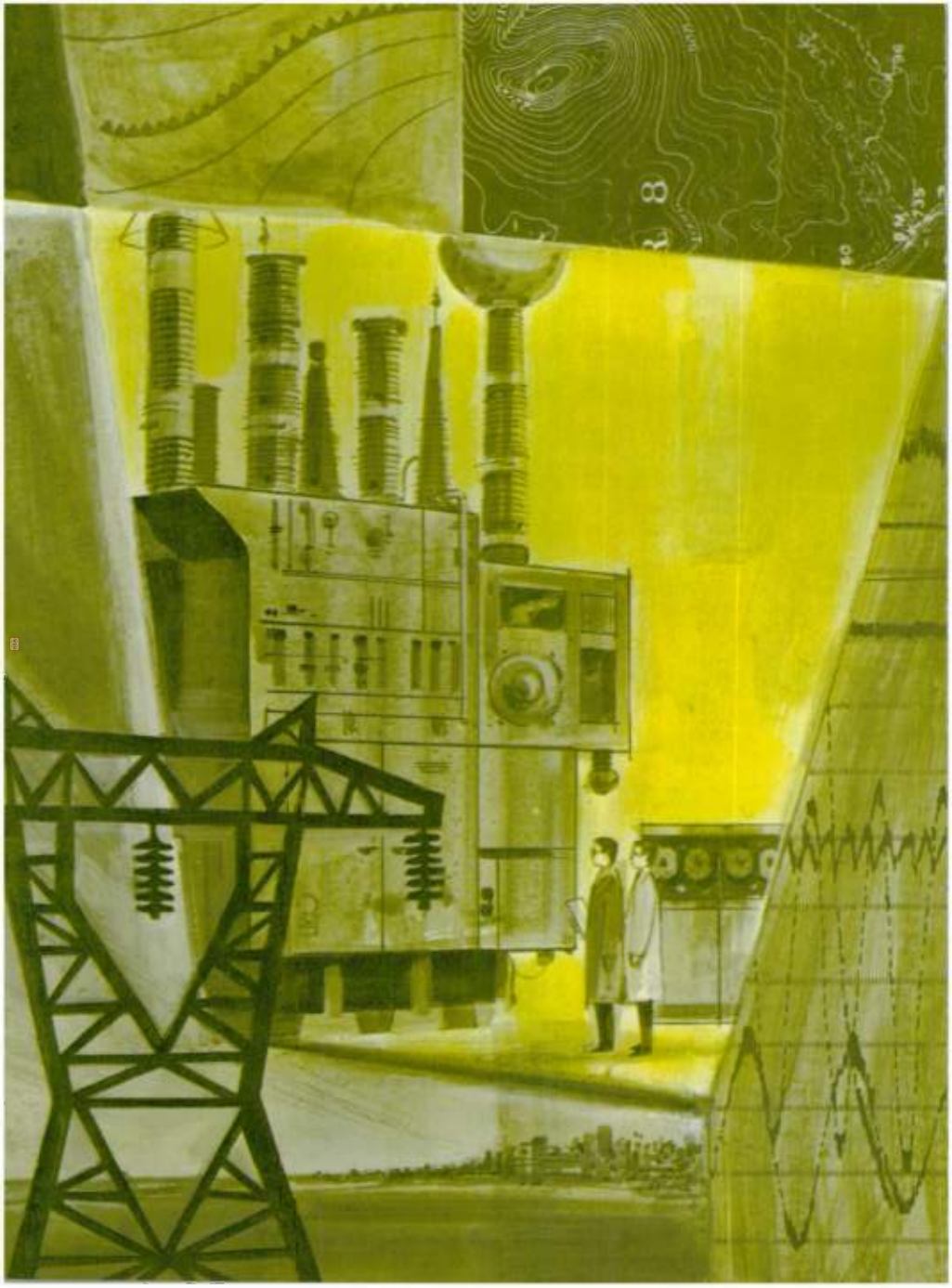
Man has come a long way from the hand-held camera in a balloon aloft over Paris. Soon this highly sophisticated spacecraft will be monitoring an entire planet from a platform 500 miles out in space.



Experts are able to identify the vegetation as revealed in the above photo. Dense mangrove jungles, brackish water marshes and mudflats exposed at low tides are some of the terrain features of Florida's Everglades appearing in this shot. (Colors simulated in all photos.)

Silt being moved by shore currents and a shoal area are identified in this Apollo 9 photo of the shoreland between Charleston, S.C. and Savannah, Ga. Below, a color infrared photo of the crops in the Imperial Valley of Southern California suggests how ERTS can provide data on crop disease.





