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Electronic Age

Autumn 1970

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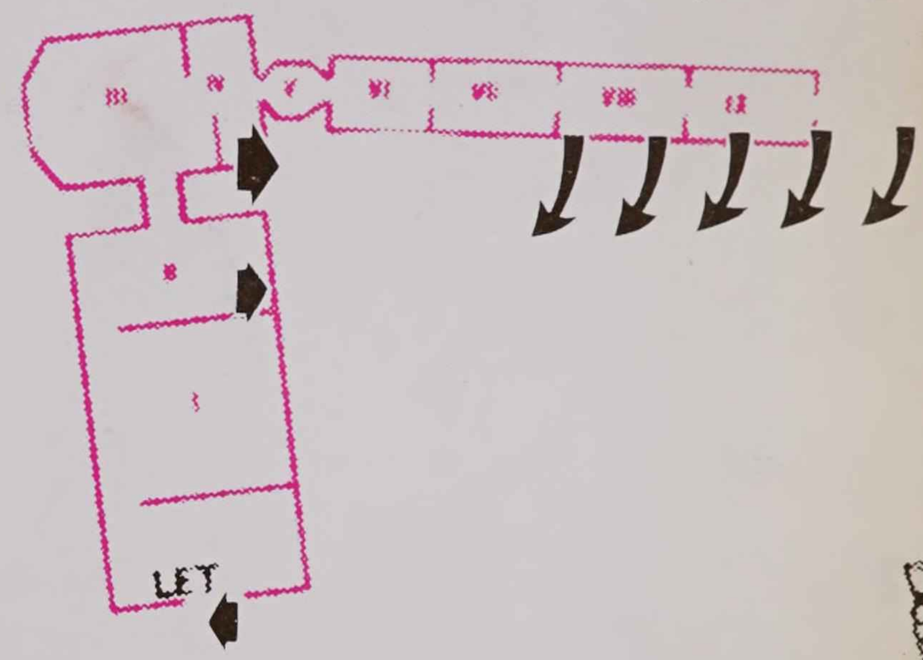
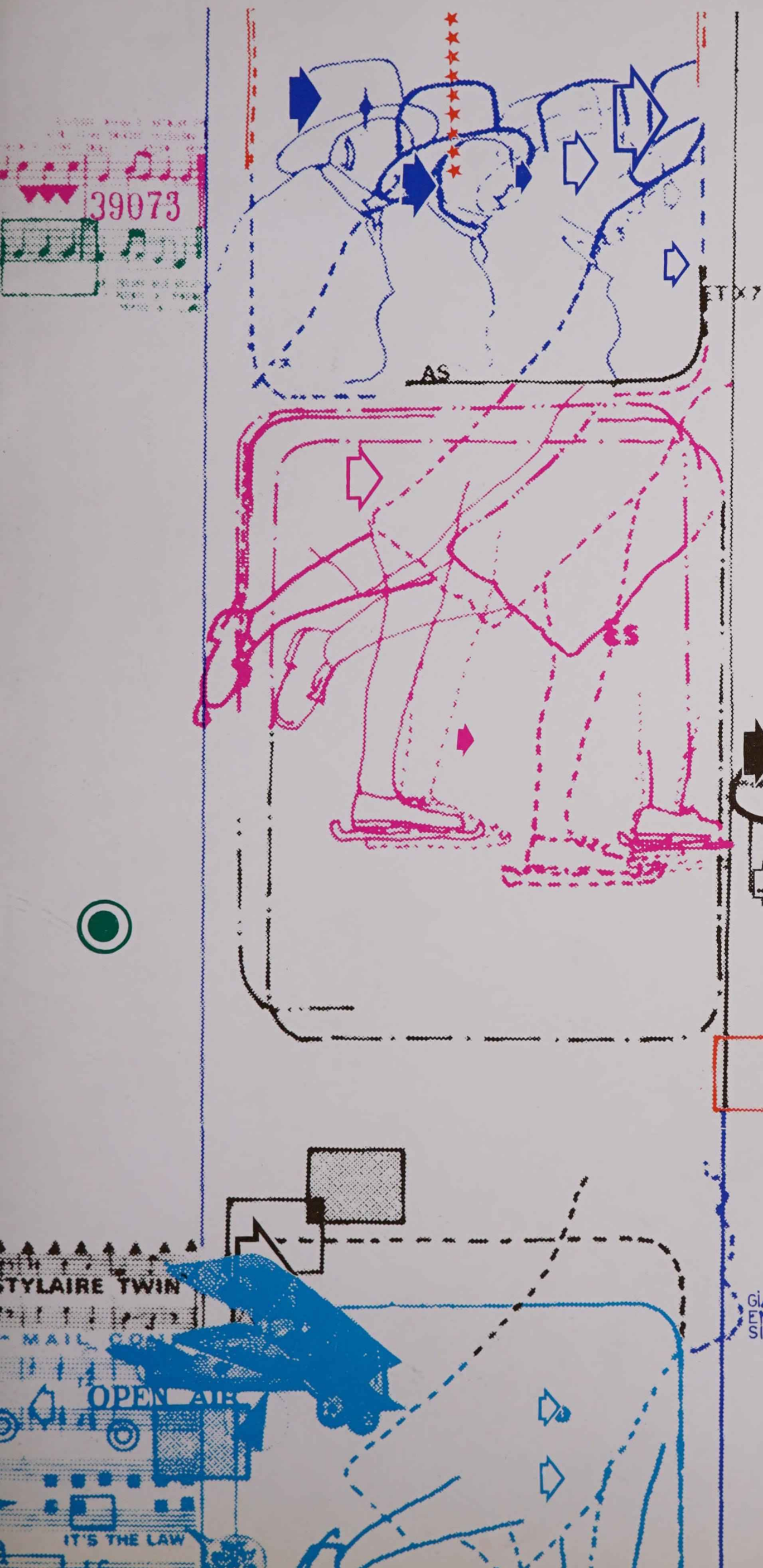
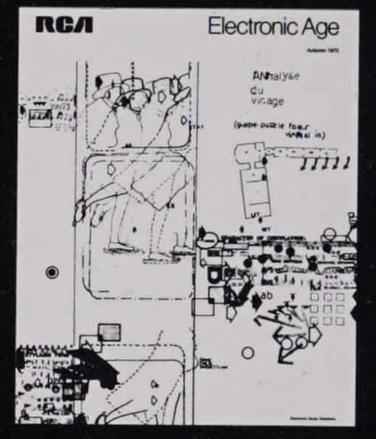




GIANNI EMILIO SIMONETTI-1967

Electronic Music Notations



Cover: Detail of Simonetti's notations is an intricate pattern of musical interpretation. Says one recording executive, "The absence of an accepted notation for any electronic music reproduction—a score in the conventional sense—illustrates the control that composers of electronic music have. The composer cannot be separated from the final result by the performer." An article on important developments in the world of electronic music begins on page 18.

Electronic Age

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Law, Order, and Outer Space

by Eilene Galloway

"The capacity to develop law for outer space depends upon international cooperation, which, in turn, must derive its strength from national space activities."

"... all countries are to benefit from the use and exploration of outer space...."

"Cooperative projects are concerned with... analysis of lunar samples; navigation, geodetic, and ionospheric experiments; surveys of earth resources; and many other subjects requiring a worldwide approach."

"Aerospace is a continuum that engineers do not divide into restrictive horizontal zones."

"A worldwide network of tracking stations was essential to . . . process data from unmanned experiments."

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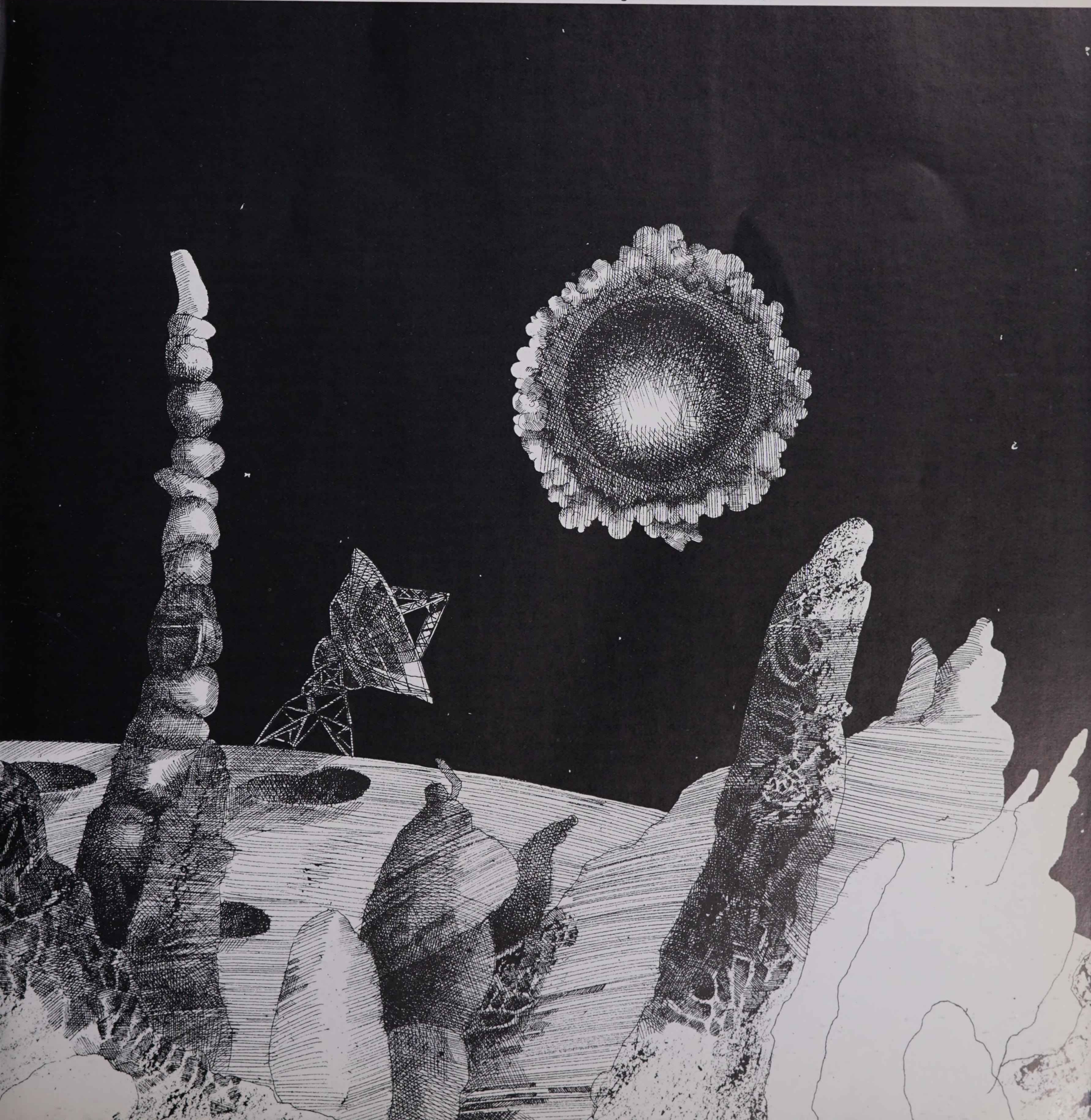


Frequently, one hears that science and technology have leaped so far ahead of man that he is suddenly overwhelmed by problems he did not anticipate. In many areas this is true, and the problems are more difficult to solve then because there was no advance planning. But man did not blunder into the space age when it came to evaluating the impact of cosmic exploration.

Although it has not been legally defined just where outer space begins, laws have already been made to govern the ways man uses and explores this new environment. Most of the legal problems were identified even before the first satellite was orbited. This circumstance resulted primarily from the interest of specialists in international law who asked how high airspace extends above the earth and drew comparisons between outer space and freedom of the seas. Prior to October, 1957, when the first artificial satellite was launched, these lawyers were considered rather "far out" in their thinking. But, after spacecraft began circling the globe, their ideas contributed to the development of space law.

Eilene Galloway is a senior specialist in international relations with the Library of Congress.

The United Nations appointed its Ad Hoc Space Committee in 1958, and by the end of 1959 the Permanent Committee on the Peaceful Uses of Outer Space came into being. During the past 13 years, the UN passed basic resolutions to guide nations in the use and exploration of space. Two treaties were negotiated and entered into force, and a third is being discussed. This record reflects the remarkable foresight of those who realized the significance of international cooperation in this area.

The task was made easier because no nation protested the flight of satellites over its territory. No nation requested the launching states to obtain permission to fly over its sovereign lands and territorial waters. Neither the United States nor the Soviet Union asked any nation for permission to fly space vehicles over the sovereign territory of other states. No nation reserved its rights with regard to spaceflights in the future. Nor did any nation set an upper limit on airspace that might have been construed as the lower boundary for outer space.

The Soviet Union's unmanned Lunik I reached the moon in September, 1959. However, official Soviet policy at the time precluded any claim of sovereignty. The United States also announced its policy against claims of ownership to the moon. Although the United States and the USSR had an early monopoly on launching spacecraft, both regarded outer space as free for use and exploration by all nations engaged in peaceful space activities.

Some of the ideas that were later to find their way into the 1967 Treaty on Outer Space were incorporated in a resolution passed by the UN General Assembly in 1961. Member nations were asked to observe that "international law, including the Charter of the United Nations, applies to outer space and celestial

"Harmful contamination and adverse changes in the earth's environment are also to be avoided."

"Space law is not intended solely to govern activities in outer space. Most space activities take place on the ground, where there is need to know what should be prohibited and what can be permitted."

"Space objects that reenter the atmosphere and land on earth . . . are to be returned to the launching authority."

bodies" that are "free for exploration" and "not subject to national appropriation."

Meanwhile, the United States inaugurated a vigorous international space program. The National Aeronautics and Space Act of 1958 is one form of "space law." Under the terms of the act and with the foreign policy guidance of the President, NASA is authorized to carry on a program of peaceful international space cooperation.

A worldwide network of tracking stations was essential to monitor U.S. manned flights and to process data from unmanned experiments. Tracking and data-acquisition stations were built throughout the world with the cooperation of countries whose scientists and engineers also participated. In developing this program, which now includes 85 nations and locations, NASA asks that cooperating governments designate a central civilian agency to negotiate and supervise joint programs. Agreement must be reached on specific projects rather than general programs. Each country must be financially responsible for its own share in joint projects of common interest and scientific validity. The results of research and development are published for general use.

U.S. bilateral and multilateral agreements reflect the international significance of the national space program. Cooperative projects are concerned with weather forecasting; space communications; analysis of lunar samples; navigation, geodetic, and ionospheric experiments; surveys of earth resources; and many other subjects requiring a worldwide approach. The scientists of more than 70 nations have participated in these projects, which involve approximately 225 agreements with some 35 countries.

The capacity to develop law for outer space depends upon international cooperation, which, in turn, must derive its strength from national space activities. The record of the United States is doubly outstanding and accounts for the major role it has played in the United Nations in the formulation of space law. Negotiations in the legal subcommittee of the Committee on the Peaceful Uses of Outer Space led to the adoption by the General Assembly of a major document that was ratified simultaneously in Washington, London, and Moscow on October 10, 1967. This was the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies.

This treaty provides that all countries are to benefit from the use and exploration of outer space and that international cooperation is to be encouraged. A significant provision is that "outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."

Some scholars once thought that such a treaty could not be drawn without an exact definition of where airspace ends

"The function of the spacecraft, rather than the space in which it flies, is the deciding factor in treaty provisions that seek to ensure the use of outer space for peaceful purposes."

"Orbiting the earth with nuclear weapons is prohibited. . . . Weapons cannot be installed on celestial bodies or stationed in outer space."

"The breadth and scope of existing space law are reason for confidence that legal adjustments can be made to technological progress."

and outer space begins. The difficulty with such a definition is that technology develops so rapidly in aeronautics and astronautics that aircraft are flying higher while spacecraft are orbiting closer to the earth. There seems to be general agreement that the area in which air flight occurs is airspace and that spacecraft in orbit or on deep space probes are in outer space. But in between there is a space — about 60 miles — where it is too high for planes to fly and too low for satellites to maintain orbits.

The way the treaty solved this problem is another illustration of the influence of technology in shaping a legal principle. Instead of waiting for boundary agreements (which are still being debated), the aerospace concept of engineering became the controlling assumption. Space vehicles are designed to fly through airspace into outer space and may come back into airspace and land on the earth. Aerospace is a continuum that engineers do not divide into restrictive horizontal zones.

The treaty provides that the nation launching an object into outer space retains jurisdiction and control while the vehicle is in outer space, or on a celestial body, or upon its return to earth. Furthermore, each ratifying nation has agreed to be internationally liable for damages caused "in airspace or in outer space, including the moon and other celestial bodies." The function of the spacecraft, rather than the space in which it flies, is the deciding factor in treaty provisions that seek to ensure the use of outer space for peaceful purposes.

Orbiting the earth with nuclear weapons is prohibited, and other weapons of mass destruction are also forbidden. Weapons cannot be installed on celestial bodies or stationed in outer space. The moon and other celestial bodies are to be used "exclusively for peaceful purposes." Military facilities, maneuvers, and the testing of weapons are forbidden; and military personnel may be used only for peaceful scientific research. Harmful contamination and adverse changes in the earth's environment are also to be avoided. If there is a possibility of potential harm, nations are to consult with one another. Information on space research by any nation is to be widely disseminated.

It was recognized that some of the guiding principles in the treaty would require more detailed arrangements, and the general article on astronauts as "envoys of mankind" was spelled out in an additional Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space.

This agreement, which entered into force on December 3, 1968, requires nations to render all possible assistance to any astronaut who makes an emergency landing and return him safely and promptly to the nation that launched him into outer space. Similarly, space objects that reenter the atmosphere and land on earth, even in small pieces, are to be returned to the launching authority.

The treaty contains other general principles that require more specific rules and regulations if they are to be effective. A notable example is that of liability for damages resulting from space accidents. The subject has been studied for several years by the legal subcommittee of the UN Committee on the Peaceful Uses of Outer Space.

Trying to determine who may be at fault if an accident occurs in outer space may prove to be technically impossible. Therefore, some lawyers have contended that liability should be without fault. This would mean that a nation may claim damages from a space accident without being required to prove that the launching state was at fault. Furthermore, if a spacecraft collision occurred in outer space, neither launching authority might claim damages.

There are a number of unresolved issues, however, and the pace of negotiating the convention on liability is slower than were negotiations on either the main treaty or the agreement on the rescue of astronauts. The delay is understandable when the committee debates are studied. The group has considered such questions as whether or not liability should be limited to a certain amount of money; whether personal injuries and death claims should have priority over property damages; and whether a commission should be created for handling claims or whether nations should go through the regular diplomatic procedures for redress.

Although it may take some time to reach a consensus among nations on such specific issues, it is a measure of the degree of international cooperation to recognize that the general guiding principle of liability for damages has already won approval.

Space law is not intended solely to govern activities in outer space. Most space activities take place on the ground, where there is need to know what should be prohibited and what can be permitted. Spacecraft are built in factories and launched from centers on the earth. They are controlled from laboratories manned by scientists and engineers who acquire and evaluate data sent from outer space. Many legal problems arising from space activities are similar to those of any other industrial complex. But there are some legal problems peculiar to space activities. Again, scientific and technical facts have a way of determining the pattern of law that develops.

The relationship of science and technology to national and international programs is best illustrated by the laws made to govern the creation and operation of the global communications satellite system. On August 10, 1962, the U.S. Telstar satellite relayed the first live television transmission between North America and Europe. The feasibility of this new technology gave momentum to the legislative process. And, on August 31, 1962, the Communications Satellite Act became law.

Congress declared that the policy of the United States was to establish, as soon as practicable and in cooperation with other nations, a commercial communications satellite system. Convinced that this system would contribute to world peace and understanding, Congress directed that global coverage should also include services to less developed countries and areas.

On the basis of space technology applied to this practical purpose and with a national law to implement peaceful objectives, negotiations moved into the international sphere. The long-existing pattern of cooperation in communications, arising from use of transatlantic telegraph cables and the work of the International Telecommunication Union, facilitated the organization of satellite communications.

On August 20, 1964, two sets of agreements brought about the creation of the International Telecommunications Satellite Consortium (Intelsat) and the Communications Satellite Corporation (Comsat), the latter of which became manager of the satellite system.

Only 14 countries signed the original agreements. Today, there are 76 member nations. Public and private entities have joined to establish a new form of international organization to operate the space segment of a global communications network, but all still recognize that each nation is in charge of its own domestic system.

The original agreements provided for renegotiation in five years. Since 1969, Intelsat members have debated major issues concerning management, financing, membership, and voting privileges. When Intelsat achieves general approval of definitive arrangements, a new course will be charted for cooperation by governments in world institutions with operating programs. Meanwhile, the existing pattern of organization and administration remains in effect and continues its successes in providing space communications throughout the world.

Intelsat's arbitral tribunal, which came into force in November, 1966, is a noteworthy step in the development of peaceful means for settling legal controversies. The arbitration and settlement of disputes have always been regarded as key factors in adherence to international law. This law for space activities may prove to be a model of cooperation.

Space law is not lagging behind scientific and technological progress. Lawyers and government representatives know the direction in which they are going and have already worked out guiding principles for the foreseeable future. This does not mean that there is an easy formula for solving all the problems that are likely to arise. Nor does it mean that solutions will be rapidly achieved.

The process of reaching a consensus among nations on subjects that affect individual vital interests is often a lengthy one. Negotiators are likely to be slow in deciding, for example, to accept or reject the idea of unlimited liability for space accidents. The length of time it takes to get agreements on the future organization of Intelsat is an indication of difficulties encountered in reconciling political, economic, and legal demands.

