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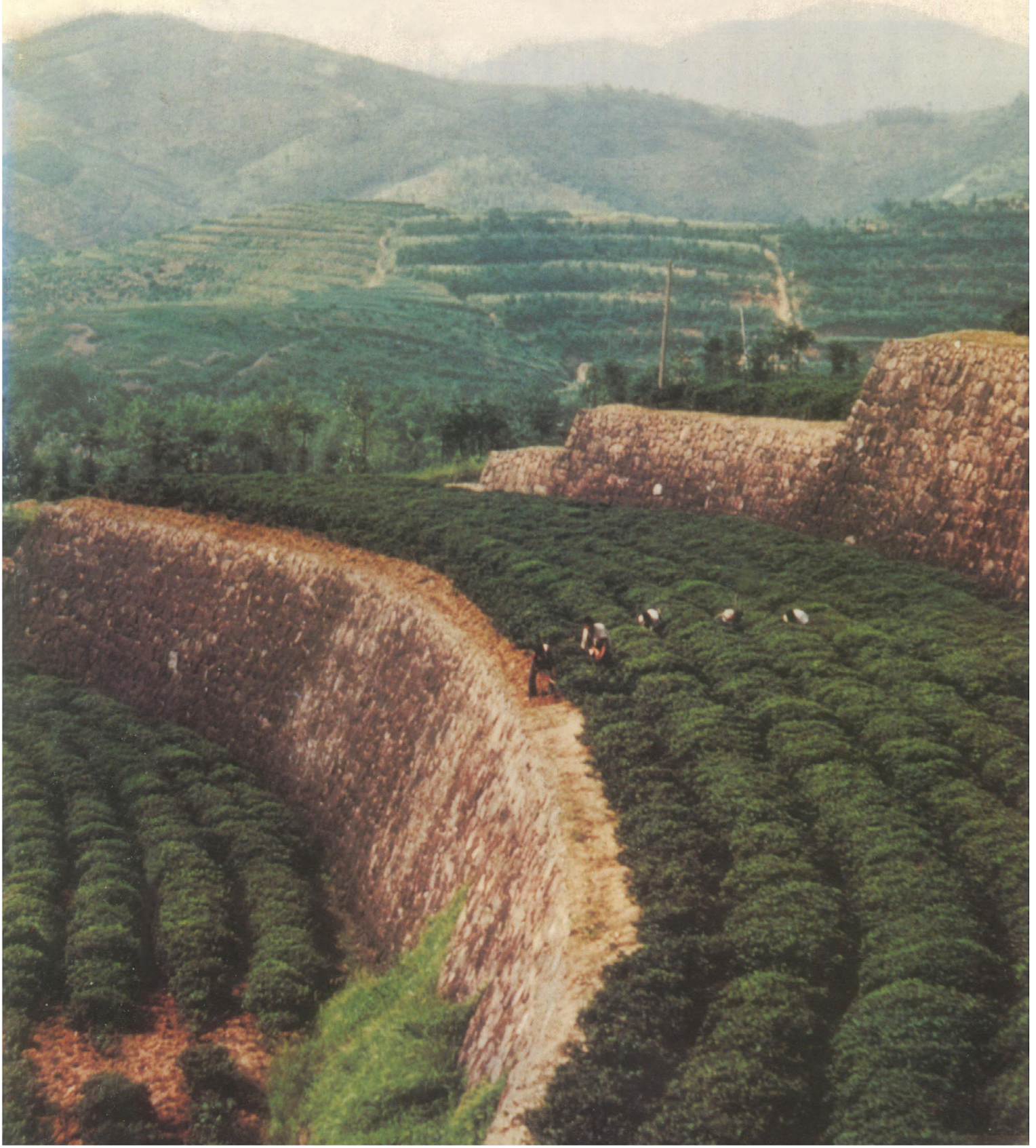
SCIENCE