The Power / Environment Interface

The electric utility industry, like other industries a contributor to environmental ills, is also a major source of cures for them. It has traditionally taken the lead in resolving environmental problems. In 1907 it supported the first air pollution control association. In 1929 the Federal Power Commission included, in a hydroelectric license, provisions to preserve scenic beauty. In 1940 General Electric promoted a modern sewage-treatment disposal system.

In 1970, according to Electrical World, *the utilities will spend nearly 400 million dollars on air and water quality control ... another 383 million on underground lines... and many millions more to improve the appearance of visible power systems.*

R and D projects now sponsored by Edison Electric Institute cover such wide-ranging subjects as effects of thermal discharges into streams, underground high voltage transmission, effects of stack effluents on animals, and design of esthetic transmission towers.

GE's power generation businesses are joining with utilities in studying the use of cooling towers and other means of minimizing the thermal effects of generation on water, and also the practicality of a combined high-temperature vortex incineration and power generation plant.

Another step in the direction of "more-power-but-no-pollution" is the balanced use of nuclear power plants and gas turbines for peaking power. Environmental requirements pertaining to esthetics, air and noise pollution are being factored into the basic design of new GE gas turbines.

Problems resulting from technological progress can be solved by further progress, and by greater utilization of electric energy—not by rationing, as some suggest. Illustrative of the opportunities offered to us by environmental problems are:

- ☐ *The Eugene, Oregon, Water & Electric Board is engaged in a project to pipe hot water from a paper mill to irrigate crops and protect orchards from frost. Water is filtered through soil and returned to the river at normal temperature. A proposal to irrigate millions of acres of semi-arid land with water from proposed nuclear plants in Washington and Oregon is an off-shoot of this pilot project.*
- ☐ *A major source of pollutants going into the air comes from transportation sources. One electric transit car can replace 200 automobiles, and mainline railroad electrification has shown its potential in the Metroliners.*

Technological progress offers the best hope for a future in which Americans can continue to use more electric energy and still enjoy an environment in which the quality of life is preserved.

PROGRESS REPORT:

Transmitting Electrical Power

By 1980 electric utilities must double their productive capacity while continuing to transmit a dependable, low-cost supply of energy.

As an important element of the problem, utilities must maximize the capabilities of electric power transmission corridors at a time when the availability of overhead rights-of-way are a cause of increasing public concern.

Underground transmission has necessarily been adopted in high-load density urban areas where overhead is obviously impractical. In suburban and even in rural areas, where natural beauty or historical importance enters the picture, social pressures tax the ingenuity of utilities and equipment suppliers to find improved or new economic avenues for bulk power transmission.

Research is being intensified in both overhead and underground methods.

Overhead. High voltage transmission is being worked out with the aid of computers to improve towers, insulators and similar hardware. Project UHV, ultra high voltage, is currently providing knowledge for transmission at 500-to 765-thousand volts.

In the future, Project UHV will provide thorough understanding of electrical characteristics of tower structure and conductor configuration requirements for voltages twice this high.

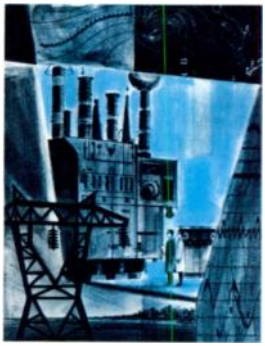
Another such program is the high voltage direct current transmission (HVDC) project which permits a great increase in the efficient use of over-head rights-of-way over long distances. The use of solid state terminals is expected to have a significant impact on reducing the cost of conversion equipment needed at terminals.

Underground. Despite the high cost of underground transmission, as contrasted with overhead cables, usage is expected to increase in the future. Typical underground to overhead cost-multipliers range from 10-15 to 1.

Particular attention is being given to existing and new underground pipe systems. Tests show that load capability of high-pressure, oil-filled, pipe-type cables can be increased by 50 percent or more by forced circulation cooling of oil. Heat is removed from the oil by mechanical refrigeration units and exhausted to the air.

At present, pipe-type cables are available up to 345kV. Current research on pipe-type systems includes cable testing at 500kV, and the 1970s will probably see successful installations at this voltage.

Compressed gas insulated systems for underground use are showing promise.



These systems have a center conducting material and an enclosure for the gas dielectric and insulating spacers to support the conductor within the enclosure. Dielectric losses are negligible.

Since the compressed gas-insulated transmission line's capabilities can exceed 2000 MVA, it is a logical underground extension of overhead—avoiding cost of multiple channels of lower capacity, conventional type cables. For this reason, CGI bus may well represent the next major system development for underground/underwater power transfer.

Cryogenic systems. Cryogenics are receiving intensive investigation under the sponsorship of Edison Electric Institute and TVA. Since 1968, General Electric has been studying the feasibility of using liquid hydrogen at about 425 degrees Fahrenheit below zero to reduce the resistivity of pure copper by a factor of 500 or more. Under this system a single cryogenic underground cable inside an insulated pipe 18 inches in diameter could carry 3000 megawatts of electricity. This amount (three billion watts) is enough to supply one-third of the total power requirements of the entire city of New York.