More readily forthcoming is international cooperation on weather satellite projects. All nations have a stake in accurate weather forecasting, and, historically, governments have cooperated in the exchange of such information.

Functional projects, such as the World Weather Watch and the Global Atmospheric Research Program, elicit the enthusiastic support of scientists from many nations. Should science and technology advance to the point where man can increase or decrease natural rainfall, it is likely that more hard choices would have to be made by the countries affected.

As Thomas F. Malone, Chairman of the Committee on Atmospheric Sciences of the National Academy of Sciences, has warned, "Much could be gained, little would be lost by forging the links among scientists and nations that would better prepare us for the stresses and strains that we dare not exclude as a possibility."

The breadth and scope of existing space law are reason for confidence that legal adjustments can be made to technological progress. We have made progress in developing institutions with regulations based upon the premise that the uses and exploration of outer space must be for peaceful purposes to benefit all mankind. ■

SUPERCOLD

Cryogenics has fast become the basis of a billion-dollar industry; it could furnish valuable breakthroughs in all areas of technology.

by Kenneth Witty

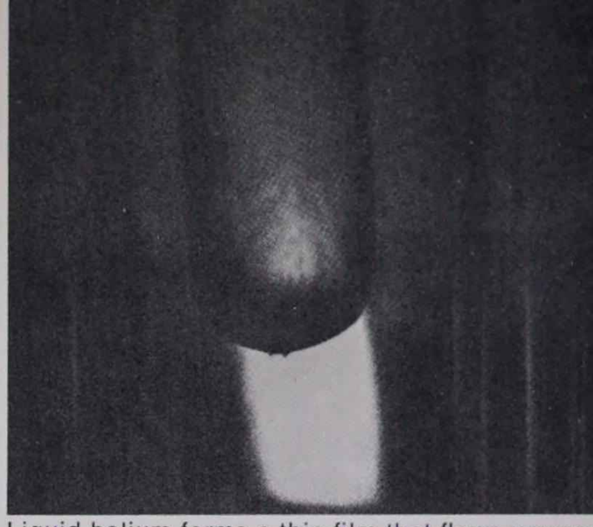
Kenneth Witty is on the staff of CBS News.

The technology of space exploration has yielded valuable insights into many areas of science. Among the most exciting spin-offs is cryogenics, the study and use of very low temperatures. Such temperatures range from —150° F down to absolute zero (—459.6° F). The latter is the physical limit of coldness, the point at which all atomic activity comes to a halt. Until very recently, such temperatures were thought to exist only in the extreme reaches of the solar system or in the confines of the laboratory. In the last decade, however, as the lower limits of temperature have been approached more easily, cryogenics has become the basis of a billion-dollar industry.

Scientific research into the properties of matter at very low temperatures actually began in the 1800s, when physicists demonstrated that such gases as hydrogen, oxygen, and nitrogen could be turned into supercold liquids. Helium was the last gas to be liquefied — at a

Scientists experiment with cryogenic techniques for preservation of internal organs.

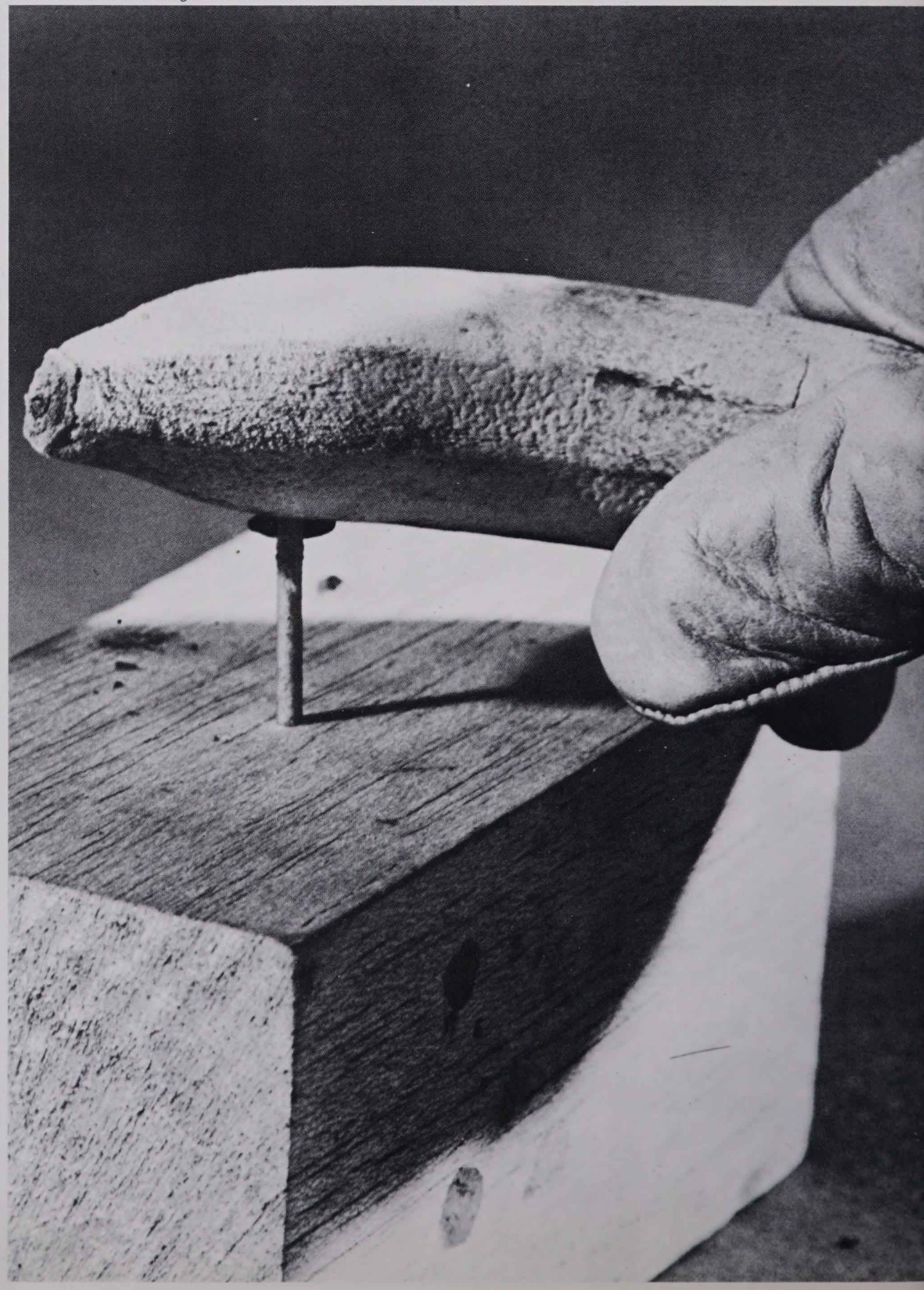
"Now that cryogenic technology has made the liquefaction of natural gas both safe and economical, millions of dollars' worth of surplus natural gas... may now be carried to foreign markets in giant refrigerated tankers."

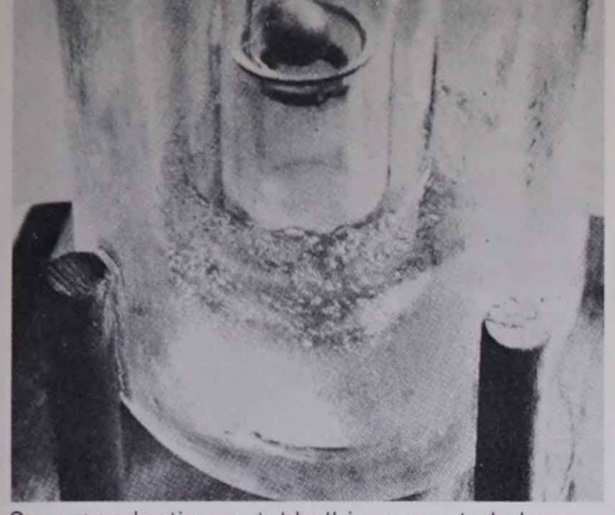


Liquid helium forms a thin film that flows upward and over the sides of a test tube.

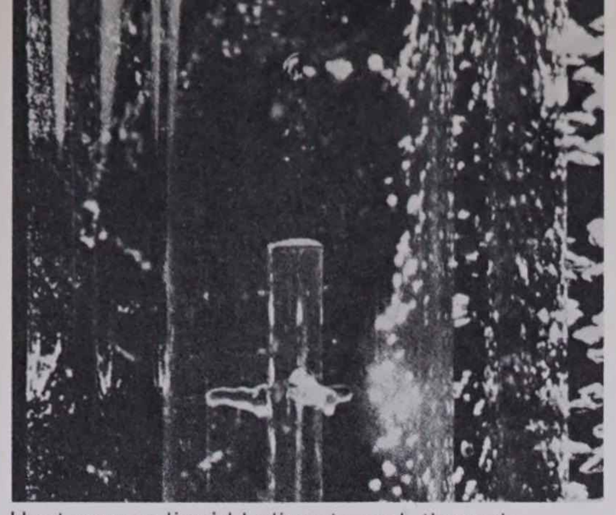
Banana, cooled in liquid nitrogen,

... becomes hard enough to drive a nail into a wooden block.



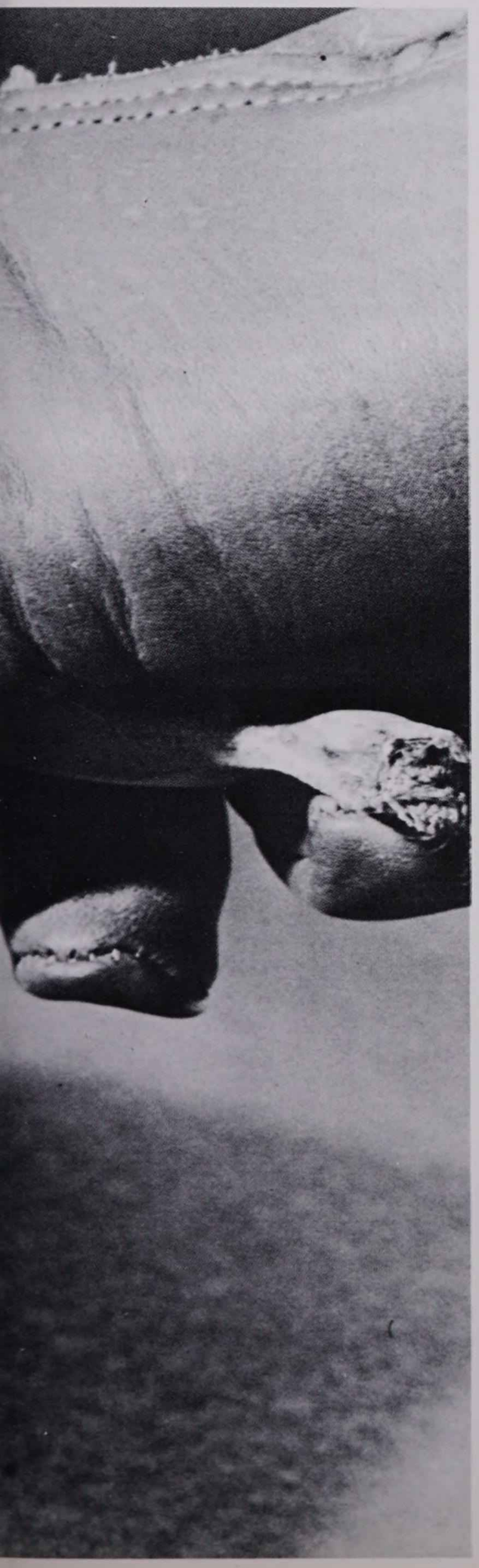


Superconductive metal ball is supported above toroidal magnet by inherent magnetic repulsion.



Heat causes liquid helium to rush through capillary tube and create "fountain effect" as it emerges from the top of the tube.

Aerial photograph of Dallas, Tex., taken at an altitude of 4,000 feet by infrared detector cooled to —420°F by miniature cryogenic refrigerator.



temperature only 7° F above absolute zero. This took place in 1908. Although valuable work continued during this century, real interest in low-temperature research sharply declined. In fact, not until the late 1950s was the science of cryogenics found to have important practical applications. The impetus came with the beginnings of the space age, when large amounts of liquid oxygen and liquid hydrogen were needed to fuel rockets that travel beyond the earth's atmosphere.

Today, cryogenic liquids are being used by doctors for both surgery and the preservation of blood and other tissue, by food processors for the freezing of perishables, and by electrical engineers to cool metals to the point at which they become perfect conductors of electrical current. Some of the recent marvels of cryogenic engineering include surgical treatment of Parkinson's disease, improved scuba diving equipment that enables a man to stay underwater for as long as eight hours, electrical generators four times as powerful and one-tenth the size of those used at present, and a high-speed magnetically suspended train.

Polar explorers who endured temperatures exceeding —100° F certainly never dreamed that temperatures more than four times lower had much to offer mankind. But cryogenic researchers are finding an ever increasing number of uses for extremely low temperatures — and a number of puzzling surprises as well.

The most surprising phenomenon is what physicists call superconductivity. As a metal is cooled, its resistance to electrical current decreases. In most substances, this reduction in electrical resistance slows down to a fixed point and then remains steady. However, when certain metals are cooled to just a few degrees above absolute zero, a strange change occurs. Resistance to electrical current disappears altogether, and the material becomes a superconductor of electricity.

If current is sent through a normal conductor, such as copper, a significant amount of power is lost, mainly in the form of heat. In a superconductor, however, the amount of current sent along a wire will be virtually undiminished.

This phenomenon was discovered almost 60 years ago, but physicists have yet to find an adequate explanation for it. Especially puzzling is that the metals made to function as superconductors are, at normal temperatures, generally inefficient conductors of electricity.

Still not fully understood, the phenomenon of superconductivity is on the threshold of a number of technological breakthroughs. The efficiency of superconducting materials has already been used to build electromagnets with very high fields for research in solid-state and nuclear physics. The largest of these, made by RCA for the National Aeronautics and Space Administration, creates fields up to 155,000 gauss (the earth's magnetic field is one-half a gauss) at one-twentieth the cost of conventional magnets. Many university laboratories can now obtain high-field electromagnets for scientific experimentation that they could not have afforded before. Along with increased efficiency and much lower costs, scientists have achieved considerable reductions in size. Superconductive magnets one-fortieth the size of their predecessors can produce fields of equal strength and perform much more efficiently.

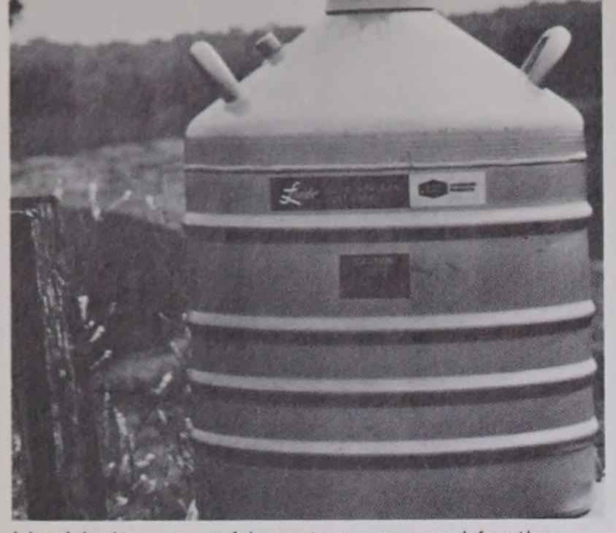
This ability of superconductors bears important implications for power utilities, since high-field electromagnets are basic units of electrical generating equipment. As electricity requirements rise at fantastic rates, so does the need for larger generators. The largest unit today, at Consolidated Edison's Ravenswood plant in New York City, produces 1,000 megawatts of electricity. However, manufacturers of power-generating equipment say that the present machines, using conventional copper wiring, are becoming too big to transport and are subject to mechanical stresses produced by their enormous bulk. An example of the problem was the breakdown this past summer of the Ravenswood unit that led to brownouts in New York during hours of peak use.

Projections made by the Edison Electric Institute show that, in the next 15 years, this country's electricity needs will more than triple. The use of superconductive generators may well provide the solution to the problems of size and power capacity. Professor Herbert Woodson of MIT has recently built a prototype alternating-current generator using superconductive techniques. He and others believe that, within the decade, such smaller and more efficient generators can be built, developing as much as 5,000 megawatts, or enough electricity to serve a city of 5 million people.

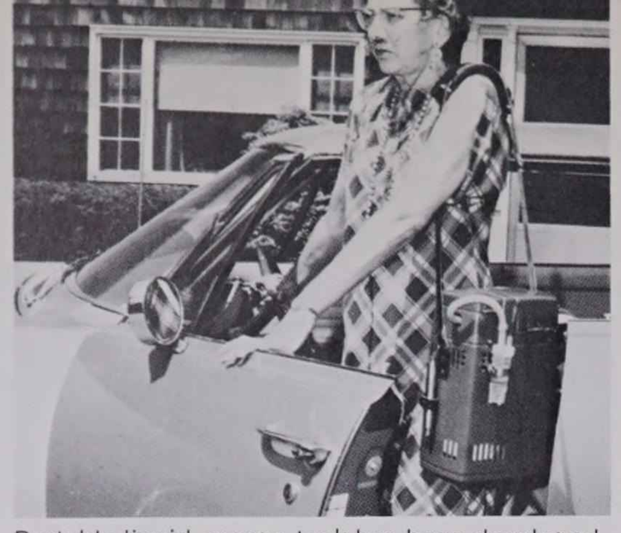
Another imminent breakthrough in cryogenic engineering is development of superconductive electrical transmission lines. Power lines of this type, immersed in a coolant of liquid helium, can carry tremendous loads of electricity — up to 25 times greater than conventional facilities — with almost no loss of power. Such a system will dramatically cut power transmission costs in populated areas. It will also enable electric utilities to build power stations outside urban areas, as antipollution and other civic groups have been urging the utilities to do for years. Furthermore, construction of underground facilities would be economically advantageous and eliminate the eyesore of transmission lines mounted high above the ground.

The cost of refrigeration is a major barrier to the development of superconductive transmission lines as well as other cryogenic electronics devices. At present, liquid helium must be used for cooling, and this is too expensive for most large-scale applications. If hydrogen, which liquefies at a higher temperature, could be used, then the cost of refrigeration could be lowered significantly — perhaps to one-hundredth the present cost. But the transition temperature — the temperature below which a material becomes superconductive — of all known materials is still too low. Scientists continue to search for materials that will remain superconductors at higher temperatures.

"The biggest mystery of superconductivity today is why the transition tempera-

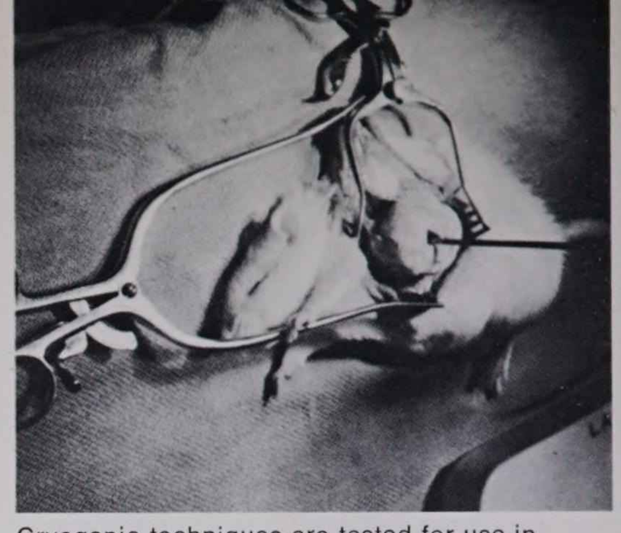


Liquid nitrogen refrigerators are used for the preservation of biological specimens.



Portable liquid oxygen tank has been developed to aid persons with chronic respiratory ailments.

Quick-frozen foods are transported by conveyor from nitrogen-vapor freezing unit.



Cryogenic techniques are tested for use in neurosurgery.

ture is limited to —423° F," explains Dr. Jonathan I. Gittleman of RCA's materials research laboratory in Princeton, N.J. "Theoretically, there is no reason why materials should not have higher transition temperatures, but none has yet been found. If we can raise the transition temperature of superconductors 10-15° F, the possibilities for actual use will be greatly enhanced."

One such use is the superconductive computer memory. Superconductors make excellent computer memory cores; when formed into loops, they can carry current indefinitely. The flow of current can be interrupted by the introduction of a sufficiently strong magnetic field, thus shutting it off. The presence or absence of current in a circulating loop represents one bit or unit of information. Millions of these on-off switches constitute the memory core of a computer.

Over the years, demand has grown for larger and larger computer memories as problems and computer programs have become increasingly complex and as time sharing has made it possible for many users to work concurrently on a single system. Superconductive memories can increase capacity from millions of information bits to billions. They also promise increases in reliability and operating speed as well as relative size reduction. An experimental superconductive memory plane built recently by RCA contains 262,144 individual information-storage loops in an area 4½ x 5 inches; it operates three times as fast as present-day electromechanical devices.

Why, then, have superconductive memories not been introduced commercially?

"It is strictly an economic problem," says Gittleman. "People have experimented enough to know they can build them, but superconductive memories still cannot compete because the costs of refrigeration systems are too high."

The hope for such devices lies in finding materials that remain superconductive at higher temperatures. If such a breakthrough can be achieved, then we can expect all kinds of futuristic applications — from high-speed trains that are magnetically suspended above ground to supermagnetic "bowls" enabling man to produce power out of the fusion of hydrogen atoms (the same type of power that heats the sun).