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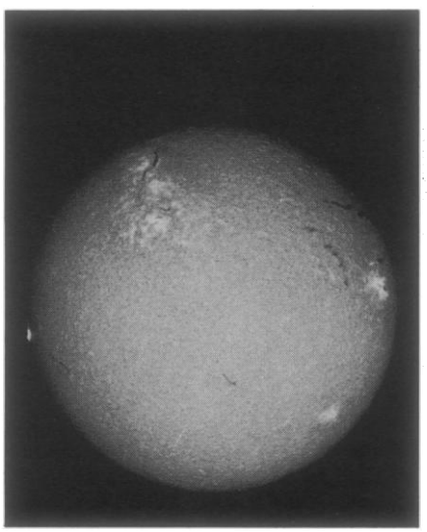
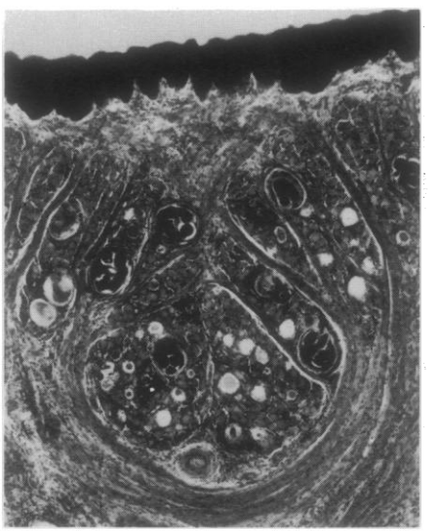


Hydrogen-alpha photograph of solar flares. Sacramento Peak Observatory, Sunspot, N.M.



Photomicrograph of *trichinella spiralis* in muscle, 175×. Tungsten-halogen source (3200 K) with KODAK WRATTEN Filter No. 58.

Meteorological imagery from geostationary satellite. VIZIR laser-beam recording by Société Européenne de Propulsion (France).

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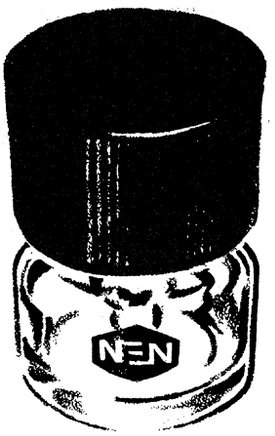

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COVER

Tea terraces on state farms in Anhui Province, China. See page 898. [Nancie L. Gonzalez, Department of Anthropology, University of Maryland, College Park 20742]

How Exxon's "energy is saving millions of

Bill Lockett's guidelines set the targets for Exxon's refineries; creative engineering helps reach them.

Oil refining is the largest consumer of energy in the petroleum supply cycle. In fact, energy accounts for about half of a refinery's total operating costs. Recognizing this, Bill Lockett and his colleagues at Exxon Research and Engineering Company (ER&E) developed a unique system to measure and analyze energy efficiency in refineries—a system that helped Exxon save 30 million barrels of oil in 1981 alone.

Developing accurate, but broadly applicable standards for energy use was no easy task. Refineries by nature are extremely complex energy networks, with a wide variety of processes operating from temperatures below freezing to more than 2000°F, and from deep vacuum to 3000 + psi. These processes consume and release energy in many different forms. Furthermore, feedstocks, product slates, and refining intensity vary frequently.