The cost advantage of low resistance will be offset by added costs of producing low temperature conditions. However, it is believed that cryogenic systems will be found feasible in applications where blocks of power of 5000 megawatts or higher must be transmitted as an equal capacity extension of UHV overhead.

Visionary systems. Other systems which are under study include several which on paper appear to have special interest, for example—microwave transmission.

It is estimated that tranmission by microwave at frequencies of from 2000 to 10,000 megacycles would require wave guides ranging from three to ten feet in diameter, with power transmitting capabilities in the order of 4000 megawatts. Losses associated with this type of transmission, however, are many times greater than those associated with conventional transmission; one recent estimate indicating approximately 25 percent per 100 miles, even assuming a line-of-sight wave guide.

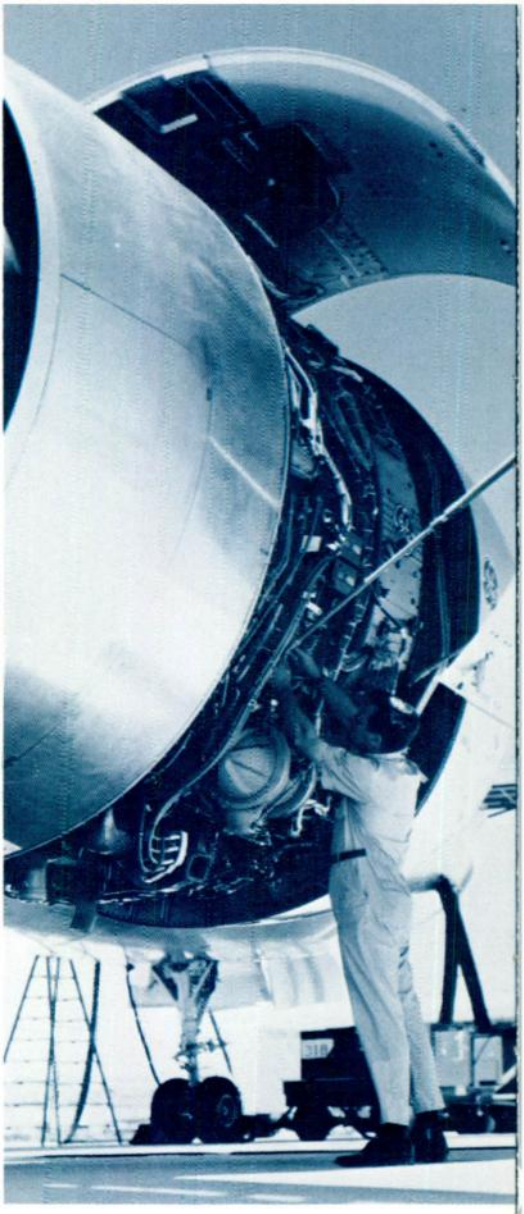
Lasers could be used for power transmission, but probably would be limited to short distances. Theoretically, scientists and engineers report, great amounts of power could be transmitted. However, it is believed that high power loss during inclement weather does not make this method feasible at this time or in the near future.

Interior mock-up of the GE-powered McDonnell Douglas, wide-bodied, DC-10 trijet.

Step into

the new era of quiet, smokeless jets . . .

The General Electric CF6 engines produce 40,000 pounds of thrust each. Even more powerful engines will be used on the intercontinental models.



As she rolls down the runway she looks much like any other jet—the sleek, silvery profile one expects as the symbol of the jet age. But years of research and engineering effort infuses her with characteristics that make her stand out from the crowd.

No black smoke plumes trail behind as three mighty jet engines propelled her down the runway and into the air. Though General Electric's CF6 engines are three to four times more powerful than commercial engines developed in the 1950s, they are nearly smokeless and much quieter.

These quieter engines are the result of basic design improvements and a unique acoustic paneling system which further lowers sound levels. Researchers continue to work on the basic problems of jet noise and engine emissions.

The McDonnell Douglas DC-10 is planned to fill the size gap between the Boeing 747 and the 707s and DC-8s. The initial series is designed for service on domestic routes of 300 to 3600 statute miles.

This three-engined jet carries 270 passengers in a spacious, 20-foot wide configuration. Twelve airlines have already chosen the DC-10. Currently undergoing flight testing, initial reports indicate that the DC-10s' performance has exceeded expectations.

A distinguishing feature of the DC-10 is the appearance of the aft engine assembly. The air intake and nacelle form a straight tube 43 feet long and 9 feet in diameter. The craft is 20 feet in diameter with a 161-foot wing spread and an overall length of 182 feet.

GENERAL ELECTRIC

CAMPUS Monogram

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