Superconductivity may well prove the most important use of cryogenics, but other applications have already taken hold. The petroleum industry uses cryogenic cooling for the transportation and storage of natural gas. If natural gas is refrigerated to —258° F, it liquefies and compresses into one-sixth of 1 per cent its original volume. Now that cryogenic technology has made the liquefaction of natural gas both safe and economical, millions of dollars' worth of surplus natural gas that used to be burned off for lack of storage and transportation facilities may now be carried to foreign markets in giant refrigerated tankers. Gas companies in at least a dozen U.S. cities now liquefy natural gas for storage during off-season months. At times of peak winter demand, the liquid is vaporized for pipeline transmission.

Scuba divers have recently adopted the principles of cryogenics to help overcome limitations in the length of time they can stay underwater — usually about an hour. The use of liquid air, a mixture of oxygen and nitrogen cooled to —318° F, permits a diver to submerge for as long as eight hours with a backpack that weighs only half as much as a compressed air tank. The liquid air is stored in dewars, thermos bottles that keep the icy liquid cool and also protect the diver's back and shoulders from freezing. From the tanks, the liquid air is piped through warming coils that heat it until it expands into a breathable gas.

The same principle has been used by a major chemical corporation to produce a portable liquid oxygen tank that can be strapped over the shoulder. This allows people with chronic respiratory ailments, who need a ready source of oxygen available at all times, to retain their freedom of movement.

The most obvious use for cryogenic cooling is in the manufacture of freezing units. Freezing with liquid nitrogen at —320° F has, in recent years, become quite inexpensive — 2,500 times cheaper than with liquid helium. At present, it is being used extensively in the food-processing industry and in medicine.

The major advantage of freezing food with liquid nitrogen is speed. Freezing never improves food; but the longer the freezing process takes, the greater the deterioration. In contrast to earlier freezing systems, which blast cold air over the food and take hours to do the job, cryogenic systems freeze the substance in minutes. This helps preserve moisture as well as texture, appearance, and flavor. Perishable items, including bakery goods, highly spiced foods, meats, shellfish, and certain produce (such as mushrooms and avocados), are especially prone to loss of flavor when frozen. These are now preserved by liquid nitrogen.

While cryogenic freezing is becoming more and more widely used, particularly for specialty foods, conventional freezing techniques are still cheaper for most produce. At the present rate of technological advance, however, this may not be true much longer.

Nitrogen is colorless, odorless, inert, and leaves no trace in food. It has, therefore, been used as the basis of a new commercial freezing system for shipping perishables. Users claim less spoilage, lower maintenance costs, and no breakdowns, since the refrigerant is simply sprayed from a storage tank.

Cryogenic techniques have also been used successfully for the preservation of blood. Before these techniques were developed, red blood cells had to be thrown out after three weeks; and only the plasma, or clear liquid part of the blood, could be stored for later use in transfusions. Ice crystals formed inside the frozen red cells, breaking the thin cellular wall and killing the cell. Research with cryogenics determined that red cells could be soaked in a chemical protector called glycerol, then immersed in liquid nitrogen and chilled within minutes to —320° F. Cells thus frozen remained virtually intact.

These fast-freezing techniques permit storage of blood for years, perhaps indefinitely. National Red Cross researchers, among others, are now looking for ways to reduce the freezing period even further in order to simplify procedures and lower costs.

Blood is not the only animal substance that has lent itself to quick freezing. Veins, arteries, and tissue cultures are now included in liquid nitrogen storage banks. The U.S. Naval Hospital in Bethesda, Md., reports that skin tissue has been frozen for up to three months and then successfully transplanted; bone tissues have been kept alive for as long as six months. Cattle breeders have already used cryogenic techniques to freeze the semen of prize bulls for artificial insemination. The frozen sperm, which will keep for months, enables outstanding bulls to be bred into more strains at less cost and more conveniently than natural breeding could ever allow.

Attempts to preserve whole organs have been somewhat less successful. A crucial factor in freezing live cells is the rate at which they are frozen and thawed. All freezing results in the formation of ice crystals, some from water inside the cells; and many cells are damaged in the process. There is also a dangerous build-up of salts within the cell, which leads to further damage during thawing when water outside the cells rushes back to neutralize the concentration of salts inside. This, too, does irreparable damage to the cellular wall. In fact, most cell destruction occurs during the thawing process.

Until such problems are overcome, the freezing of whole organs for transplant surgery will not be possible. This is bad news for members of the Cryonics Society, a group that espouses freezing persons pronounced legally dead until medical science develops cures for the illnesses with which they were afflicted and then reviving them. The group, whose motto is "Never Say Die," claims a membership of more than 1,000. At least a dozen persons have been frozen in liquid nitrogen since the first case — a 73-year-old California psychologist who had died

Blood is preserved by immersion of flat steel container in a still pool of liquid nitrogen.

of lung cancer — was reported in 1967.

Scientists, however, hold little hope that cryogenics will ever lead to reviving the dead. The freezing of a whole kidney for only a short period of time would be considered a major breakthrough.

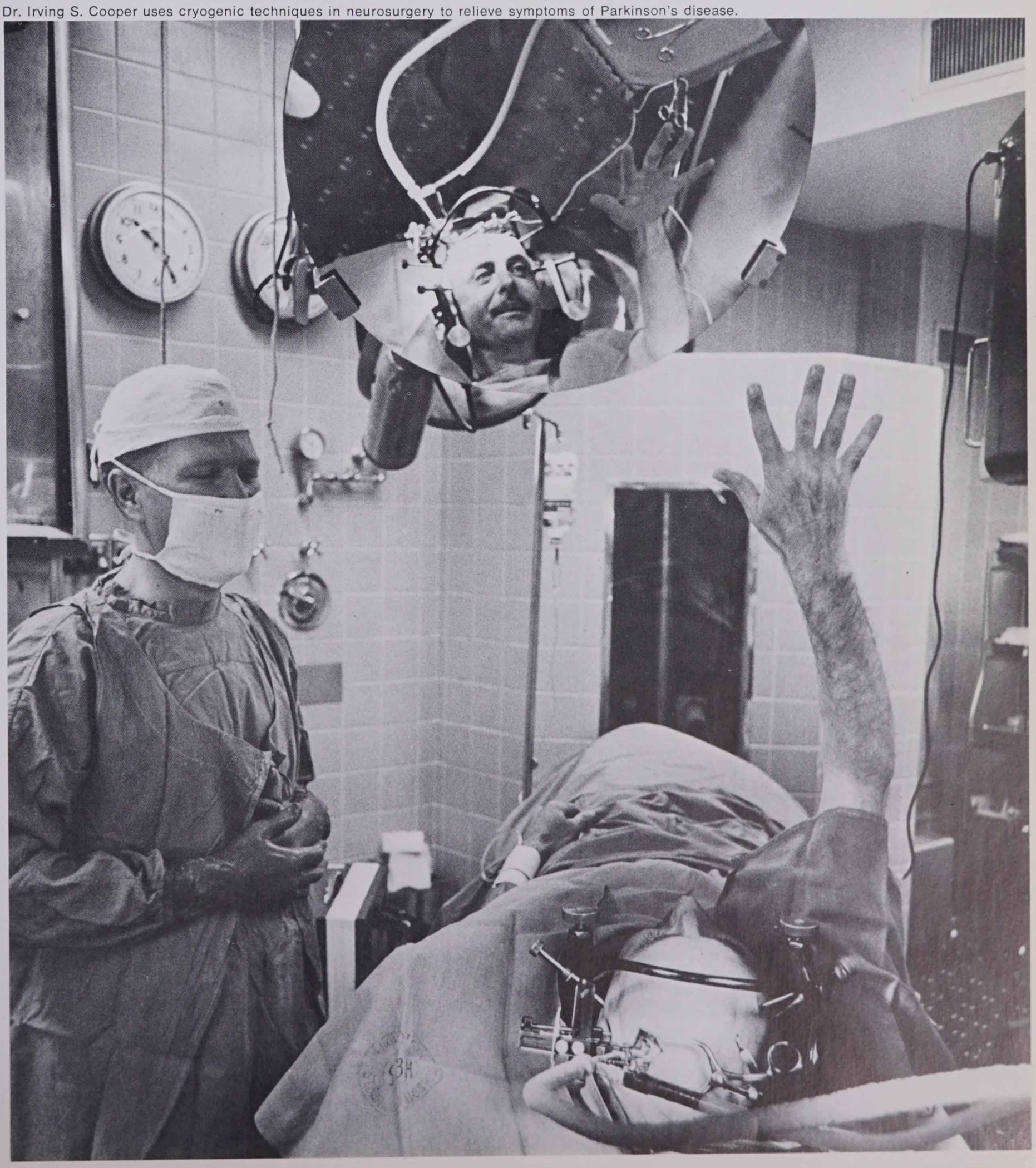
But cryogenic techniques have been effective — sometimes dramatically effective — in the surgical treatment of Parkinson's disease, detached retinas, and certain types of cancerous tumors as well as in the removal of prostate glands, tonsils, and cataracts. Cryosurgery reduces intense pain, since the frozen region loses all sensation. And, because blood vessels constrict when frozen, there is virtually no bleeding. This makes cryosurgery particularly useful in the treatment of patients with hemophilia and other blood diseases.

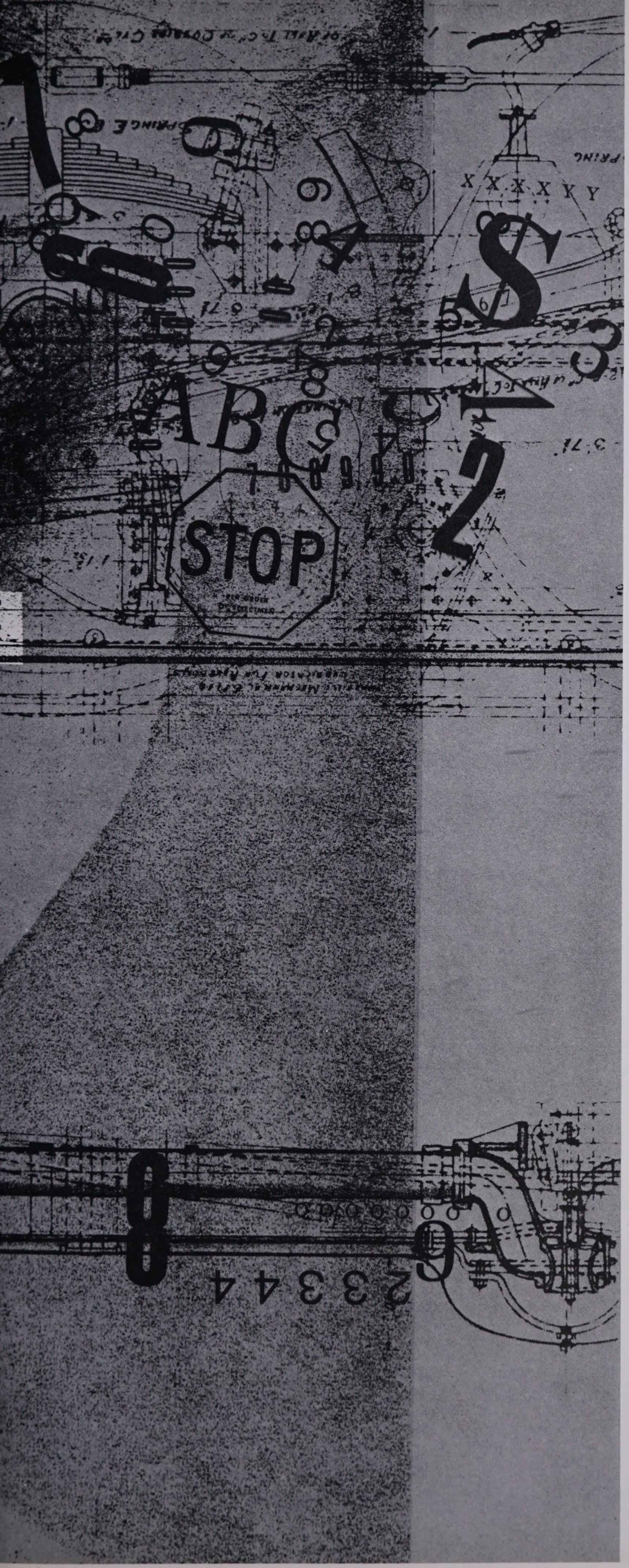
Dr. Robert Wolfson, of the Presbyterian–University of Pennsylvania Medical Center in Philadelphia, has had excellent results in the cryosurgical treatment of an inner-ear disorder called Ménière's syndrome. The illness causes loss of hearing, ringing in the ears, and, in some cases, extreme vertigo. Although most patients respond to medication, about 20 per cent can be cured only by surgical destruction of the affected portion of the inner ear.

With the burgeoning of practical applications for cryogenic technology, further research has introduced the possibility of increasingly varied uses. The space industry, which gave cryogenics its impetus, will require new and more sophisticated developments for flight to distant planets. The long missions will need improved propellants, advanced refrigeration units to dissipate heat generated in flight, and small, lightweight motors to run various systems aboard the vehicles. Superconductive magnetic shielding will be needed to protect spaceships and their crews against the harmful effects of cosmic radiation.

Cryogenics, a science until recently confined to the laboratory, may make possible these and other important technological advances. ■

Dr. Irving S. Cooper uses cryogenic techniques in neurosurgery to relieve symptoms of Parkinson's disease.





The Future of Computers

By the year 2000, many of today's jobs may have vanished–with computers performing and supervising functions in the home and in industry.

by Richard B. Rusch

Most people have never handled a computer. At present, few imagine they ever will. And yet, the increasing use of computers indicates that they will soon affect the life of almost everyone — in education, medicine, transportation, finance, and the very nature of job opportunities.

Extensive use of computers to serve the individual's need for information is becoming possible through time-sharing computers. With time sharing, a person no longer has to travel to the computer to process information or to wait for a trained computer operator. Many persons in different locations can use a single computer simultaneously for a variety of needs, provided suitable computer programs have been developed for it.

Imagine the day when computer terminals may become as available and as simple to operate as telephones. Although the procedure is rather slow, the pushbutton, touch-tone telephones of today can, with some modification, be used for feeding information into a computer. Even household television sets can be adapted to a computer via telephone line or cable connection.

There is almost no limit to the types of terminals that can be developed and the ways in which they can be used. However, widespread access to and use of these terminals by the general public,

Richard B. Rusch, a member of the RCA Information Systems staff, is the author of *The Future of Computers*, published this fall by Simon and Schuster.

"...we cannot completely predict the impact of their use upon mankind. The direction man takes will depend on how he plans in the coming era of the computer."

except perhaps for special purposes such as education, probably will not occur until some time in the middle-to-late 1980s or even the early 1990s. Time is still needed to solve a number of problems, such as the insufficient supply of transmission facilities, tremendous numbers of programs that need to be written, and limited ability of today's computers to handle mammoth data storage, retrieval, and processing requirements.

Much that man does starts with education, and acceptance of computers and familiarity with their workings might begin in the classroom. Although it seems improbable that this country will turn to an all-encompassing system of education by computer, a strong possibility does exist. The major consideration therefore is not whether such an educational system will be developed, but what it might mean if it were.

Will teachers become less important or necessary in a computerized educational system? Probably not. But their basic responsibilities might change, for they would be dealing with new ways of presenting and learning material.

Obviously, a teacher would have to learn programmed learning procedures and how to operate the computer. On the basis of test scores, a teacher would have to be able to recognize a student who was not responding quickly enough to certain material and adjust it to his needs as well as to recognize a student who was progressing rapidly and give him advanced material.

This may make it no longer necessary or even possible to separate students into grades and might require the teacher to guide learning activities not on just one grade level at a time but on all levels simultaneously. It is very likely that the elementary school teacher might ultimately specialize in one subject for all grades, as high school and college instructors now do.

Education of teachers might change from the present four-year college program followed by refresher courses to a program of continuous training. In fact, the education of all people, regardless of age or occupation, may have to be continuous simply to help them stay abreast of new information. Education might be continued in the home, with nothing more than a computer terminal. Courses could be provided free — as National Educational Television courses are today — or a small tuition fee might be added to one's telephone bill.

It is also possible to foresee the day when academic degrees become a thing of the past. A highly intelligent and motivated high school graduate might be considered just as qualified for a particular job as a college graduate, or a two-year college student as qualified as a six-year student. A student could serve as an apprentice on a job and find out if he is suited for it before he makes the heavy financial commitment for a college program in that field.

The computer will become important in fields other than education. Besides specially constructed TV and typewriter terminals, other types can be used for communicating with the computer. Pressure sensors or electronic scanners, for instance, can record vehicular traffic on city streets and transmit the information directly to a computer. The computer can then control timing of stoplights to permit the most efficient flow of traffic.

Some traffic engineers believe computer-controlled, automated highways could be constructed within the next five years. Existing toll roads, they say, could be modified to include recessed conveyor tracks that would transport cars at speeds of 80 or 90 miles an hour. Cars would attach to the track at an entrance ramp and then be automatically shuttled into the flow of traffic. To leave the track, the driver might pull a dashboard lever, causing the car to disconnect from the track. The car would then roll to an exit ramp or, in case of emergency, to the side of the road.

In medicine, another use of computers involves remote monitoring of a person's physical condition. Small electronic instruments, called transducers, are attached to different parts of the body surface, and the data they pick up are transmitted to a computer. This procedure is used in the space program to monitor the physical condition of astronauts and in some hospitals to monitor the condition of critically ill patients. The advantage of the computer is that it can continuously check the condition of several persons at once, tell when something is wrong and what is wrong with one of these persons, and signal to a doctor when treatment is necessary.

With an office TV terminal connected to a hospital computer, a doctor today can type in a set of symptoms and have the information immediately transmitted to a computer. In seconds, the computer displays on the doctor's terminal suggestions as to what the symptoms mean, even indicating additional tests to be made. However, the physician is still responsible for diagnosis and treatment.

In coming years, computers will be used more and more in recording and analyzing data on the treatment and control of disease. It is anticipated, for instance, that a person's entire medical history may soon be carried on something the size of a credit card that can automatically be read by a computer each time the person is treated. This card would eliminate the time-consuming and frequently error-filled chore of recording the patient's medical history. When the doctor has finished examining or treating the patient, information indicating the nature of the treatment or the findings of the examination would be recorded in the computer and the patient's history card automatically updated.

Television has become an important campaign medium of modern political candidates. Yet, in the next quarter-century, television may be overshadowed in importance as every aspect of an election campaign becomes computerized.

In our computerized age of the future, speeches, though important, are no longer the major source of information about a candidate. Newspapers have almost disappeared, and ballots are cast right from your own home, using touch-tone telephones connected to a computer in the election center.

The computer that has recorded your vote also has provided much of the information you used when you chose a candidate. With the touch-tone telephone, you first instructed the computer to display on your television screen a profile of the backgrounds of each of the candidates, including past legislative experience and current political views. You also may have asked the computer more detailed questions: How has each man voted previously on foreign aid, civil rights, crime control, tax bills, urban development, or pollution? What bills has he introduced (if he is a legislator), and how many were passed or rejected?

One of our present institutions that might change first and affect our lives greatly would be the medium of money. Imagine living in a nation where no one uses actual money, yet where merchandise and services are still bought and sold. Bankers call this kind of living "the cashless society," though most of them will not admit that its day is near. However, they will tell you why it is needed:

"New uses of the computer indicate that man is moving faster and faster toward the day when he can eliminate work he considers boring, alienating, undignified, and unfulfilling."

too much paperwork. Under present methods, almost every purchase or financial transaction is accompanied by slips of paper — currency, checks, money orders, receipts, invoices, bills, ledgers, and credit memos. As the population grows, the day approaches when the entire economy could be buried beneath a mountain of paper.

Credit buying and the use of credit cards do not effectively reduce the paperwork problem at this time because there is still need for billing and accounting. Ultimately, the problem could be eliminated completely by using only credit cards and handling all financial accounting through an interacting, nationwide network of computers.

First, there will have to be general public acceptance of credit and credit cards. Then, some central means of complete credit verification and control, covering everyone continuously in all parts of the country, will have to be established. These computer terminals in every home would let people know the status of their bank accounts at any time.

Based on the current growth of credit card distribution, it is obvious that the population is being given every opportunity to familiarize itself with credit card procedures. Also, a nationwide complex of computerized credit verification centers is being constructed, whose sole responsibility is to indicate who is and who is not a good credit risk.

One procedure involves depositing an employee's paycheck directly into his bank account. Coupled with this is bank payment of a customer's bills directly from his account. Many mortgage and time payments are now handled this way, and, in some areas, customers can authorize their banks to pay utility bills without ever seeing them. Ultimately, direct bank payment of all consumer bills may become part of the cashless society, primarily because it would reduce paperwork so greatly.

If the cashless society does become a reality, it would probably mean an empty wallet — empty, that is, of currency, checks, and money orders. About all a wallet would contain is a single credit card and a stack of receipts.

This system may also have its dangers. One of these is the threat to the individual's right to privacy, for all income and expenditure information will be recorded in one computer. However, having this information centralized may also help correct certain national ills.

First, analyzing the earnings and expenditures of all citizens by computer could aid in the development of more sophisticated national economic programs to control inflation and recession. Second, information available from these records could help pinpoint employment trends and lead to a better utilization of national manpower.

Last, and possibly most important, a cashless society could have a major effect on crime, including such borderline cases as tax evasion and certain business practices. What national or international crime syndicate, for example, will want to import narcotics into this country when the buyer could provide only a credit card in payment?

An even more profound change than the way we spend money will be the way we earn it, for widespread use of the computer will change the type of work we do. By the year 2000, most of today's jobs may not exist. It is expected that computers will be doing many of the routine, noncreative chores as well as such complicated ones as the supervision of industrial processes. A computer society survey of 250 computer experts from 22 countries predicts that, by the end of the 20th century, all major industries will be managed by computers.