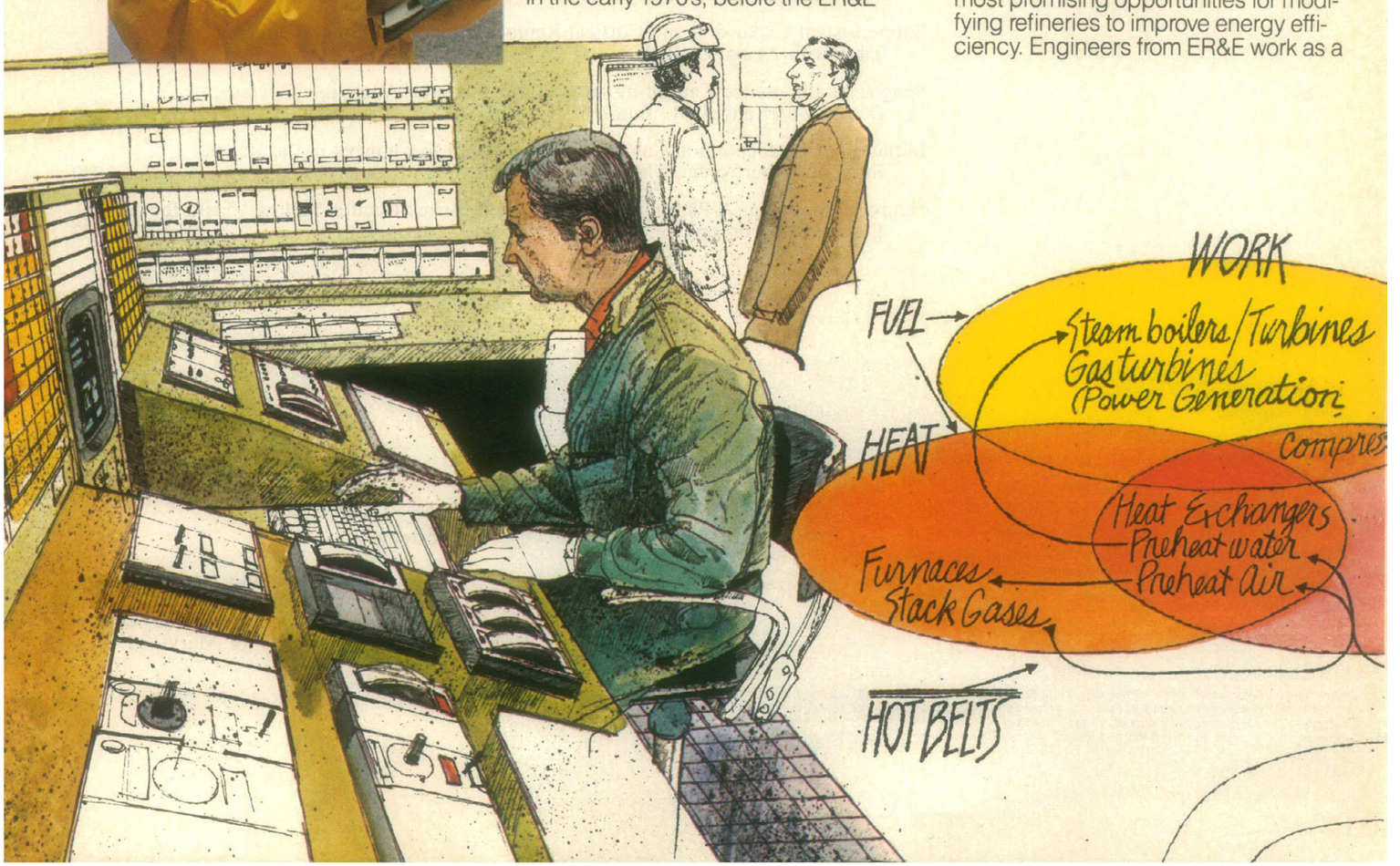
The Energy Guideline Factor System

Several approaches had been tried in the early 1970's, before the ER&E team led by Lockett devised Energy Guideline Factors (EGFs) to provide the basis for comparing actual plant performance to an energy-efficient plant doing the same job. EGFs were developed for each type of refinery unit, such as distillation towers, desulfurizers, or catalytic crackers. The factors take into account such variables as feedstock quality, processing intensity and throughput. Refinery engineers anywhere in the world can evaluate actual performance of their process units against these standards and can combine individual guideline factors into a customized energy-consumption yardstick for an entire refinery.

The EGF system has proved to be a real success. It is used in all of Exxon's refineries around the world and has been licensed to twenty-seven other oil companies as well.

The Site Energy Survey

Another major element in Exxon's Energy Conservation (ENCON) program is an on-site survey to identify the most promising opportunities for modifying refineries to improve energy efficiency. Engineers from ER&E work as a



management" system barrels of oil a year.

team with local refinery personnel to monitor and assess all aspects of energy use, treating the entire refinery as an integrated energy system. Synergistic conservation opportunities are sought, not only within the refinery, but also with neighboring industries and utilities. Projects which could foster cooperative energy efficiency, including heat integration and heat/power cogeneration possibilities, are considered.

Highly specialized computer programs help the team synthesize potential energy-saving alternatives, and evaluate them according to thermodynamic, operational and economic criteria. The results are used by refinery managements to plan and implement both short-term and long-range energy-saving programs.