The impact on the labor force will be tremendous. Studies show that many of today's factory workers may have to find new positions in the next 10 to 20 years. This will also apply to many office workers. None of these people will necessarily be out of jobs. New employment opportunities will open up in fields such as teaching, engineering, health services, recreational planning, government, and management.

Even today, the volume of technical, professional, social service, and managerial jobs is expanding; one half of current career opportunities did not exist 20 years ago.

The most dramatic change in the nature of work may be the eventual elimination of work itself — or, at least, a lessening of its importance in the social order. This may mean we will have to develop a social system in which everyone is assured a guaranteed income. Any earnings in excess of this amount would be up to the individual.

Our changing attitude toward computers is reflected in the words of Dr. Suzanne Keller, a professor of sociology at Princeton University, who writes that "in identifying man with a function that can be done better by machines, we make man inferior to the machine by definition. This is the reason why computers are perceived as threatening to our identities, why machines can be seen as potentially man's superiors. However, once we shift our admiration and respect to human talents and gifts that machines cannot equal, we have put the machines in their rightful place as our servants."

New uses of the computer indicate that man is moving faster and faster toward the day when he can eliminate work he considers boring, alienating, undignified, and unfulfilling.

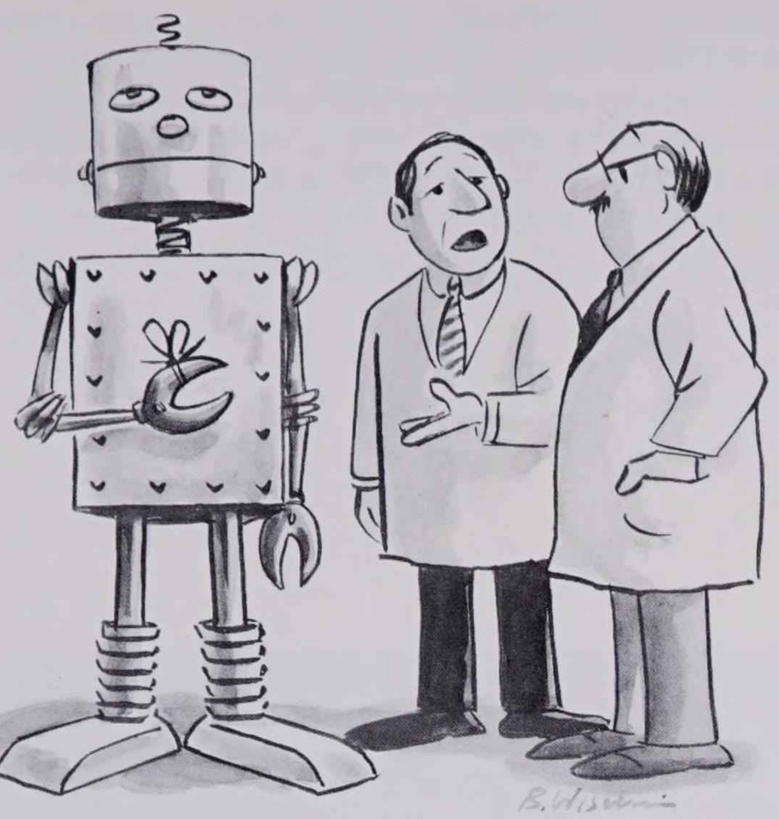
As man moves toward more creative endeavors, his attitude toward what he finds important as a reward for work can shift from money or power to personal recognition, excellence, and autonomy. "Already, many of the nation's youth see no reason to work for work's sake, to be a slave to one's job, neglecting play, family, and personal interests," says Dr. Keller. "They question the value of work that yields money and a certain measure of prestige, perhaps, but no sense of autonomy and all too little fulfillment."

These factors—the elimination of old jobs and the creation of new ones, the need for more and better education, and changing attitudes toward work — are placing society in a painful period of transition. Those who cling to the old concepts of work are fighting the use of computers, while those who seek a redefinition of work are looking for new and better ways to use them.

This conflict is creating tensions and will continue to do so, perhaps for the next 30 years or even longer. If, through better education and social programs, we can overcome these tensions, we will gradually improve job opportunities for all.

Computers are rapidly becoming a way of life, influencing not only employment but the direction of society itself. Yet we cannot completely predict the impact of their use upon mankind. The direction man takes will depend on how he plans in the coming era of the computer. ■

This Electronic Age...



"We've still got a few bugs to work out on his memory circuit . . ."

"I move we postpone discussion of peaceful uses of atomic energy and turn to peaceful uses of human energy."

"Eureka! I've done it! I've gotten blood out of a turnip!"

Electronics and the Sound of Music

The latest musical instruments include generators, filters, and polyphonic oscillators.

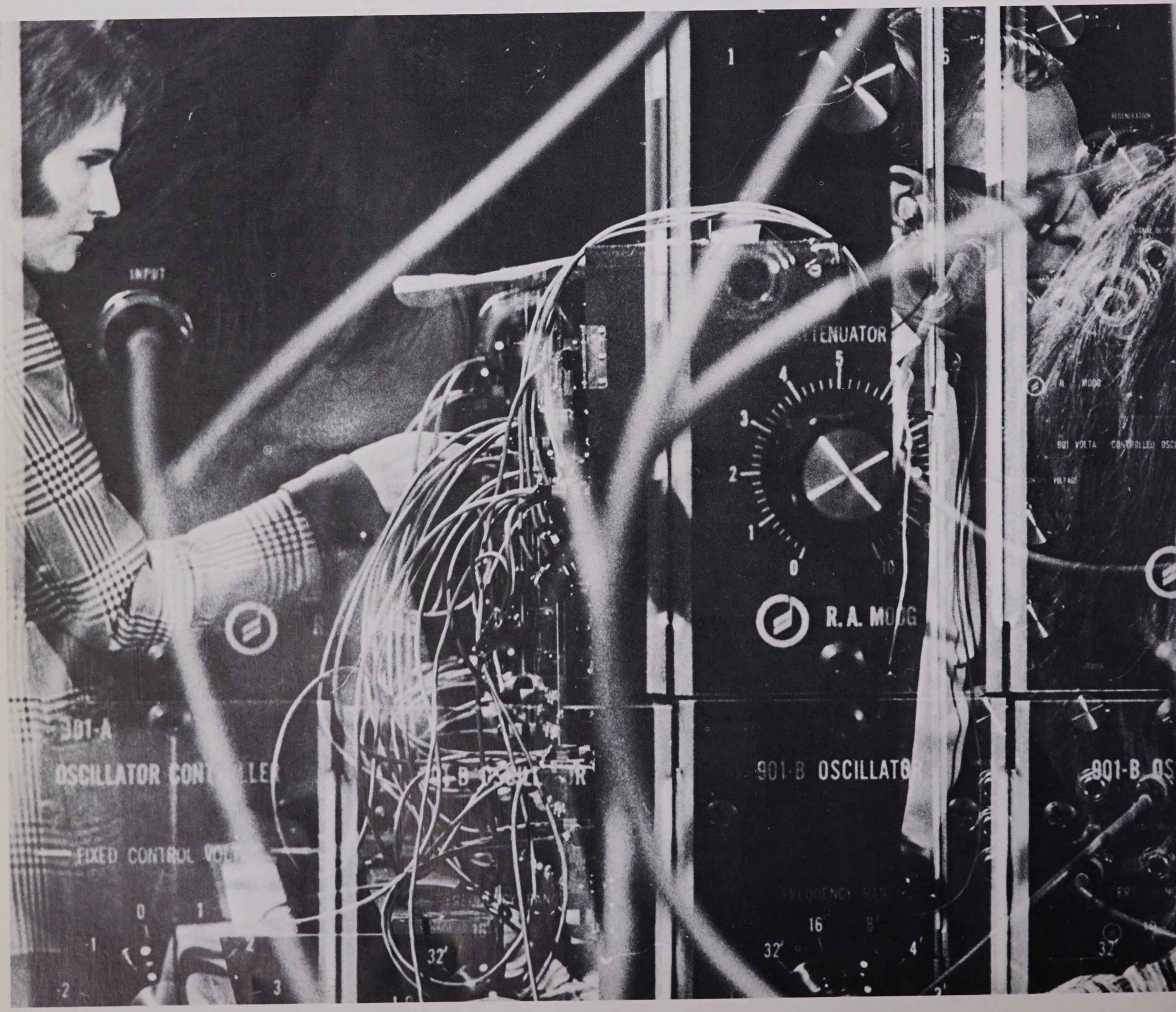
by Norman H. Solon

Charles Wuorinen, an assistant professor of music at Columbia University, pianist, and prolific young composer, created "Time's Encomium" on the typewriter keyboard of the RCA Electronic Music Synthesizer and garnered the 1970 Pulitzer Prize for music.

The 30-minute composition was painstakingly "written" — each note created electronically from its basic components — over a 12-month period at the Columbia-Princeton Electronic Music Center specifically for recording without the limitations an orchestral performance would have entailed. As Milton Babbitt, a leading composer of electronic music, explained, "Wuorinen's precise control of time — speed of the frequency change and the rate of change between loud and soft — places his work beyond the sonic capacity of conventional instruments and the dexterity of musicians, yet well within the limits of the human ear to hear and interpolate." Wuorinen explains that "because I need time, I praise it. 'Time's Encomium,' roughly translated, means in 'warm praise of time.' "

"Time's Encomium" also disputes the feeling held by some that electronic music is a kind of sterile sound — technically

Norman H. Solon is on the RCA Public Affairs staff.



perfect, but impersonal and lacking warmth and soul. Critic Theodore Strongin, in a *New York Times* review wrote "Time, minutely controlled... is what gives 'Time's Encomium' its sense of live personality, the composer's personality, pure and complete."

In fact, with today's sophisticated equipment, most composers feel that there is no discernible common denominator of electronic music, except the use of sounds that transcend the limits of conventional instruments. Everything from the muted twanging of rubber bands or the clashing of cymbals to entirely new sounds can be synthesized electronically. Wuorinen, says Strongin, "uses sounds that quite often seem like a real piano, organ, or harpsichord, or combinations of all three, instead of suggesting the electronically synthesized sounds that they are."

Electronic music, as defined by Babbitt, is "music produced by instructed electronic oscillators" (instruments that produce wave forms). This is a broader definition than is generally realized. It includes the real-time electronic modification of tones as they are played live by rock groups. Other electronic music is made by recording the sounds of each instrument or singer on separate magnetic-tape tracks, modifying them in a studio, and then combining them into a master tape. Most pop and rock releases are recorded this way, as are some radio and TV commercials.

Electronic music is also generated by building up tones from their component elements, a process known as synthesis. This can be done in a tape studio or on a music synthesizer or computer. Synthesis is based on the identification and generation of the basic characteristics of a sound, and the result can be music of any known or imagined instrument.

The characteristics of a sound can be briefly described: Frequency is the number of regular vibrations per second, which distinguishes tones from random noise and is heard as pitch. Wave form, the shape of a sound wave, determines timbre. Intensity is heard as loudness. Envelope comprises the growth, duration, and decay of a note. Portamento is the ability to slide smoothly from one note to another, a quality associated with the hu-

Composer Walter Carlos adjusts custom-made Moog synthesizer to create works of electronic music.

" '... given sufficiently efficient instruments, anything that can be heard, can, I am convinced, be played.' "
Charles Wuorinen

man voice or with instruments such as the violin. Vibrato refers to cyclic changes in frequency or intensity that give a slightly tremulous effect. Deviation includes all the random factors — such as slight changes in bowing motion by a performer on a stringed instrument or the way air currents affect sound in a room — and is valued as a beautiful and artistic attribute.

Traditionally, synthesis of electronic music has been done in a tape studio by what critic Ivan Berger described in the *Saturday Review* as "the laborious building up of tones from endless dial settings on separate generators, filters, and other instruments followed by the transcription of these tones to bits of tape that had to be edited or spliced together."

However, in 1955, Dr. Harry F. Olson and Herbert Belar at the RCA Laboratories in Princeton, N.J., developed the RCA Electronic Music Synthesizer, which builds up tones from their basic elements by means of a coded punched paper tape that controls the instrument. With this new instrument, a composer is able to create all types of sounds without tedious studio manipulation.

The possibilities this opened up were revealed that year on the first commercial recording by the new machine, "The Sound and Music of the RCA Electronic Music Synthesizer." The record includes songs that sound as if they are played on a harpsichord, an organ, and several entirely new instruments producing deeper tones and faster action than conventional instruments as well as by a hillbilly band and a dance orchestra. In addition, demonstration recordings were made that, according to Dr. Olson, exactly duplicated the style of such musicians as José Iturbi and Fritz Kreisler.

A second version of the RCA synthesizer — the Mark II — was developed in 1957 and loaned to the Columbia-Princeton Electronic Music Center.

Other types of synthesizers were unveiled during the past decade. The most publicized is the Moog synthesizer, developed in 1964 by Robert A. Moog, a young engineer then studying for his doctorate at Cornell University. It is operated manually through a piano-like keyboard that acts as a general switching device to control the generation of tones. The Moog has also been used as a performing instrument. (Another instrument, the Buchla synthesizer, uses a touch-sensitive metal plate instead of a keyboard as the control mechanism.)

Late in 1968, "Switched-On Bach" was taped directly from a custom-made Moog by Walter Carlos, a composer, assisted by musicologist Benjamin Folkman. Carlos' synthesizer, unlike most others, which can create only one note at a time, is equipped with polyphonic oscillators that allow one of the two keyboards to produce chords or overlapping notes.

The album by Carlos and Folkman promptly became the best-selling Bach recording of all time, with sales of more than 1 million copies. The result, according to the *Saturday Review,* was "patently

"what is the purpose of writing music? one is not dealing with purposes, but sounds... music is a way of waking up to life...which is so excellent once one's mind and desires are out of the way, letting it act of its own accord."

John Cage, *Silence,* M I T Press.

electronic sounds mixed with apparently instrumental ones." Critics were largely favorable in their reviews, although some other serious composers talked about gimmickry replacing creativity. Folkman claims that Baroque music shares characteristics with electronic music "such as crisp, bright sonorities, terraced dynamics, and high relief of voices."

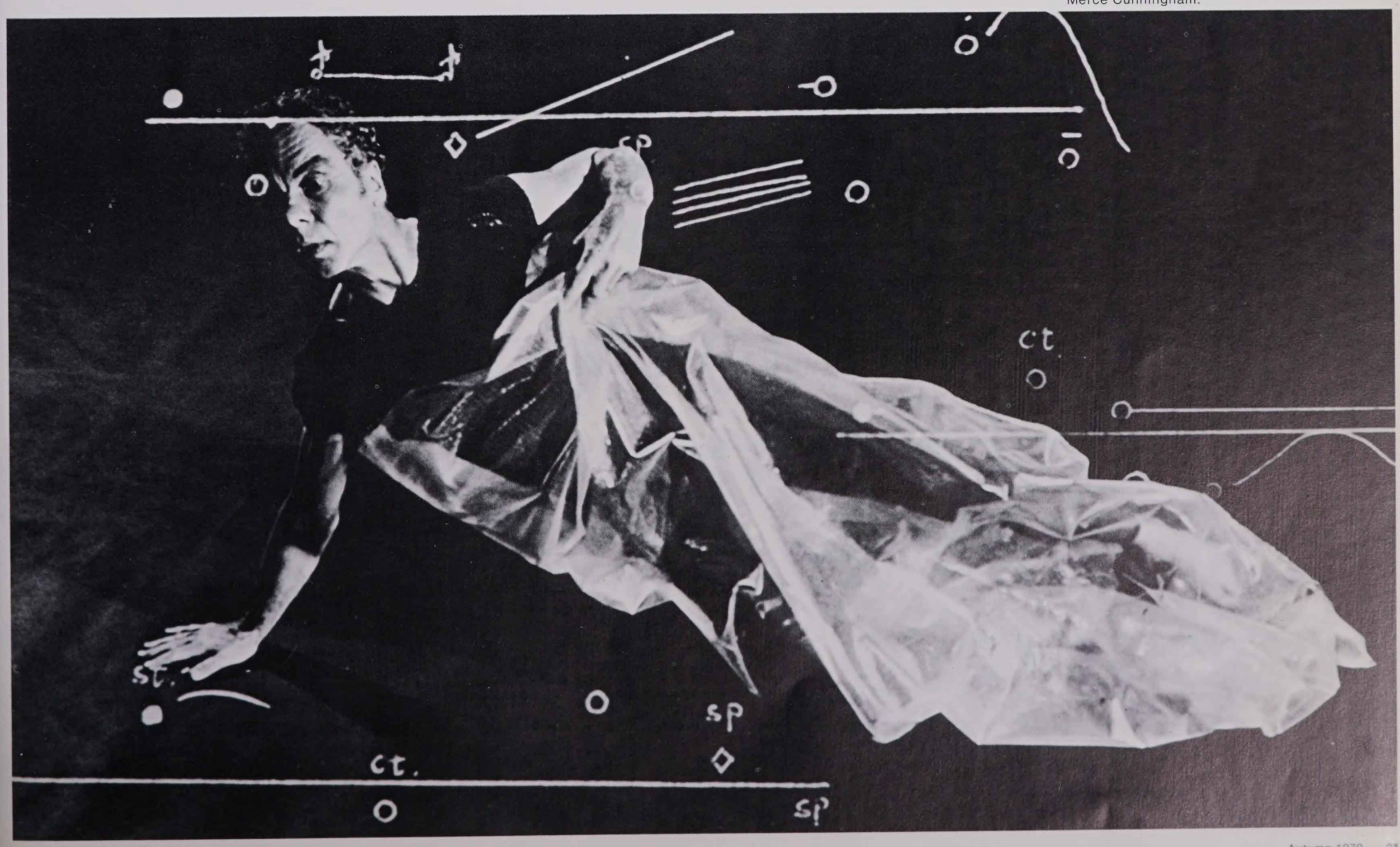
Even more recent is the use of the digital computer for musical synthesis. However, there is a general public misunderstanding about the role of computers in music. The computer doesn't create sound — rather it is a system that can produce anything that the composer can specify. Each of the characteristics of sound has a value that can be specified in arithmetical terms. These numbers are fed into a computer for processing, and what results is a sequence of digital samples. These figures are then converted to pulses, the amplitudes of which are proportional to the digits. These pulses are then smoothed by a filtering process to produce an analog signal that is then amplified and fed to a loudspeaker for acoustical output.

Most composers are convinced that the future of serious electronic music lies with the computer simply because of economic considerations. Once the software considerations are taken care of, all that is required is time on an existing computer and a hookup to an audio system. However, the present version of the RCA synthesizer would cost some $250,000 to duplicate, although Dr. Olson claims that a solid-state synthesizer could be built for less than $100,000 and that, if several were manufactured, the price would be still lower.

For all these recent advances in electronic music, the medium cannot be considered wholly a product of the 20th century. Many of its principles are based on research that began in antiquity. In the sixth century B.C., Pythagoras discovered a formula for the mathematical determination of musical intervals and identified the arithmetical ratio of string length to the number of sound vibrations. Panini, a Sanskrit grammarian, demonstrated the relationship between mouth position and sound in the third century B.C. Toward the end of the 19th century, Thomas Edison's invention of the phonograph, the development of various acoustical principles by Alexander Melville Bell called "visible speech," and Hermann von Helmholtz's experiments in the analysis and synthesis of the human voice by isolating the component frequencies laid the foundation for electronic music.

The beginning of the 20th century brought the development of the first electronic instruments for the production of sound, such as the unwieldy dynamophone, a 200-ton machine that generated music by means of a series of dynamos run by an alternating electric current. First demonstrated in Holyoke, Mass., in 1906, the dynamophone was described by its inventor, Thaddeus Cahill, as an "extraordinary electrical invention for the production of scientifically perfect music." It turned out to be less than perfect, since the music was transmitted over telephone wires too delicate to carry the load. However, even at that time, some musicians saw the machine as a portent of the future. After viewing a demonstration of the dynamophone, Ferruccio Busoni, a pianist and composer who helped launch the Italian Futurist movement, wrote: "I almost think that, in the new great music, machines will also be necessary and will be assigned a share

Computer-prepared notations for electronic music score and accompanying choreography are superimposed on photograph of dancer Merce Cunningham.