Today, Exxon's refineries around the world are, on the average, 23% more energy-efficient than they were in 1973, and Site Energy Surveys completed to date have identified substantial additional energy-savings opportunities.

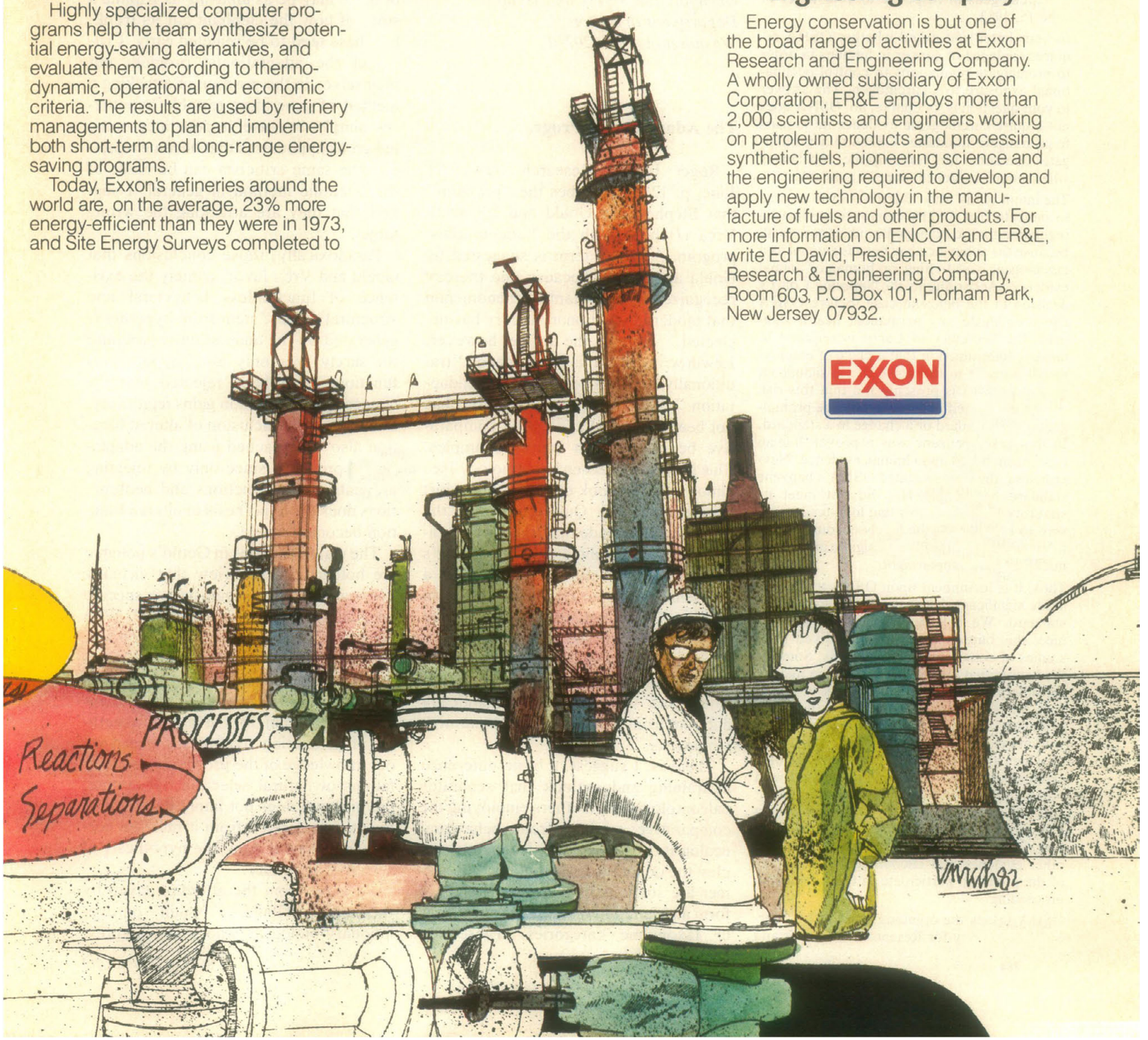
Hot Belts and Other Technologies

ER&E is applying a variety of other technologies in the search for energy savings as well. One concept is the heat transport loop, or "hot belt," that exchanges energy between multiple sources and sinks within the refinery, and even outside of it. High activity catalysts which permit lower reaction temperatures are being researched, as are low-energy separation processes such as membranes, and sophisticated computer control systems for on-line optimization of energy efficiency.

Exxon Research and Engineering Company

Energy conservation is but one of the broad range of activities at Exxon Research and Engineering Company. A wholly owned subsidiary of Exxon Corporation, ER&E employs more than 2,000 scientists and engineers working on petroleum products and processing, synthetic fuels, pioneering science and the engineering required to develop and apply new technology in the manufacture of fuels and other products. For more information on ENCON and ER&E, write Ed David, President, Exxon Research & Engineering Company, Room 603, P.O. Box 101, Florham Park, New Jersey 07932.

EXXON



SCIENCE/SCOPE

For his pioneering contributions to geostationary communications satellites, Dr. Harold Rosen of Hughes has been given the prestigious Alexander Graham Bell Medal by the Institute of Electrical and Electronic Engineers. Rosen is credited with conceiving the first practical geostationary communications satellite, which orbits 22,300 miles high and appears to hover in the sky. A single satellite covers over a third of the globe. Early satellites orbited at low altitudes and would have required a large orbiting fleet and complicated tracking procedures if continuous communications were to be provided.

A complete 3-D microelectronic 32x32 array processor is significantly closer to being demonstrated now that Hughes scientists have fully interconnected a stack of two wafers. Each of the wafers has a 32x32 array of aluminum feedthroughs migrated through the silicon wafer, forming low resistance paths across the wafer. Micro-spring bridges made for each unit cell of the array connect one wafer to the other. Improvements in fabrication and assembly techniques led to a performance yield on bridge/feedthrough interconnections of better than 99%.

Scientists have tracked the ash plume from the Mexican volcano El Cinchon with the aid of a weather satellite. Daylight and infrared pictures from GOES-5 (Geostationary Operational Environmental Satellite) clearly showed the April 4 eruptions even from 22,300 miles in space. Subsequent images revealed the plume rising high into the stratosphere and across the Yucatan peninsula. The dust now rings the planet in a wide band. Because El Cinchon blew far more dust into the stratosphere than did Mount St. Helens in 1980, scientists are speculating on the volcano's long-term effects on world climate. GOES-5 was built by Hughes and is operated by the National Oceanic and Atmospheric Administration.

The new Intelsat VI communications satellite is configured to minimize launch costs and to be deployed easily from NASA's Space Shuttle. The drum-shaped spacecraft, when folded, fits snugly in less than half of the Space Shuttle's cargo bay. Its weight and length are proportioned to take advantage of launch pricing policies. Intelsat VI will be ejected from its cradle much as a flying disc is thrown. The method imparts a slow spin to stabilize the spacecraft. A perigee motor will kick Intelsat VI into synchronous orbit, after which spin thrusters will fire to stabilize it. Finally, the antenna system will unfold and an outer panel of solar cells will telescope down to provide extra power. Hughes heads an international team building the Intelsat VI series for the International Telecommunications Satellite Organization.

Career growth opportunities exist at all levels at Hughes Support Systems for a variety of engineers qualified by degree or extensive work experience. They include systems engineers and software and hardware design engineers for major simulation and test equipment programs. Also, field engineering posts throughout the U.S. and the world offer travel, autonomy, and responsibility for the life cycle of Hughes electronics systems. Phone collect (213) 513-5235. Or send your resume to Professional Employment, Dept. SE, Hughes Aircraft Company, P.O. Box 9399, Long Beach, CA 90810-0463. Equal opportunity employer.