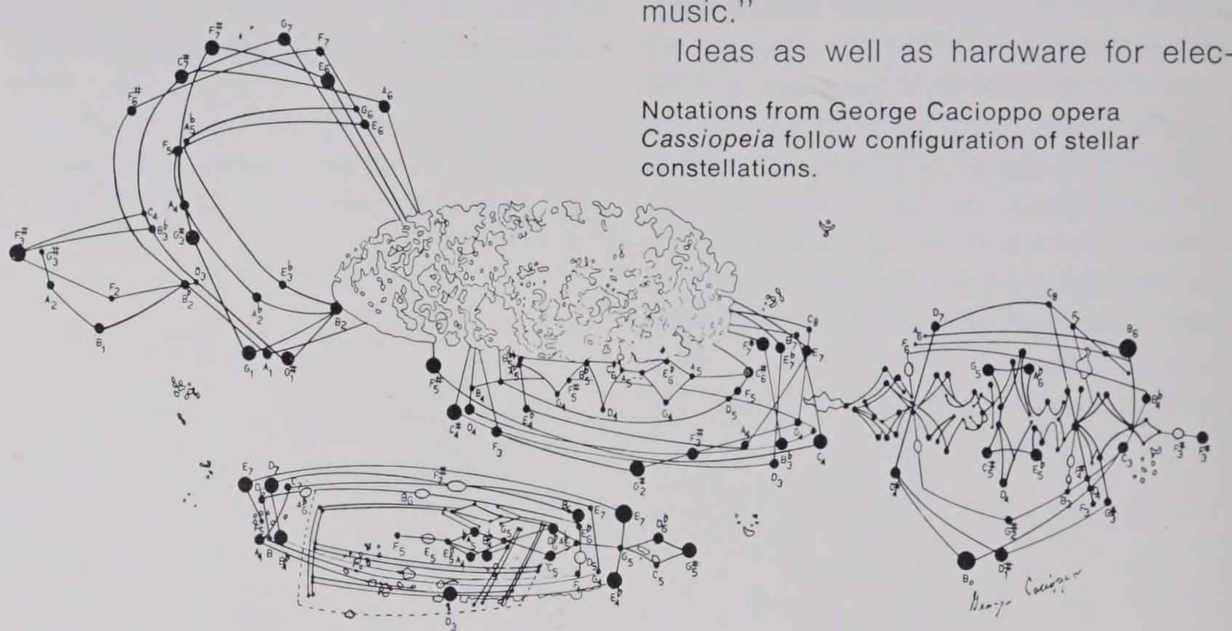
in it. Perhaps industry, too, will bring forth her share in the artistic ascent."

During the 1920s and '30s, several electronic instruments for the production of music were developed. One of the most successful was the theremin, named for its inventor, Leo Theremin. Compositions were written for it by a number of leading composers, including Schillinger, Slonimsky, Varèse, Martinu, Fuleihan, and Grainger, and it was manufactured for a time by RCA. The instrument (basically two oscillators and a loudspeaker) was played by moving the hands back and forth near a vertical rod antenna on its right and a horizontal rod antenna on its left. In France, another electronic instrument, the *Ondes Martinot,* was unveiled in 1928 at the Paris Opera by Maurice Martinot. A decade later, a custom version of the instrument was built to reproduce the microtonal refinements of Hindu music.

However, general acceptance of electronic musical instruments by the public and musicians was slow. Babbitt, looking back, writes that these early instruments "offered little beyond limited sonic novelty." Musically, they were not perfected — control of timbre was not exact. The theremin, for example, could not go from one pitch to another without an intervening glissando. Composer Otto Luening claims that another principal reason for the slow development of electronic music before World War II was that electronic hardware seemed to displace standard instruments rather than supplement them.

But criticism of electronic music by musicians of that period was by no means universal. In 1929, conductor Leopold Stokowski stated: "It is only a few years before we shall have entirely new methods of tone production by electrical means. One wonderful feature of the new electric instruments is, or will be, the practical absence of technical difficulty in playing them. There will be no long hours of practice every day, for electricity will do all the mechanical part. The performer will give musicianship, interpretation, variety of tone color and tone volume, and all the nonmaterial side of music. Thus will begin a new era in music."

Ideas as well as hardware for elec-



Notations from George Cacioppo opera *Cassiopeia* follow configuration of stellar constellations.

"musical ideas and notation are separated as a matter of convenience. they are actually interdependent- inseparable. since my musical ideas are always changing, so does my notation."

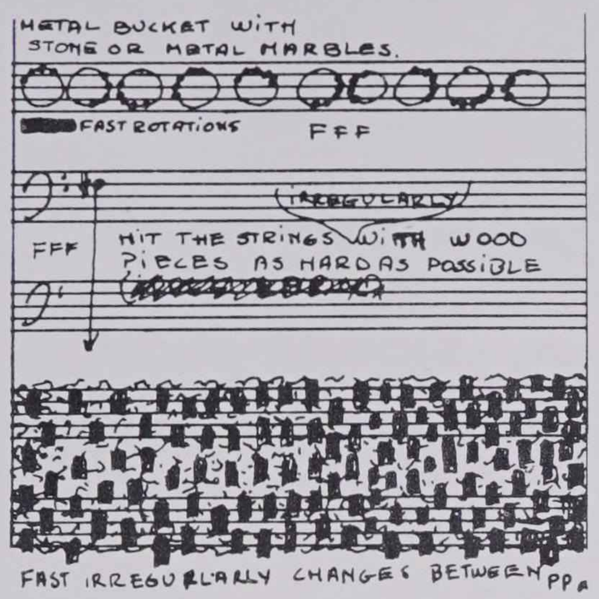
Jōji Yuasa, *Notations,* Something Else Press, Inc.

tronic music were also being created in this period. During the last years of the Weimar Republic, a research program was instituted at the *Hochschule für Musik* in Berlin to study the use of recordings as a creative tool in musical composition. By 1930, Paul Hindemith and Ernst Toch were creating short musical montages by using phonographic speed-up and slow-down methods, polyrhythmic experiments, sound transpositions, and mixings. Their work preceded the *musique concrète* movement in France by about two decades. At this time, the tape recorder was developed and recognized as a creative tool, although it was not exploited in electronic music for another two decades.

The birth of *musique concrète* took place in 1948, when engineer musician Pierre Schaeffer presented a "Concert of Noises" over the French radio network. In a manner similar to the earlier Hindemith and Toch experiments, Schaeffer arranged natural and instrumental sounds into a series of montages, but with much greater freedom than had the German composers. Schaeffer suggested the name *musique concrète* because the music is "made of concrete material and organized experimentally, whereas ordinary music is created abstractly, written in symbols, and only at the completion results in instrumental concrete sounds."

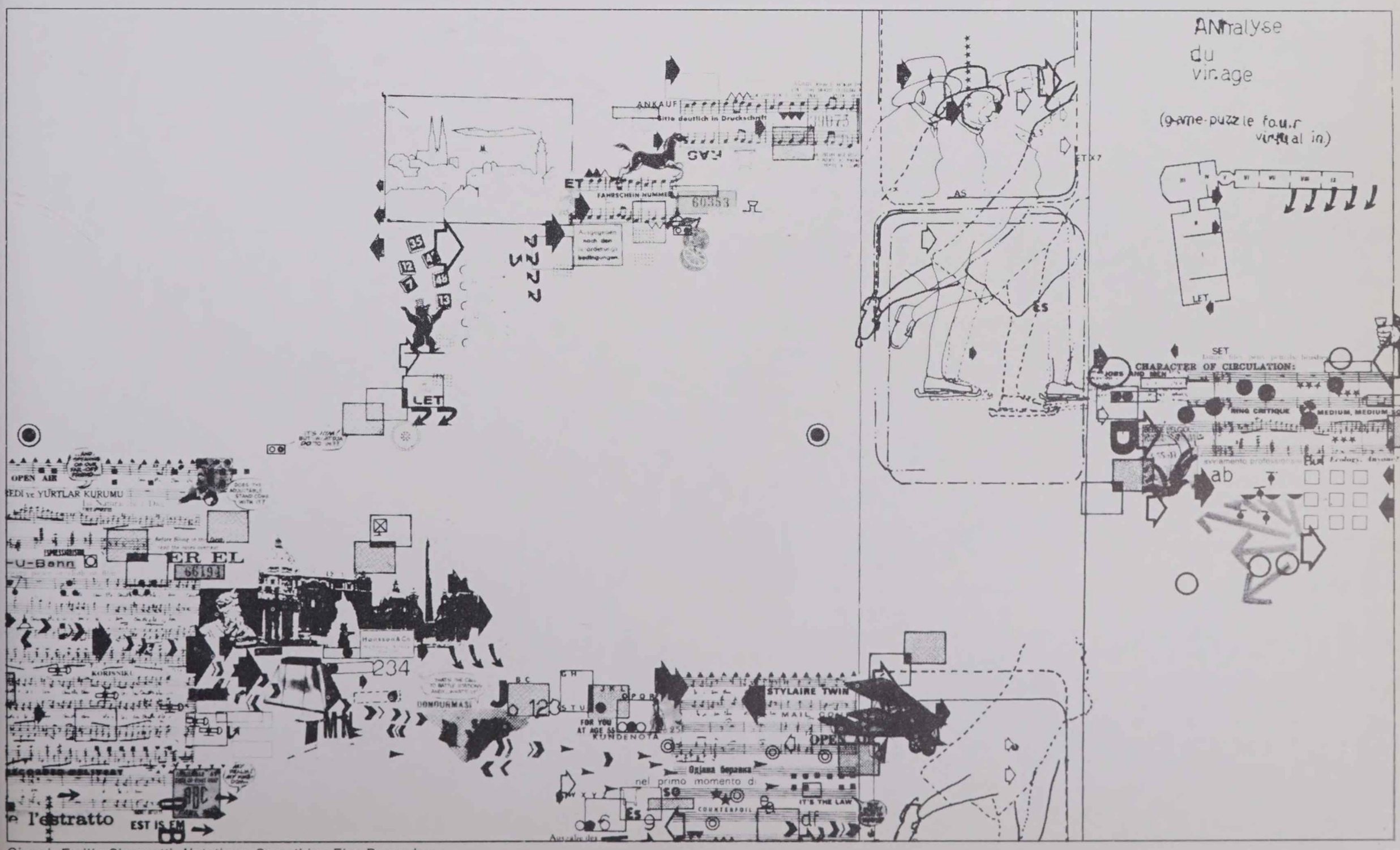
In 1949, composer Pierre Henry joined Schaeffer to create "Symphony for a Man Alone" in this medium. In a sense, Schaeffer and Henry made a success out of failure. Their "Orpheus," an experimental opera, was performed at the Donaüschingen Festival in Germany and was so vilified by the audience and critics who were unprepared for the "new sound" that international attention was focused upon them and their new musical movement.

From score of *Semikolon; Dag Knutson In Memoriam* by Lars-Gunnar Bodin.



The first studio for electronic music was established at the Cologne, Germany, radio station in the early '50s by a group of musically oriented scientists who also experimented with ways of composing directly onto magnetic tape. In 1952, the studio presented a public concert entitled "Music of Our Time" using tapes of sounds generated only by electronic means. The musicians represented were Karlheinz Stockhausen, who is now director of the studio, Goeyvaerts, Pousseur, Gredinger, and Eimert, and the works played at that concert were termed the first truly electronic compositions anywhere.

In the United States, electronic music evolved primarily from the tape studio. During the early 1950s, Vladimir Ussachevsky, a composer and professor of music at Columbia University, experimented with an Ampex tape recorder and a special feedback device developed by Peter Mauzey to incorporate raw sounds



Gianni-Emilio Simonetti, *Notations*, Something Else Press, Inc.

of instruments into a musical composition. The first concert of tape recorder music took place at the Museum of Modern Art in New York City in the fall of 1952. Consisting of Ussachevsky's "Sonic Contours" and Luening's "Fantasy in Space," it received general critical acclaim. New York *Herald Tribune* critic Jay Harrison wrote: "It has been a long time in coming, but music and machine are now wed."

Early tape recorder works were also created by John Cage, who experimented with multiple-speaker projections of highly fragmentary tape compositions. Cage is a controversial philosopher and composer who believes that music should be free of any limitations.

In 1967, Cage began working with Lejaren Hiller, an engineer and composer of computer music, on "HPSCHD" (the computer designation for harpsichord). Perhaps the most elaborate composition of its kind, "HPSCHD" combines electronic and instrumental music with visual stimulation. In 1969, the work was performed at a four-and-a-half-hour concert at the University of Illinois, using 7 harpsichords, 52 tape recorders, 59 power amplifiers, 59 loudspeakers, and 208 computer-generated tapes.

These were supplemented by 64 slide projectors that showed 6,400 slides, 8 motion-picture projectors that showed 40 films, and a myriad of silver balls reflecting dots of light in all directions. Richard Kostelanetz, covering the event for *The New York Times,* described it as "an atonal and structural chaos...continually in flux," although he called the sound "rather mellow except for occasional blasts of ear-piercing feedback." This year, "HPSCHD" was shortened to a 21-minute recording minus the visual pyrotechnics.

Another major figure in electronic tape music is Edgar Varèse who, in his studio in 1954, created "Déserts," a highly praised work combining live and electronic sounds. He was aided in this effort by the *musique concrète* studio of Paris. Varèse later re-created the electronic portion of his composition on the RCA synthesizer.

Electronic music in America has moved in directions other than recordings and concerts. Commercial use of electronic sound also began in the 1950s, mostly in private studios. Louis and Beebe Baron, for example, used electronic generators as their only sound source in producing scores for numerous motion pictures, including such forgotten epics as "Atlantis" and "Forbidden Planet." Luening and Ussachevsky also created electronic background music for a CBS "Studio One" production, the "Brief Sound Score" for an NBC-TV series of films on mathematics, and the "Carlsbad Caverns Sequence" for NBC's "Wide Wide World."

The future of electronic music may be even more startling than its past. According to Milton Babbitt, the "electronic vocalist" equipped with a universal repertoire together with all of the qualities and none of the limitations of the human voice will soon be a reality.

"Actually," he explains, "it is easier at the present state of the art to duplicate the human voice than to synthesize the sound of string instruments. This is simply because more of the voice variables have been identified and described. In fact, the voice of the operatic diva Galli-Curci has already been duplicated on the synthesizer.

"At present, Godfrey Windham, a research assistant working at Princeton University in conjunction with Bell Laboratories, is almost ready to announce the development of a musical voice synthesizer. The one problem still to be overcome is to create a smoother transition from one word of the lyric to another. By the way, the first electronic voice will be a boy's, although a girl's voice is easier to synthesize."

Whatever direction it takes, the growth of electronic music seems inevitable. Babbitt believes it will be part of the continuous evolution of music—not a revolution that might eventually sound the death knell for human performers.

"I know of no serious electronic composer," he says, "who asserts that we are supplanting any other form of music or musical activity. After all, the human voice was not supplanted by the musical instruments that came into being during the 16th through 19th centuries, despite the fact that they introduced all kinds of flexible capacities the voice doesn't have. Anyway, who wishes to do anything more than simply make music available in all its maximal resources?"

Babbitt uses his electronic work, "Philomel," as an example. "Although it is a 20-minute composition," he points out, "there is no 10-second segment that could be performed by conventional instruments. In my particular case, every orchestral work that I compose has to be disappointing. The orchestra and I are fellow victims of each other. They don't have time to rehearse my works properly, and I can't simplify my compositions to their liking."

John Pfeiffer, composer and an executive producer of RCA records, believes the future of electronic music will be built on the present: "An electronic music era must evolve from an experience continuum — use as its developmental springboard some existing musical experience. The obvious one is, of course, music itself. Enjoyment of a cultural experience is a learned, not a natural, reaction. To gain the acceptance of today's audience, electronic music must be centered around a discernible recurring form. For example, if electronic music is to be hemmed into the traditional diatonic scale division, why not use classic harmony rules? They are infinitely better proven and make more aesthetic sense."

Pfeiffer has attempted to "bridge some previous musical experience with the new freedom of electronically oriented sounds" by means of a studio method he calls electronomusical. In his recording, "9 Images," he takes conventional sounds and converts them electronically to his new music.

Pfeiffer's interest in the medium, as is the case of most electronic music composers, stems from his belief that it makes the composer a complete artist. "Composing for an orchestra is simply a case of leaving instructions that have to be interpreted," he explains. "With electronic music, the composer is the interpreter. The mechanics for producing electronic music are almost exclusively designed for composer performance. The absence of an accepted notation for any electronic music reproduction — a score in the conventional sense—illustrates the control that composers of electronic music have. The composer cannot be separated from the final result by the performer."

Charles Wuorinen once wrote, "I have been emboldened by personal experience to conclude that even the most difficult new music is far from approaching the limits of human capacities; given sufficiently efficient instruments, anything that can be heard, can, I am convinced, be played." ■

Bridge to the Planets

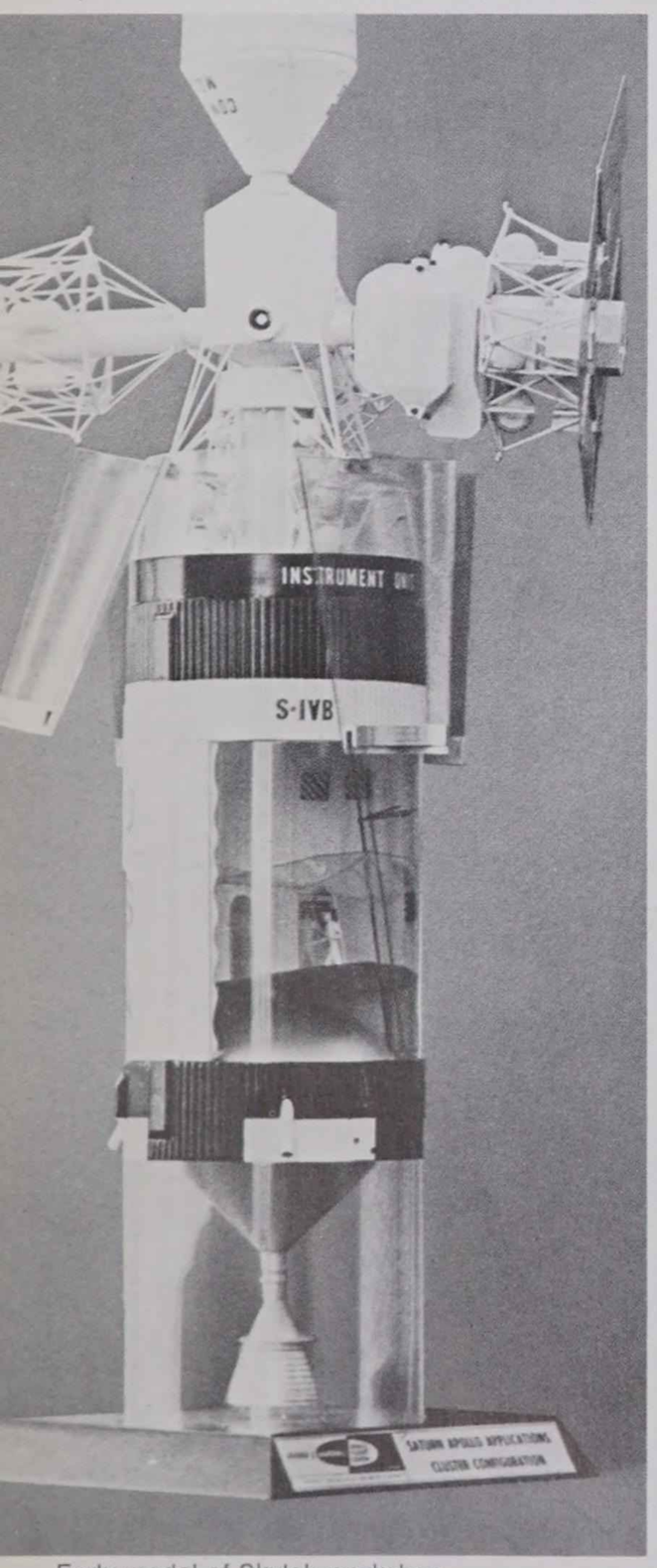
Space officials are planning three new types of craft: a space shuttle, an orbiting laboratory, and a space station that might be used for trips to Mars.

by John H. Lannan and Tom Elliott

Two major questions facing American space planners long before the Apollo 11 lunar landing last year were: where to go in space and how to get there. The overriding consideration was to develop a program of space exploration that would maintain the country's preeminence in space and yet fit within the cost constraints dictated by other national priorities.

Although the options remain open, a number of advanced concepts already have emerged to fulfill these requirements and are now on the drawing boards of America's aerospace industry. They involve three reusable, multipurpose, and long-lived types of spacecraft.

Planners envision a manned space station that can be enlarged while in orbit and enjoy a lifetime of at least a decade. The station could be resupplied by a second vehicle, a reusable space shuttle that could take off like a rocket, land like an airplane, and be refueled and reoutfitted for another flight in a relatively short period of time. In addition to ferrying men and cargo between earth and the space station, the shuttle could also perform numerous other missions while in either lunar or earth orbit. The third type of spacecraft — already being built for a 1972 launch — is a $2-billion "Skylab" workshop.



Early model of Skylab workshop.

A new era in U.S. space exploration will thus open late that year, when a Saturn 5 rocket lifts off from Cape Kennedy. The first two stages of the rocket will propel the craft into an orbit some 235 nautical miles above the earth, as they did on the Apollo missions, and then burn out and separate. The third stage, which was used to inject the craft into lunar orbit during the Apollo flights, will remain in earth orbit. Devoid of the tons of propellant and miles of intricate piping it would normally carry, it will be a scientific workshop with an array of instruments and living quarters for three astronauts.

A day or two later — after the Skylab is checked out by ground control — a Saturn I-B rocket will orbit a modified Apollo Command/Service Module (CSM) with three astronauts aboard. After five earth orbits, this spaceship will rendezvous and dock with the Skylab, to which the astronauts will transfer for a 28-day stay. Working in an environment in which spacesuits will not be necessary, the men will begin a series of tasks to make the workshop operational.

At the end of their 28-day orbit, the astronauts will prepare the Skylab for storage, return to the CSM, undock from the Skylab, and return to earth in much the same manner as did the early Apollo earth-orbit missions.

Two months later, the Skylab will receive its second group of visitors, another three-man crew transported by an Apollo Command/Service Module. This time, however, the astronauts will remain aboard for 56 days and will work primarily with the Apollo Telescope Mount (ATM), which will be attached to the Skylab and will function as a solar observatory.

ATM instruments will be configured to obtain precise measurements of the sun in the extreme ultraviolet and x-ray portions of the electromagnetic spectrum, two areas that cannot be observed from the earth because of the shielding effect of the atmosphere. From their vantage point in space, the astronauts also will obtain pictures of the sun's corona in the white-light portion of the spectrum. (Ground-based scientists "see" the sun only in visible light and in portions of the infrared and radio frequencies of the electromagnetic spectrum.)