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3 September 1982, Volume 217, Number 4563 **SCIENCE**

Applied Biology in Developing Countries

In the near future, advances in biology will be important to the developed countries. However, the impact of advances on some of the less developed countries will be even greater. In the developed countries the big unmet need that will be supplied is for pharmaceuticals effective in combating viral diseases in humans and animals. Improvements in medicine will be welcomed everywhere, but the people of the less developed countries have even more urgent needs—food, cooking fuel, and other forms of energy. In most of the world, outside of Africa, per capita production of food has been increasing, but to maintain this trend will require continued efforts and new advances. In many countries supplies of firewood are being depleted, accompanied by soil erosion. Costs of oil and fertilizer have become nearly prohibitive and long-term prospects are even worse. Thus, around the world, news of advances in applied biology has been noted with great interest. Research has been discussed, planned, or initiated in many countries. Priorities differ according to local needs. For example, in the Philippines,* the National Institute of Biotechnology and Applied Microbiology has accorded priority to research in biofuels; nitrogen fixation; food fermentation; plant hydrocarbons; antibiotics, vaccines, and microbial insecticides; and biomass production. India has chosen genetic engineering, photosynthesis, tissue culture, enzyme engineering, alcohol fermentation, and immunotechnology as priority areas.

In the Philippines, Imelda Romualdez Marcos, who is First Lady of the Republic, Minister of Human Settlements, Member of Parliament, and Governor of Metropolitan Manila, has been active in pushing for reforestation. In a book which she edited,† she has written of the potentials of plantation forestry. She points out that managed forests can outproduce natural growth by factors of 5 to 10. She also notes the potentials of biomass as a source of glucose for fermentation or as a fuel for small rural electric power plants.

Nitrogen fixation by plants is universally regarded as a high-priority goal. In the United States there has been much talk of incorporating nitrogen fixing genes in corn. But at least 17 genes are involved in the nitrogen fixing systems, and success in reaching the goal may be elusive. Practical success is likely to come sooner in the rice paddies of Southeast Asia. Indeed, for centuries the Chinese and Vietnamese have maintained agronomic practices leading to natural fixation of nitrogen. A number of mechanisms exist. In the rice paddy, conditions are favorable to fixation of nitrogen. Blue-green algae are one type of nitrogen fixer. Another is bacterial flora associated with rice roots. Improvements in the capabilities of such organisms through either selection or genetic engineering may be feasible.

Rice is the principal cereal grain consumed by most of the world's population. Development of new strains at the International Rice Research Institute (IRRI) in the Philippines during the past two decades has been an important factor in meeting increased needs for food. Recently, new strains have been developed that grow well under such adverse soil conditions as salinity and alkalinity. Their adoption will increase production. M. S. Swaminathan, the director of IRRI, suggests that additional improvements in yield can be obtained at his institute by applying both conventional and new recombinant DNA methods.

If and when advances in biotechnology are achieved that are applicable to world needs, mechanisms will exist for their transfer around the world. A remarkable international framework is in place, financed in part by the Agency for International Development. As a result of the stimulus of the Green Revolution, governments are aware of potentials for improving crop yields and are maintaining indigenous agricultural stations capable of acting as centers for technology transfer.—PHILIP H. ABELSON

*M.S. Swaminathan, paper presented at the Workshop on Priorities in Biotechnology Research for International Development, National Academy of Sciences, Washington, D.C., 26 to 30 July 1982. †*The Energy Crisis and the Philippine Experience*, Office of Media Affairs, Manila, 1982.

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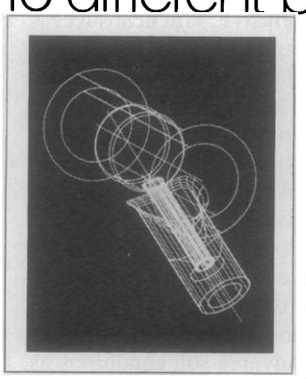

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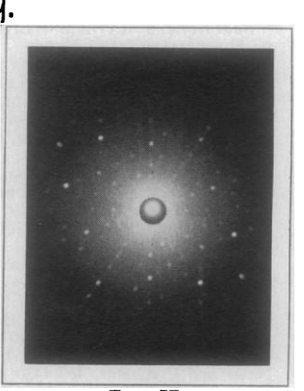

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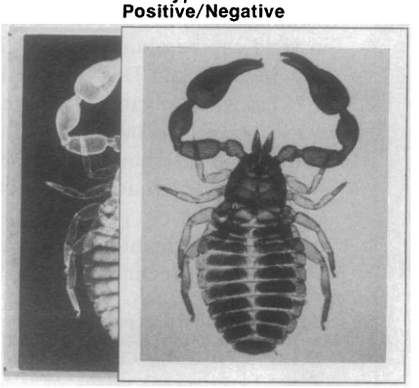

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