Although telescopes have been flown in space before, aboard unmanned satellites, this will be the first opportunity to have a man operate such a system firsthand. From their own observations and from consultations with scientists on earth, the astronauts will be able to acquire data on specific instances of solar activity, including flares, which are of great interest to the scientific community. The crew's freedom to don spacesuits to change and retrieve film in the camera outside the spacecraft is another major advantage, since an unmanned system cannot function after its film supply is exhausted.

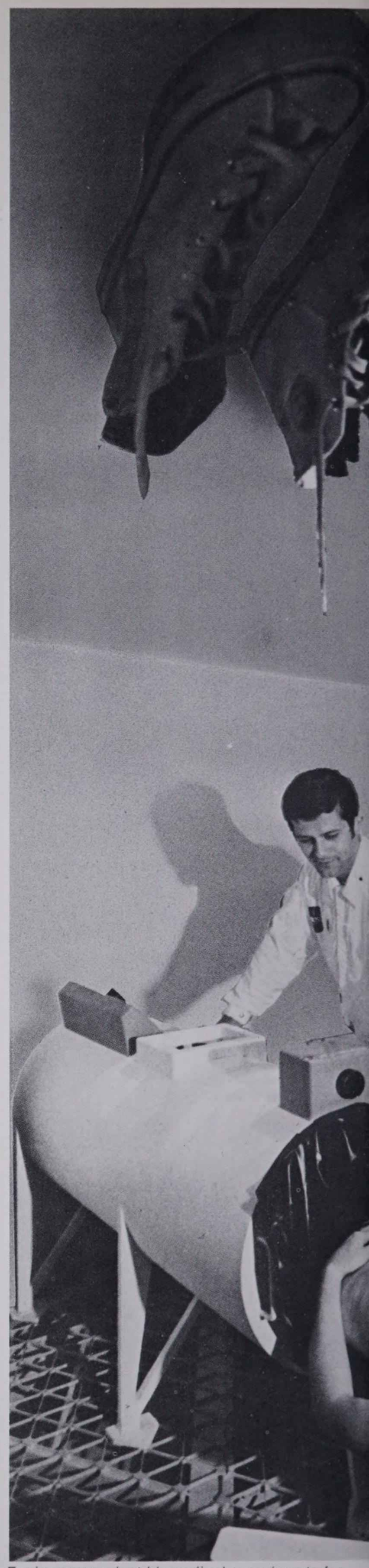
Even after the second crew returns to earth, the Skylab's mission will not be completed. About a month later, a third group of astronauts will be sent to the workshop for another 56-day stay.

In addition to the ATM, the Skylab will house equipment designed to view the earth. Ultrahigh-resolution cameras that function in various portions of the light spectrum and other instruments will image the surface of the earth. The resulting data can then be used to identify and analyze the vigor of crops and natural vegetation, to categorize forests, to detect and measure pollution, and to reveal other information of critical interest to specialists in the earth sciences.

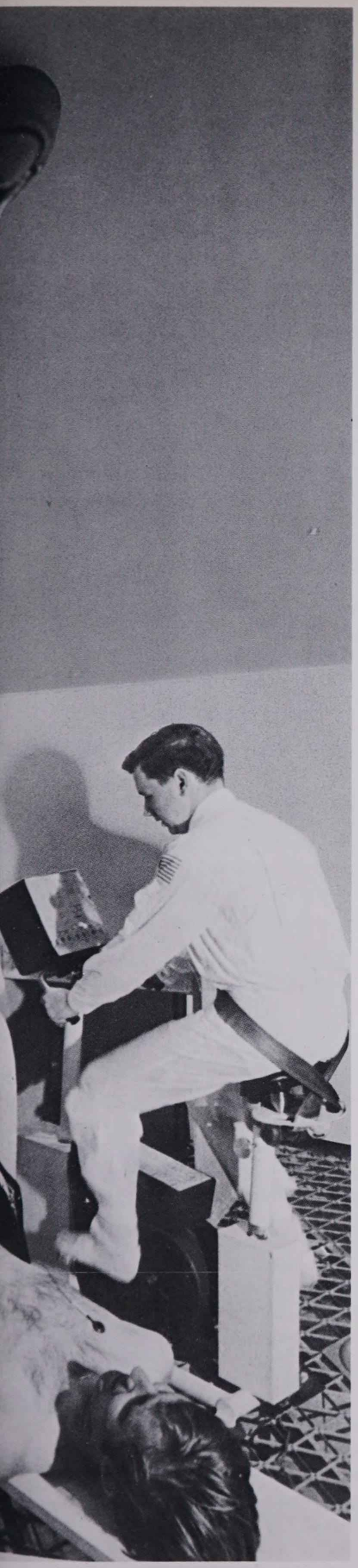
Altogether, during the Skylab's eight-month life-span, some 80 different experiments will be performed by the three crews. Many of these experiments will focus on the effect of prolonged flight upon the astronauts themselves. Among the medical problems associated with long-duration weightlessness are blood abnormalities, bone calcium deficiencies, underworked parts of the body, and fluid imbalances in the inner ear.

The longest space flight on record to date is that of the Soviet Union's Soyuz 9, which remained aloft for 18 days. The U.S. record is Gemini 7's two weeks. Skylab missions, lasting up to eight weeks, will provide an opportunity to find out how well man can withstand long voyages to the planets and to the edges of the solar system.

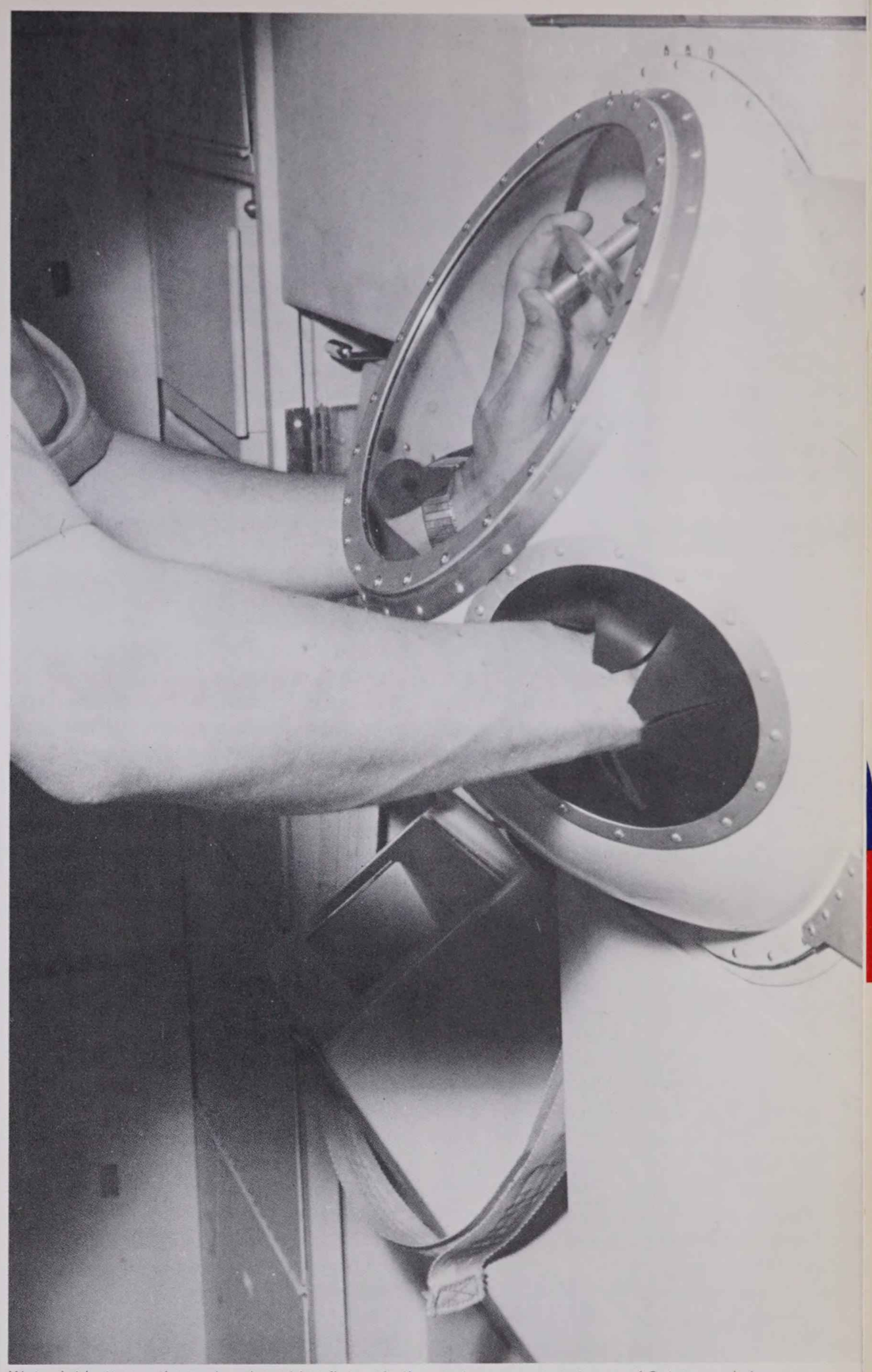
Skylab will make maximum use of equipment developed for the Apollo moon landings. In fact, before the program acquired its present designation, it was known as the Apollo Applications Program. The most ingenious use of Apollo hardware involves conversion of the third stage of the Saturn rocket from a launching device into the workshop itself. For the Skylab mission, this stage will not only undergo interior modifications but also sprout "wings" of solar cells, which will transform solar energy into electricity for the Skylab. A 17-foot-long Multiple Docking Adapter (MDA) will be added to the craft to serve as the docking point, entrance way, and control and film-storage area for the ATM. The MDA will also contain part of the Skylab's scientific payload.


Engineers conduct biomedical experiments for Skylab work compartment.

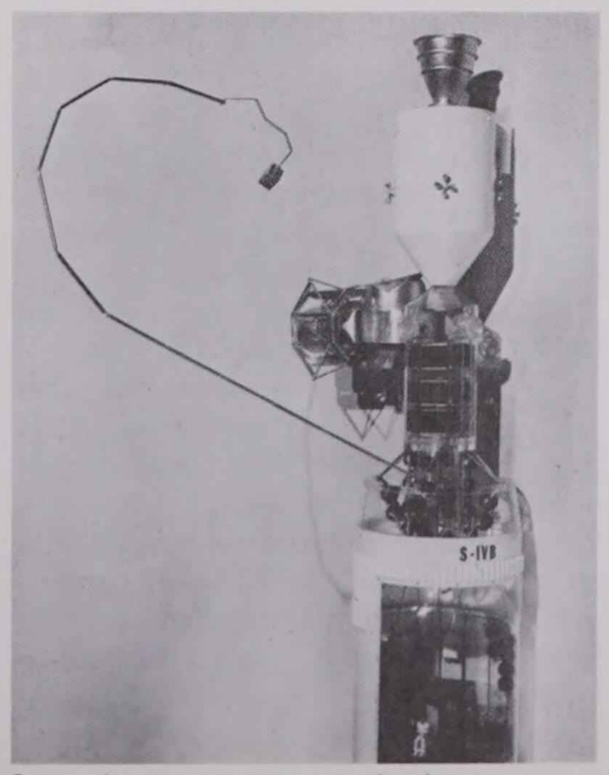
John H. Lannan is science editor of the *Washington (D.C.) Star*. Tom Elliott is on the RCA Public Affairs staff.



Since astronauts have no need for horizontal beds in the weightlessness of space, their "sleep restraints" are secured at ceiling and floor.



Water-jet button activates hand washing fixture in the waste management area of Saturn workshop.



Serpentine actuator can move hardware through space as shown in this model of an Apollo CSM connected to an orbital workshop by a multiple docking adapter.

"Official requirements for the planned shuttle are stringent: economy, reusability (up to 100 flights), and fast turnaround time on the ground."

Other Apollo subsystems will be incorporated into the Skylab program and will need little or no modification. For example, a very-high-frequency ranging system, developed by RCA to measure distance between the Apollo Command and Lunar modules when the two craft are separated, will be employed by Skylab crews as they maneuver to rendezvous and dock with the workshop.

Officials and planners for the National Aeronautics and Space Administration consider the Skylab the precursor of long-lived orbiting laboratories from which an entire spectrum of scientific experiments and practical tasks could be accomplished. Such laboratories also could serve as relay stations for trips to the moon and other points in space — what some NASA officials call a "bridge to the planets."

As the space agency proceeds toward the 1972 Skylab launch, it has simultaneously let contracts for studies of a larger and more advanced space station. The basic concept is to launch a number of individual modules and then assemble them in earth orbit, much the way children's "pop it" beads are snapped together. The station would begin as a unit of doughnut-shaped modules, each module 33 feet in diameter. Five layers of these units would make up a single 25,000-cubic-foot module, and each layer would have a specific function within the station.

A number of these larger modules could be assembled, while in earth orbit, into cylinders some 150 feet long. These cylinders, in turn, could be joined in any number of ways — end to end or even at the ends of long arms that would radiate from a central point or from another module. When fully assembled in this manner, the space station could accommodate a crew of 100.

The 10-year life-span of the space station would make it possible to amortize development, manufacturing, and launching costs — a far cry from the short-term missions that now characterize American space efforts.

With such a station in orbit, teams of scientists might be shuttled back and forth to perform a variety of experiments. It has even been suggested that the station become a high-technology manufacturing site — a place where electronic crystals could be grown without distortion caused by gravity on earth or where perfectly spherical ball bearings, impossible to create on earth, could be easily manufactured. The station might also conceivably be used as a medical facility, since weightlessness may be beneficial to patients suffering from respiratory, cardiovascular, and similar ailments as well as helpful in performing certain types of surgery.

The space station also could be a starting point for trips to the moon or to Mars. One of the cylindrical modules, after having its oxygen, food, and other essential supplies replenished, could be detached from the station and towed into lunar orbit by a tug vehicle.

The tug, another new concept for advanced space flight, could be a nuclear-powered, shuttle-type vehicle that would provide propulsion over extended periods of time. After completion of its lunar mission, the module could then be propelled back into earth orbit, where it would rejoin the space station.

Several modules could be joined to make the two vehicles needed for a trip to Mars. These might be used to house the crew during the long trip. The only other equipment necessary would be a tug to propel the vehicles (which would be joined for the voyage) and individual landers carrying astronauts and equipment to the Martian surface. After exploration of the surface was completed, the astronauts would reenter the landers, which would then reunite with their respective module vehicles. The two module vehicles would, in turn, reunite as a single vehicle while still in orbit around Mars and be towed back into earth orbit for link-up with the space station.

According to planners, the station will be like having in orbit a family of planaria — 150-foot-long "space worms" capable of splitting themselves in half and, with the aid of new building materials, reassembling into new structures for a variety of missions.

In addition, the space agency has let contracts for design studies of a space shuttle. The vehicle will provide an inexpensive and fast way of getting into and out of orbit. According to present plans, it will be capable of delivering 25,000 pounds of payload at a cost of $20 to $50 a pound, compared with the $1,000 now needed to get one pound of payload into orbit.

Official requirements for the planned shuttle are stringent: economy, reusability (up to 100 flights), and fast turnaround time on the ground. There is the added requirement that the pre-launch checkout be performed by the crew, in much the same way that a commercial airline crew goes through pre-takeoff procedures. (A manned launch using present technology requires up to 20,000 people for support.) The shuttle crew would be aided in the checkout by on-board computers and other electronic gear.

If all these criteria are met, NASA and the Air Force will have a vehicle that could not only supply a space station but could also serve as an orbital taxi. It could, for example, capture and carry in its belly a satellite that had malfunctioned. The satellite could then be worked on in a drydock section of the shuttle or carried to the space station for repairs and ultimately, on another shuttle flight, redeployed in orbit.

The shuttle's huge payload capacity and volume might enable it to serve as a satellite ferry — carrying and orbiting an entire array of satellites while going about its other missions. The shuttle could shift orbit, deploy one or more satellites, change to another orbit and deploy more satellites, and so on, until the entire payload was distributed on proper course. Since it could be launched on short notice and could maneuver in orbit, the shuttle holds further interest for NASA and the Air Force as a rescue vehicle.

The versatility of the shuttle promises to generate across-the-board cost reductions in all classes of space hardware. Today's satellite must either function with near-perfection or drift uselessly and endlessly in orbit. Because of the resultant high-reliability requirements, instrumentation aboard these satellites costs about $1,000 a pound. With the repair capability offered by the shuttle, these costs might be brought more toward the level of earthbound laboratory equipment—no more than about $100 a pound.

The reusability of the shuttle also means less emphasis on miniaturization of payload, which is now necessary to get the most capability into space per launch. It has been projected that 50 shuttle flights could be made at a total operating cost less than that of a single Apollo/Saturn 5 flight.

The shuttle would also do away with the need for large fleets to be stationed at sea to pick up returning spacecraft and crews. It would land near, if not beside, its launch site and would be equipped with all the flight equipment that a commercial airliner carries. Should it be necessary, the shuttle could put down at any major airport.

A basic approach to the design of the shuttle — and a likely candidate for the final version — is a two-part vehicle consisting of a booster vehicle and an orbital vehicle. Each part would be manned and capable of up to 100 flights. The booster would carry the orbital vehicle piggyback into the outer atmosphere, to an altitude of 60 or 70 miles. The orbital vehicle would take over at that point and propel itself and the shuttle's payload into orbit.

Since the design of both vehicles of the shuttle is still in the preliminary stages, the final product could have wings of almost any kind: straight, stubby ones; delta forms; or even swing wings. The final configuration may even turn out to be one of the lifting body shapes with which NASA and the Air Force have been experimenting for several years. These are bluff, blunt-shaped vehicles in which the lift, upon reentry, comes from the broad, flared belly of the craft.

The booster would fire only briefly, building up velocity to 9,000 feet a second before separating from the orbiter. The orbital vehicle would then proceed into orbit with the shuttle payload, and the booster would begin its fall back to earth. At 50,000 feet, however, just as the atmosphere created enough drag to control the craft, the astronauts would pitch the booster over, point the nose down, and start the air-breathing jet engines with which they could maneuver an aircraft-like approach to the launch site or an airport. They would land horizontally at a speed of about 130 knots.

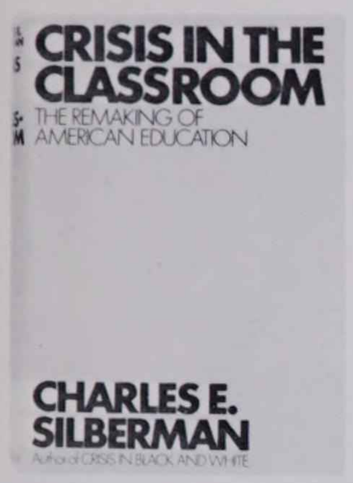
One of the basic objectives of the shuttle is to create an environment in which engineers and scientists can be transported with ease and comfort without undergoing training as extensive as that required for astronauts. As a result, the orbital vehicle cannot be exposed to strong gravitational forces upon reentry.

The craft will also have to withstand searing heat upon reentry. Engineers believe that a stub-winged vehicle coming in at a high angle, perhaps as much as 60 degrees, could spread the heat over enough of the underside to dissipate it safely. New metal alloys, careful design, and a delicate touch with the maneuvering jets could keep the shuttle at the proper angle and thus overcome the problem.

The shuttle would remain in its high-angle flight attitude through descent, to approximately 40,000 feet. At this point, the nose would be pushed down and the vehicle would dive until it reached adequate velocity for level flight. The turbojets would then start up, and the shuttle would fly to its landing site, using standard aircraft procedures. Once passengers and cargo had been discharged, the shuttle would be refueled, resupplied, linked with a booster, and readied for another mission.

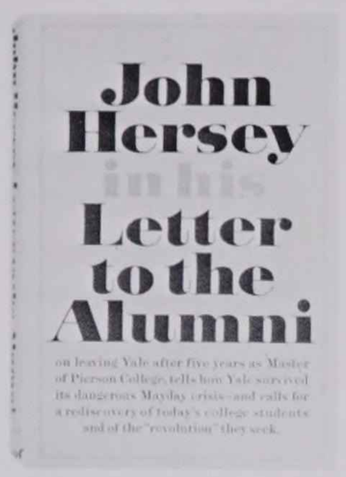
With preliminary design studies now under way for development of both the shuttle and a larger space station, it is entirely possible that, before this decade is over, Americans will be crossing that "bridge to the planets." ■

Books at Random...



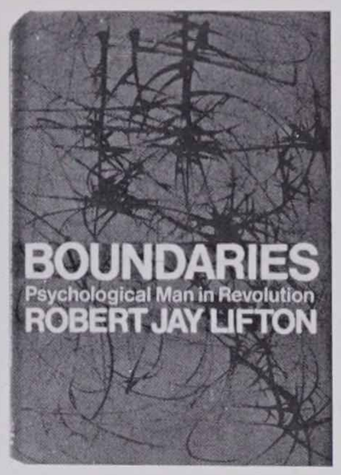
Crisis in the Classroom
by Charles E. Silberman (Random House)

This study is the result of three-and-a-half years of research commissioned by the Carnegie Corporation of New York. The author examines problems besetting American education today with the same intelligence, compassion, and honesty that marked his award-winning best seller, *Crisis in Black and White*. Anyone concerned with the nation's public schools and with its colleges and universities will be disturbed by Silberman's picture of current practice. Many will agree with his insistence that it is not enough merely to ask, "How can we bring the worst institutions up to the level of the best?" For, all too often, the best is simply not good enough.



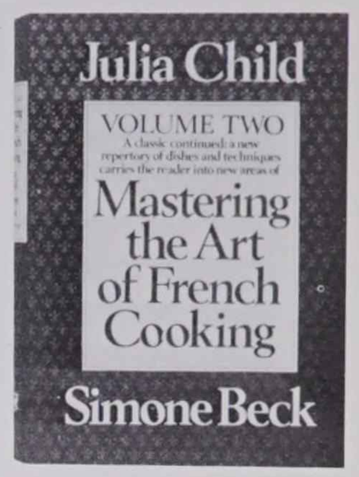
Letter to the Alumni
by John Hersey (Alfred A. Knopf)

On leaving Yale, after five years as Master of Pierson College, Hersey has written his *Letter* to help the older generation rediscover the young and to help youth find its own best self. The book takes as a framework the events surrounding Yale's historic May Day weekend last spring and examines the polarizations taking place in this country. Hersey traces the major aspects of the student movement: the rebellion against hypocrisy, injustice, and bureaucracy and the insistence on involvement, awareness, and immediate change. Speculating on the future of American colleges and universities, he sets forth, with understanding and concern, the complex ways and wants of young people.



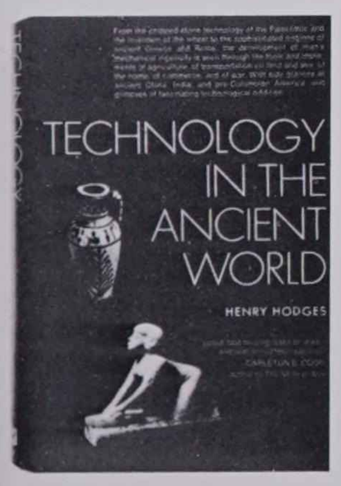
Boundaries
Psychological Man in Revolution
by Robert Jay Lifton (Random House)

In this study, Dr. Lifton takes up the themes of death, revolution, and man's changing sense of himself. He examines the relationship between contemporary events and one's inner life and suggests the existence of totally new involvements. The extremity of recent experience — nuclear attack, revolution, mass communication — has shattered our boundaries. Man is torn between the safety of a mythical past and a hunger for a new future. Lifton is especially concerned with "the boundary between the living and the dead that man has struggled so desperately to maintain." In this challenge, however, he sees profound possibilities for revitalization.



Mastering the Art of French Cooking: Volume Two
by Julia Child and Simone Beck (Alfred A. Knopf)

Here, at last, for the more than 680,000 persons who already own, swear by, and cook from Volume One, is the long-awaited sequel to the cookbook that has inspired so many to seek new levels of culinary achievement. Each of the new master recipes and variations is worked out step by step with a clarity and precision that will enable Americans, working with American ingredients, to re-create the classic dishes and regional specialties of France. Included in Volume Two are the first recipe for making authentic French bread with all-purpose flour, a selection of provincial fish stews, and 13 recipes for poached chicken.

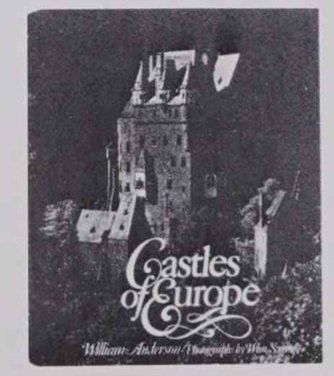


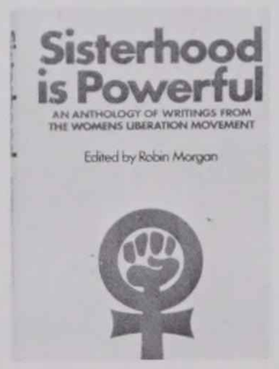
Technology in the Ancient World
by Henry Hodges (Alfred A. Knopf)

Beyond its fascination for anyone interested in the way things work, this book's survey of early technology will disturb many preconceptions about ancient societies. In this authoritative and lively narrative, the early products of technical ingenuity in the ancient Near East are explained and related to social developments, with comparisons made to the technology of ancient China, India, and pre-Columbian America. The book is illustrated with photographs and specially commissioned drawings of objects never before seen by modern man that have been reconstructed from ancient writings and other archaeological evidence.

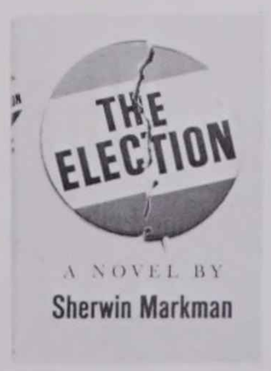
Teitlebaum's Window
by Wallace Markfield (Alfred A. Knopf)

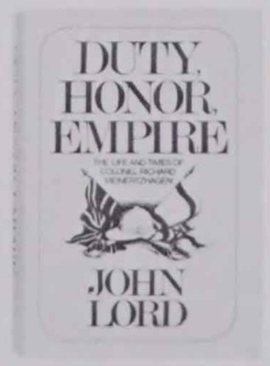
Out of everything we lived, read, saw, said, ate, bought, loved, hated, and feared in the 1930s, from Betty Boop to Adolph Hitler to the dairy delights in Teitlebaum's window, comes Wallace Markfield's new novel. The book is set in Brooklyn's Brighton Beach neighborhood, near Coney Island. Full of the feelings and popular culture of the '30s, it tells the story of Simon Sloan from age 8 to 18. The novel is Markfield's first since his memorable *To An Early Grave,* published in 1964.

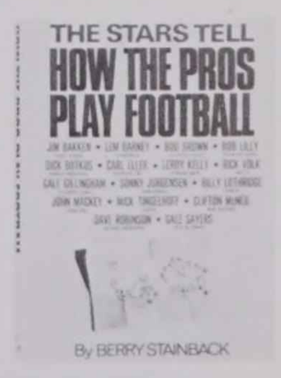




Other Recent Random House Books







CANADA The Second Century

This 103-year-old confederation may soon emerge as one of the world's great economic powers and a key to the continuing prosperity of North America.

by Leslie Roberts

A collage of the faces of Canadians today reflects the nation's cultural past as well as current political and intellectual leadership. Included are Prime Minister Pierre Elliott Trudeau (second from left) and Marshall McLuhan (far right).

Canada, it has been said, is a country dominated by its own vastness. It ranks second only to the Soviet Union in total area, with nearly 4 million square miles of land and water stretching coast to coast as far north as the North Pole and as far south as Detroit. It ranks fifth in international trade, with exports exceeding $11 billion a year. Its vast northern and Arctic frontier is immeasurably rich in underdeveloped resources. Its wealth in coming years may make Canada one of the world's great economic powers as well as the key to the continuing productive prosperity of North America.

The country's population, however, totals only about 21 million, and more than a century after confederation of its provinces, the historic struggle for unity is still being waged. Region combats region for dominance within the national structure, while traditional English-French antagonisms continually threaten to disrupt the essence of that structure altogether.

Most of the population of Canada occupies a narrow east-west corridor along the country's southern border. Indeed, nine out of every 10 Canadians live no more than four hours' driving time from the United States, a geographic fact that permeates virtually all aspects of life in Canada.

"Living next to you is in some ways like sleeping with an elephant," said Prime Minister Pierre Elliott Trudeau last year. "No matter how friendly and even-tempered is the beast, if I may call it

Leslie Roberts, a Montreal newspaperman and radio commentator, is the author of 17 books on Canadian and world affairs.

Construction in Calgary, Alberta, typifies the building of an increasingly modern, industrialized Canada.

that, one is affected by every twitch and grunt."

A huge slice of industry within that east-west corridor is owned by U.S. corporations, which provide jobs and family incomes for a majority of the Canadian work force. Hence, the two national economies have become tightly interlocked, and the result is a great many surface likenesses. But there exists a deep and growing desire among Canadians to establish their own national identity.

In an effort to help unify the country, the federal authority in Ottawa began establishing a nationwide radio network early in the 1930s. One reason for government sponsorship was a desire to ensure development of a system that would serve not only to provide broadcast communications but also to link all parts of a huge, underpopulated country. Another was that private enterprise was not then prepared to risk a huge capital investment.

In the ensuing decades, the Canadian Broadcasting Corporation has created a coast-to-coast network of some 100 government-owned and 200 affiliated television stations, making it one of the world's major electronic enterprises. Private sources have since established a second TV network, but all broadcasting remains under the direct supervision of a federal commission.

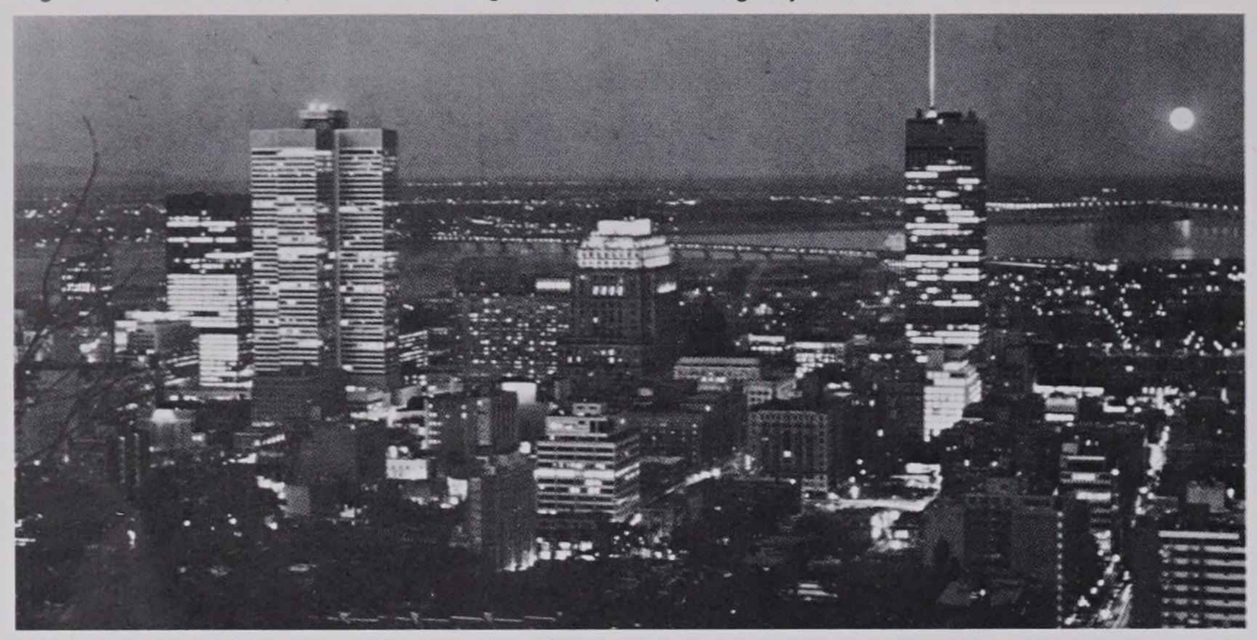
In May, 1970, this commission laid down a new set of programming rules, specifying the amount of "Canadian content" to be included—that is, the percentage of all programming that must be of Canadian origin. These rules have not been accepted without opposition from private broadcasters. Some operators, in fact, have questioned the sufficient availability of native talent. Viewers and listeners, too, have voiced loud criticism of the rules, insisting on their own right to see and hear what they want. The commissioners frankly admit the difficulties of their assignment—which is not merely to maintain, but to broaden, the feeling of Canadian identity without simultaneously encouraging outright chauvinism.

Similarly, the National Film Board uses

Research technician at Chalk River, Ont., handles toxic plutonium alloy for development of peacetime applications of nuclear energy and radioactive isotopes.

"Canadians of French ancestry number more than 6 million, some 5 million of them living in the province of Quebec... Montreal, in fact, is often described as 'the second-largest French-speaking city in the world.' "

Night view of Montreal, "the second-largest French-speaking city in the world."



the motion-picture medium to tell the world about Canada — and to tell Canadians about their own country. The Canada Council, a federal agency analogous to the U.S. National Foundation on the Arts and the Humanities, gives direct financial assistance (more than $31 million in the past year) to a wide range of projects undertaken by individuals and groups.

Provincial and city administrations sponsor a variety of cultural activities. Although many of these were in existence prior to 1967, the country's centennial celebrations that year certainly intensified the Canadian national spirit.

In 1967, Canada and the city of Montreal were hosts to "Expo 67," an international exposition subsequently recast as the permanent "Man and His World" exhibition. More than 50 million people went through the turnstiles that first summer, many of them U.S. visitors. Next on the international agenda are the 1976 Summer Olympics, to be held in Montreal. Such events occasion a greater intermingling of peoples, the only means through which neighbors can know and understand each other's aspirations and ways of life.

Fisherman tending nets at St. John harbor, New Brunswick.

"If we (Americans) are to understand Canada," former U.S. Ambassador Livingston T. Merchant has written in his book, *Neighbors Taken for Granted,* "then we have to accept that Canadians want to be Canadians and not 'Americans.' They want to cultivate their own distinctive national personality and culture — which is under the casual but constant bombardment of a nation 10 times more populous and 13 times richer."

The national capital has become a thriving cultural community, broadly national in outlook. The National Arts Center in Ottawa is dedicated to the work of Canadian artists and the development of Canadian art forms. The city also boasts an excellent National Gallery, National Library, and National Museum.

Canada's first century as a nation was also marked by construction of civic and public buildings in towns from Prince Edward Island to British Columbia. Among the plans that came to fruition as Canada approached the 100th birthday of its nationhood in 1967 were the opening of the Centennial Theatre in Charlottetown, P.E.I.; Bishop's Falls' library in Newfoundland; a community center in Steinbach, Man.; the North Battleford, Sask., Western Pioneer Museum; a commemorative building in Ste. Anne-de-la-Pocatière, Que.; and a Centennial Center in North Vancouver, B.C.

The English-speaking Canadian is just as pragmatic a person as his neighbor across the U.S. border — and certainly as concerned with the serious business of earning a livelihood. But he is also determined, in Ambassador Merchant's words, "to cultivate a distinctive Canadian personality." Still more determined, perhaps, is the French Canadian.

Canadians of French ancestry number more than 6 million, some 5 million of them living in the province of Quebec. They have been far less exposed to U.S. cultural influences than have their fellow citizens. Eighty per cent of all *Quebecoises* live, think, talk, and, in most cases, work in the French language. Montreal, in fact, is often described as "the second-largest French-speaking city in the world." The city's largest newspaper is the French-language *La Presse,* which currently reaches the widest French audience of any journal published outside Paris.

Book and magazine publishing, a federally owned broadcasting network, a plethora of professional and amateur theater groups, a growing motion-picture industry — all these flourish as French-language media in an English-speaking setting. Their language has thus insulated the people of Quebec from general continental influence. It has also contributed greatly to the emergence of Montreal as one of the great cosmopolitan cities in the Western world.

As with all industrialized countries, Canada has its regions of affluence and its regions of slow growth or even economic distress. British Columbia, on the Pacific coast, is notably rich in developed resources, which have given it what some political leaders insist is the highest standard of living in the country. East of the Rockies, the three prairie provinces of Alberta, Saskatchewan, and Manitoba — known not long ago as "the world's breadbasket" — suffer today from the pangs of a worldwide wheat glut. The economy there is now beginning to shift toward a growing petrochemical industry and the development of vast potash fields in Saskatchewan. But the great manufacturing enterprises of Canada remain in the central area of Quebec and southern Ontario. East of Quebec are the Atlantic Provinces — Nova Scotia, New Brunswick, Newfoundland, and Prince Edward Island — where the simple geographic fact of distance from inland domestic markets has always been a drawback to industrial development.

Only recently have the Canadian people, including many government officials, "discovered" the Arctic and the huge potential of its natural resources. That discovery coincided with the historic 1969 voyage of the mammoth oil tanker *Manhattan* through the waters of the Northwest Passage. The purpose of the trip was to test the feasibility of transporting crude oil eastward through the Hudson Strait and into the Atlantic. Almost immediately, Canadians began to worry about possible oil spillage, which might destroy the delicate balance of Arctic ecology. The federal government hurriedly enacted legislation, unanimously supported by Parliament, to protect not only the internal waters separating Canada's mainland from the islands of the Arctic archipelago but also offshore waters to a distance of 100 miles.

When U.S. President Richard M. Nixon declared the move unacceptable, Canadians stood firm. They strongly asserted the importance of their sovereignty as a nation. Equally important, however, was the emerging general belief — or realization — that the whole future of Canada is tied to development of Arctic resources.

Geologists and miners, of course, have long been aware of the value of the Yukon and Northwest Territories. Discovery in 1930 of uranium-bearing pitchblende at Great Bear Lake, near the Arctic Circle, resulted in the opening of North America's first known commercial uranium deposit. This was followed by discovery of gold-bearing ore bodies near what is now the flourishing city of Yellowknife. During World War II, an oil pipeline was thrust from Norman Wells, on the Mackenzie River, through the mountains to Whitehorse, capital of the Yukon territory. After the war, major base-metal discoveries were brought into production at Pine Point, on the south shore of Great Slave Lake.

Postwar interest, however, was not sustained. Private industry turned a deaf ear to the prospects of profitable developments in the Arctic. Similarly, a succession of Canadian governments failed to recognize the importance to Canada of its own vast resources in the far north — despite all the evidence of what the Soviet Union had accomplished in its Siberian Arctic region. Today, at last, that recognition has come very much alive, and a great deal is beginning to be said and written of the promising future that lies "down north."

The point has repeatedly been made of late by some Canadian newspapers, as well as by spokesmen for the economic community, that the nation is running short of many minerals urgently required for manufacturing. Although the statement applies with equal force to forest products and other natural resources, the concern with minerals deeply affects Canada's relation with the United States. Large quantities of raw minerals are shipped daily into the United States. Exports of iron ore, for example, now total about $300 million a year.

There is no doubt that the United States needs its partnership with Canada today more than ever. Canada has an increasingly vital role to play in the future of the North American continent and the Western Hemisphere.

Knowledge and understanding of that role, however, are vital to the common future of the United States and Canada. For Canadians are no longer willing to be "neighbors taken for granted." ■

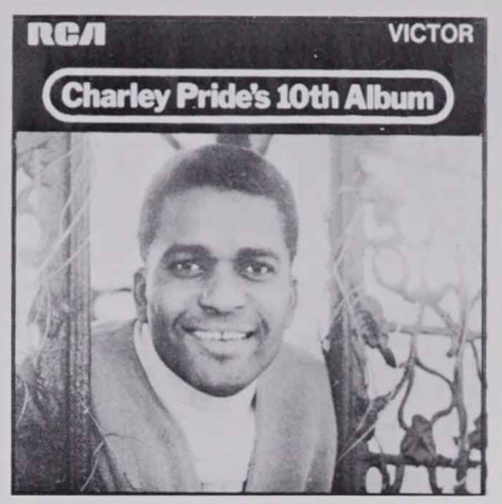
For the Records...

Orff: Carmina Burana
Seiji Ozawa conducting the Boston Symphony Orchestra
Evelyn Mandac, soprano; Stanley Kolk, tenor; Sherrill Milnes, baritone; New England Conservatory Chorus and Children's Chorus of the New England Conservatory LSC-3161

The most famous work of the German composer Carl Orff is "Carmina Burana," a musical composition based on 24 poems dealing with love, lust, drinking, and merrymaking. The manuscripts on which Orff based his score were found in the confines of the monastery of Benediktbeuern in the Bavarian Alps and are representative of the songs of the medieval goliards — seminarians and monks who had left the monastic disciplines to spend their time in earthy pleasure.

Ron Dante Brings You Up
KES-106

The voice of Ron Dante has become known to millions of people through the recordings of The Archies and The Cuff Links and through countless radio and TV commercials. Now he assumes his own identity as a singer and composer. This debut album includes 10 songs written both by himself and with various collaborators as well as two songs written by Jeff Barry and Andy Kim, composers of The Archies' biggest hits. Music supervisor Don Kirshner, president of Kirshner Entertainment Corp., has worked with Dante for about seven years since he first hired the young singer as a staff writer. The album is manufactured and distributed by RCA Records.



Charley Pride's 10th Album
LSP-4367

Charley Pride's records are invariably among the top of the country-music charts, and his personal appearances are always sold out. This recording features both sides of his most recent single, "Is Anybody Goin' to San Antone," and "Things Are Looking Up." It also includes "I Think I'll Take a Walk," "A Poor Boy Like Me," "The Thought of Losing You," and "Through the Years." Within two weeks of its release, "Charley Pride's 10th Album" replaced his ninth, "Just Plain Charley," as the nation's best-selling country album — proving once again the popularity of the talented singer-guitarist. The Nashville Edition provides vocal accompaniment.

Dvořák: Symphony No. 9 in E Minor, Op. 95 ("From the New World")
Carnival Overture, Op. 92
Arthur Fiedler conducting the Boston Symphony Orchestra LSC-3134

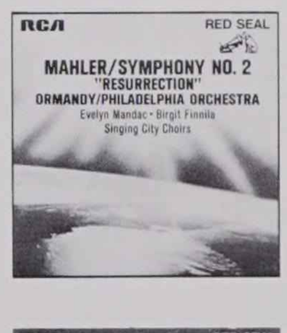
Anton Dvorak's "New World" Symphony, with its familiar melodies such as "Goin' Home" (the underlying theme of the second movement), is among the most popular works in the concert repertory. In this Red Seal release, Arthur Fiedler, long known for his association with the Boston Pops, marks his debut on records as a conductor of the Boston Symphony. This recording was made shortly after Fiedler's 75th birthday celebration last December, when he had conducted the work with the Boston Symphony.

CHOPIN A LA MOOG—with lots of strings attached
Arranged, conducted, and synthesized by Hans Wurman LSC-3171

This Red Seal album differs from previous classical recordings of the Moog synthesizer in that it incorporates the live performance of a string orchestra with that of the Moog. The synthesizer is featured as "soloist," as an electronic orchestra backing up a live string section, and as an orchestral ensemble. These 13 Chopin melodies, originally written for the piano, are enhanced by Wurman's use of the limitless types of sound that the Moog can produce in harmony with, and in counterpoint to, the string ensemble.

Elvis' Worldwide 50 Gold Award Hits, Vol. 1
LPM-6401

This four-disc set is a complete history-on-record of Elvis Presley. All of Presley's "Gold Record" singles — a total of 50 — have been assembled in one package that spans his career from "Heartbreak Hotel" (January, 1956) through "Kentucky Rain" (January, 1970). From the early years come such hits as "Hound Dog," "Love Me Tender," and "I'm All Shook Up." From the middle period of his career are "Can't Help Falling in Love," "Good Luck Charm," "Return to Sender," and "Bossa Nova Baby." Also included are such award winners of the 1960s as "If I Can Dream," "In the Ghetto," and "Suspicious Minds."



Other Current RCA Releases

Electronically Speaking...

Recent RCA Developments in Electronics

"Talking" System Alerts Pilots to In-Flight Failures

A "talking" system that can send automatic voice warning to a pilot if a critical component should malfunction during flight is being developed for the U.S. Army Electronic Command. The system consists of sensors that continuously and accurately monitor critical components of the plane, an RCA signal adapter, and a voice playback unit.

The sensors send electrical signals by cable to the signal adapter, which is the heart of the system. The adapter conditions and processes the signals and compares their values against established standards. If a problem arises, the adapter will trigger a recorded message — such as "No. 1 engine fuel pump failing" — into the pilot's intercommunications system. Since the pilot can depend on being warned instantly by the system, he can concentrate on flight operation. Also, the warning system will facilitate ground maintenance and repair because of its ability to detect and record equipment problems in flight.

The system would monitor 35 functions of an aircraft, including engine and non-engine components. For example, on Sikorsky's Flying Crane helicopter, the voice warning system can detect whether the hoist hook released its load when the pilot pressed the hook-release button.

The signal adapter, which is built with integrated circuits throughout, measures 7 x 7 x 5 inches and weighs five pounds. It is designed so that each signal that flows into the adapter has its own conditioning and processing circuits for greater accuracy.

Light-Sensitive Integrated Circuit Reads Computer Cards

A computer card reader, consisting of a light-sensitive thin-film circuit deposited on glass, has been developed at RCA Laboratories. It could eventually replace mechanical or photocell sensors now used to read stationary punched cards that activate computers.

The new device, a form of integrated circuit 5,000 times larger in area than the standard type, is a flat array of photosensitive elements with auxiliary components and interconnections deposited on a 4 x 8-inch plate of glass. Since the array is fabricated on a single substrate, the new reader could provide smaller size and much lower cost than do conventional card readers, many of which are assembled from large numbers of separate photocells.

In its present form, the unit is laid out as a computer card reader containing 960 photoconductive elements — 12 rows of 80 elements — that match the 960 positions on a computer card. Wherever a hole has been punched in a card, the corresponding photoconductive element senses light and provides an electronic signal. The same technology could be used to develop all-electronic readers for plastic credit cards, punched paper tapes, and stencils. A lock-and-key system in which a punched plastic card would act as the key and the photosensitive array as the tumbler of a lock could also be made. The cost, size, and sensitivity characteristics of these integrated sensors are also expected to make them useful for high-speed card readers.

Property Titles Deposited in Computer Bank for Fast Retrieval

A real estate title-examination system that uses TV terminals linked to an RCA computer is providing instant access to the records of more than 2 million Los Angeles County land parcels. Acquired recently by the Security Title Insurance Company, the system contains one of the largest data files of its type in the country. It has abstracts of every legal document regarding land transfers in the county during the past quarter-century and many documents dating back to 17th century Spanish land grants. In all, the memory bank of the SPECTRA 70/45 computer contains more than 32 million records relating to data on property, liens, deeds, boundaries, and easements.

Previously, it took hours or days to retrieve title information by manual methods. With the new computer system, title examiners can review the information through the video data terminals and, when necessary, have it reproduced as hard copy on a high-speed printer.

TV "Snapshots"

The first television camera tube to have built-in stop-action capabilities has been developed at the David Sarnoff Research Center in Princeton, N.J. The unit is a small, vidicon-type device that can take — and hold for later playback — single electronic "snapshots" of continuous programming being transmitted by the tube. The still picture is electronically stored inside the tube, eliminating the need for an external storage medium such as film or videotape. The picture can be relayed to a TV monitor immediately or stored for several days.

Closed-circuit television systems designed for data processing, business, education, defense, and space are expected to benefit initially from the new development. Applications in the broadcast industry may be developed eventually. Police, bank guards, and military personnel could also use the RCA vidicon device for surveillance of an area or a building.

The storage mode of the silicon vidicon, which can be used to acquire a picture at one scanning rate and read it out at another, is also expected to find use in various commercial and military systems that transmit pictures over narrow bandwidth facilities such as telephone lines.

Glōbcom Computer Service Speeds Delivery, Reduces Errors

A new computer service that reduces delays in handling international telegrams and decreases processing errors has been inaugurated by RCA Global Communications, Inc. The service automatically converts the domestic format of messages sent through the Western Union Telegraph Company to overseas points into the required international format. The computer scans the messages — in which data such as time, date, address, or number of words are presented in domestic format — and puts the necessary items into proper international standard. Formerly, such processing had to be done by hand. Now, the change is made by computer within eight seconds of local transmission.

The new procedure eliminates reprocessing delays that formerly occurred between the domestic and international carriers and reduces manual handling of messages by more than 80 per cent. Through central handling, the service also permits rapid processing of messages questioned by the overseas receiving station or by the addressee. At present, more than 6,000 telegrams filed at Western Union offices will be processed daily by the new computer service.

Tempests on TV

Weather radar designed for use in jet aircraft is adding a new dimension to weather telecasts by several stations around the country. In such cities as Memphis; Miami; Charlotte, N.C.; and Amarillo, Tex.; views of the RCA AVQ-10 radarscope are transmitted during news broadcasts, at station breaks with the station's call letters superimposed, and at other noncommercial openings.

The radar is well suited to applications in television stations because of its 360° scan capability, C-band operating frequency, and lower cost. The C-band operating frequency enables the radar to penetrate severe storms with relatively little signal attenuation from intervening rainfall. This allows more accurate representation of the storm's size, shape, and intensity on the aircraft's radar.

The radar, which can view weather at ranges up to 160 miles, is monitored at the television station by a vidicon TV camera to show viewers actual storm profiles in the area. Translucent map overlays show the exact location of the storm, and time-lapse taping enables the station to follow the storm's development and show its evolution and complete pattern at a later time.

Another RCA weather radar, the AVQ-30C, is being put to work by the Air Force to study hurricanes. Although this radar, which has a 300-mile range, is already in operation on 747s and other commercial aircraft to detect storms, this is its first use in hurricane analysis. Operating on a C-band frequency, it can penetrate to the eye of the hurricane. The information is then radioed to weather stations to prepare early warning forecasts. The reliability of the radar is enhanced by a dual-system configuration that permits the operator to transfer from one set of components to another in case of malfunction.

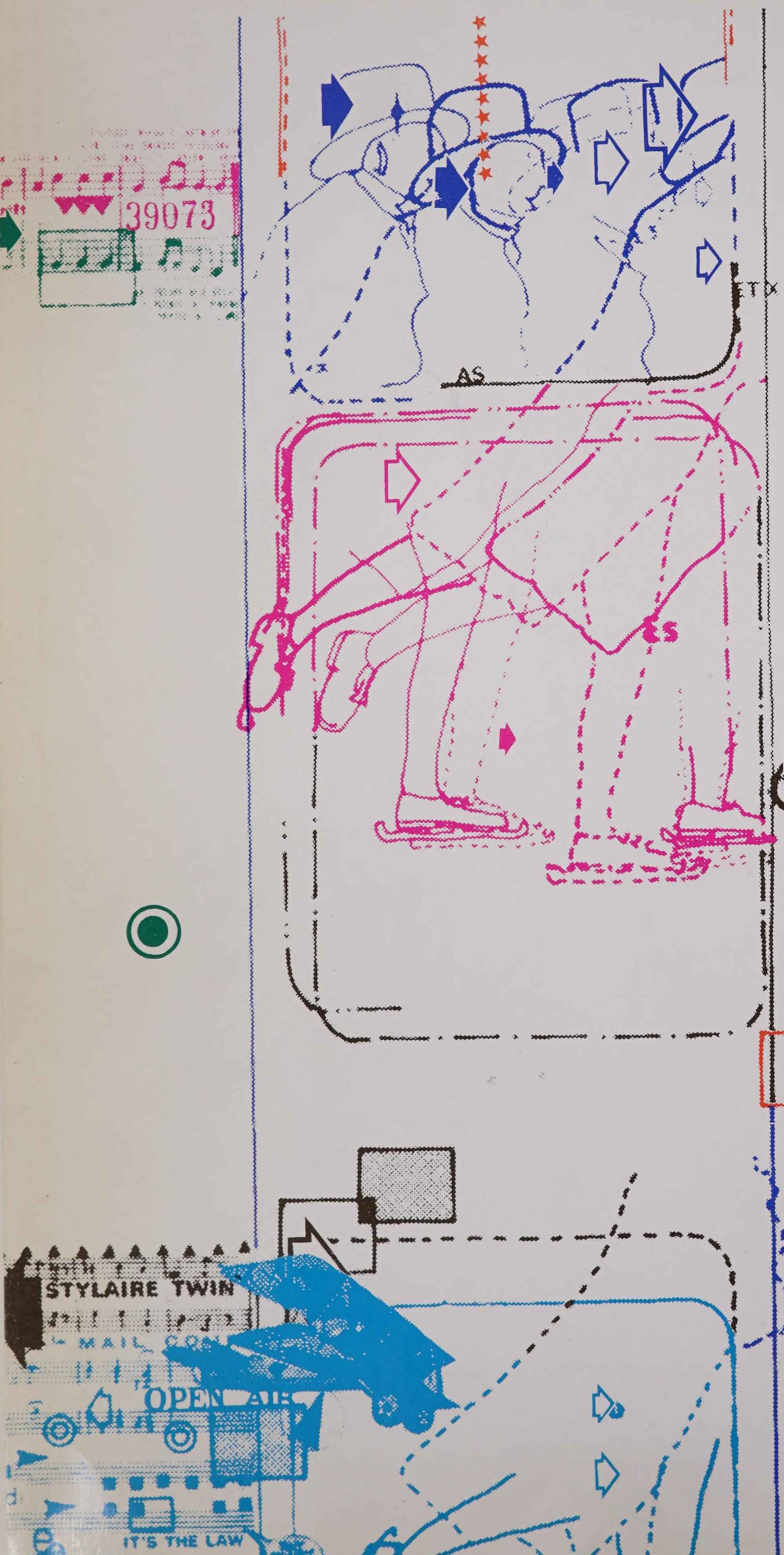
Photo and illustration credits: cover, Gianni-Emilio Simonetti; pages 2-5, Alan Cober; page 7, Declan Haun—Black Star; page 8 (left and center), Werner Wolff—Black Star; page 8 (top) and page 9 (left and center), General Electric Company; page 9 (right), Texas Instruments, Inc.; page 10 (left and left center), Union Carbide Corporation, Linde Division; page 10 (right center), Chemetron Corporation; page 10 (right) and page 11 (bottom), James Karales—*Look* magazine©; page 11 (top), Laboratory Management; pages 12-14, Fred Otnes; pages 18-19, Charlotte Brooks—*Look* magazine©; page 21, John Launois—Black Star; pages 22-23, Something Else Press, Inc.; pages 25-28 and inside back cover, National Aeronautics and Space Administration; pages 30, 31, 33, and 34, National Film Board of Canada; page 32, W. E. Garrett© 1970, National Geographic Society; all other photos, RCA.

This helium bottle from an Atlas booster rocket was found in a remote section of South Africa. The recovery of space vehicles and components constitutes only one aspect of the complex problems involved in agreements to extend the framework of existing international law to outer space. A story on cooperation among nations in developing plans for orderly cosmic exploration begins on page 2.

RCA

Electronic Age

Autumn 197



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RCA Electronic Age

Winter 1968/1969—Autumn 1970 *Volume 28/No. 1 through Volume 29/No. 4*

Index
1968-1970

This is a guide to the contents of *Electronic Age,* a quarterly publication of RCA, which has been issued regularly since 1941. This index covers the issues from Winter 1968/1969 through Autumn of 1970. Three previous indexes cover the years from January of 1953 through Summer of 1964, Autumn of 1964 through Autumn of 1966, and Winter 1966/1967 through Autumn of 1968.

Author, title, and subject matter are included in alphabetical order using the word-by-word method, i.e., "New York" before "Newark." Authors, titles, and subjects as direct entries are set in boldface type. Where subheadings are given to a direct entry, these are also in boldface. Titles of articles listed under the various entries are in italic and are alphabetized by the principal word system.

The abbreviation "f." following a page number means that a reference to the entry appears on the page listed and on the page that immediately follows. When three or more pages refer to an entry, only the first and last pages are listed, as for example, "17-19." *Passim* indicates references occur here and there.

Accidents: *see also* Safety
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Airlines: automated reservations systems, *Computer Time Sharing,* 4, Autumn '69
Alaska: *Alaska—Transportation and Communications,* 34-37, Spring '70; *Men Who Work in Remote Outposts,* 19, Autumn '69
Alaska—Transportation and Communications: H. M. Hershberger, 34-37, Spring '70
Alphabet in the Electronic Age, The: Ed Campbell, 6-9, Winter '68-'69
Alphonse, Dr. Gerald: *Young Scientists of Today,* 29 f., Summer '69
Altimeter: laser, for Apollo: *Electronically Speaking,* 36, Summer '70
American Broadcasting Companies, Inc. (ABC): *TV Evening News: A Day in the Life of a Half Hour,* 16-22, Spring '70
Angus, Robert, author: *Evolution of the Recording Studio,* 22-25, Winter '69-'70
Animals:
in Alaska: *Alaska—Transportation and Communications,* 35 f., Spring '70
artificial insemination of: *Supercold,* 10, Autumn '70
at remote outposts: *Men Who Work in Remote Outposts,* 16 f., 19, Autumn '69
survival of: *Is There Intelligence Out There?,* 12, Autumn '69
Antennas: radio: *The New Age of Astronomy,* 18 f., Spring '69
Apollo: *see under* Spacecraft
Apollo—Voyage to the Moon: Robert G. Shortal, 14-18, Winter '68-'69
Arbitration: Intelsat tribunal for: *Law, Order, and Outer Space,* 6, Autumn '70
Arctic: *Canada: The Second Century,* 34, Autumn '70; *Men Who Work in Remote Outposts,* 14-19, Autumn '69
Art:
on album covers: *Pop Music—Hit Sound of the Recording Industry,* 20, Summer '70
Canadian: *Canada: The Second Century,* 34, Autumn '70
contemporary: *Art and the Computer,* 12-16, Summer '69; *Art and Technology,* 2-7, Spring '69; *Art, Technology, and the Creative Process,* 28-32, Spring '70; *Information: An Exhibition,* 28-31, Summer '70
Art and the Computer: Tom Shachtman, 12-16, Summer '69
Art and Technology: Tom Shachtman, 2-7, Spring '69
Art, Technology, and the Creative Process: Earl Reiback, 28-32, Spring '70
Artists: *see* Art; Cartoonists; Illustrations
Arts: *see* Culture; Music
Asimov, Isaac, author: *Is There Intelligence Out There?,* 8-13, Autumn '69
Assault on Mars: Dr. I. M. Levitt, 16-20, Winter '69-'70
Asteroids: *The Grand Tour of the Planets,* 11, Summer '69
Astronauts:
Agreement on Rescue of: *Law, Order, and Outer Space, 6,* Autumn '70
monitoring physical condition of: *The Future of Computers,* 15, Autumn '70
role of: *Apollo—Voyage to the Moon,* 16-18, Winter '68-'69; *Assault on Mars,* 20, Winter '69-'70; *Bridge to the Planets,* 26, Autumn '70; *Man on the Moon,* 8, 10-12, Spring '69; *Reflections on Apollo,* 23, Autumn '69; *Surveys From Space,* 30, Winter '69-'70
voice-control devices for: *Voice Recognition: Machines That Listen,* 3, 5, Winter '68-'69
Astronomy:
electronic aids to: *The New Age of Astronomy,* 17-20, Spring '69
mapping Venus: *The Powerful Vision of Radar,* 30, Spring '69
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solar system exploration: *The Grand Tour of the Planets,* 9-11, Summer '69; *Is There Intelligence Out There?,* 8, 10 f., Autumn '69; *Prophet of the Space Age,* 5, Winter '69-'70
study of Mars: *Assault on Mars,* 17-20, Winter '69-'70
Aswan Dam: effect on ecology: *Technology: Challenge and Promise,* 6, Summer '70
Atmosphere:
analysis of: *Assault on Mars,* 17 f., 20, Winter '69-'70
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pollution of: *Pollution in America,* 8 f., Summer '70
research on: *Electronically Speaking,* 38, Spring '70
Atoms: research on: *The World of Electronic Surfaces,* 26, Spring '69
Audience Surveys, Inc.: *The Rating Game,* 13, Winter '68-'69
Audiovisual: school materials: *Technology in the School,* 12 f., Spring '70
Authors: relations with publishers: *A Publisher Looks at Publishing,* 4 f., Spring '70
Automation: *see* Computers; Electronic data processing; Electronics; and Technology
Automobiles:
automatic vehicle detection: *Crime and Computers,* 34, Summer '70
and pollution: *Pollution in America,* 9, 13, Summer '70
Automotive industry:
automatic gauge for: *Electronically Speaking,* 36, Winter '68-'69
use of computer: *The Blue-Collar Computer,* 34, Winter '69-'70
Aviation: *see also* Aircraft; Airlines; Spacecraft; U.S. Air Force
collision avoidance system for: *Electronically Speaking,* 36, Summer '70
commercial industry growth: *Aviation: On the Threshold of a New Era,* 22-27, Summer '69
electronic ranging system for: *Electronically Speaking,* 36, Autumn '69
importance of radar to: *The Powerful Vision of Radar,* 28-31, Spring '69
safety systems for: *Electronically Speaking,* 36, Autumn '70
Aviation: On the Threshold of a New Era: Norman H. Solon, 22-27, Summer '69
Awards: Grammy and Gold Record: *Pop Music—Hit Sound of the Recording Industry,* 19 f., Summer '70

Babbitt, Milton: *Electronics and the Sound of Music,* 18 f., 22, 24, Autumn '70
Bailey, Arnold C., author: *Prophet of the Space Age,* 2-9, Winter '69-'70
Ballistic Missile Early Warning System (BMEWS): *Men Who Work in Remote Outposts,* 16-19 *passim,* Autumn '69; *The Powerful Vision of Radar,* 31, Spring '69
Banks and banking: credit card systems: *Coming: A Cashless Society?,* 31-34, *Winter* '68-'69; *The Future of Computers,* 15 f., Autumn '70
Batteries: alternatives to: *New Sources of Electric Power,* 20, 23, Winter '68-'69
Bauhaus school: *Art and the Computer,* 14, Summer '69
Bell Telephone Laboratories:
computer art by: *Art and the Computer,* 14, Summer '69

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research by: *Computer Time Sharing,* 5, 7, Autumn '69; *Electronically Speaking,* 36, Spring '69; *New Sources of Electric Power,* 23, Winter '68-'69; *Voice Recognition: Machines That Listen,* 4 f., Winter '68-'69; *The World of Electronic Surfaces,* 26, Spring '69
Bernstein, Robert L., author: *A Publisher Looks at Publishing,* 2-9, Spring '70
Best-Seller Phenomenon, The: Roger Smith, 17-20, Summer '69
Blue-Collar Computer, The: Thomas I. Bradshaw, 34 f., Winter '69-'70
BMEWS: *see* Ballistic Missile Early Warning System
Boats: robot sailboat SKAMP: *Electronically Speaking,* 36, Autumn '69
Boeing Aircraft: *Aviation: On the Threshold of a New Era,* 24-26, Summer '69
Books:
custom-made for education: *Electronically Speaking,* 36, Spring '69
and public's buying habits: *The Best-Seller Phenomenon,* 17-20, Summer '69
publishing of: *A Publisher Looks at Publishing,* 2-9, Spring '70
Books at Random . . . (reviews): 29, Winter '68-'69; 27, Spring '69; 35, Summer '69; 31, Autumn '69; 33, Winter '69-'70; 33, Spring '70; 21, Summer '70; 29, Autumn '70
Bradshaw, Thomas I., author: *The Blue-Collar Computer,* 34 f., Winter '69-'70
Bridge to the Planets: John H. Lannan and Tom Elliott, 25-28, Autumn '70
Broadcasting: *see also* Color television; NBC; Programming; Radio; and Television
of recordings: *Pop Music—Hit Sound of the Recording Industry,* 20, Summer '70
of sports events: *Life in the Press Box,* 32-34, Summer '69
Burgeoning Youth Market, The: David Lachenbruch, 13-16, Spring '69
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Cables: underseas, for communications: *Alaska—Transportation and Communications,* 37, Spring '70
California: law enforcement telecommunications system: *Crime and Computers,* 34, Summer '70; *Electronically Speaking,* 36, Winter '68-'69
California Institute of Technology: *The New Age of Astronomy,* 20, Spring '69
Cambridge Research Laboratories: *Art and the Computer,* 14, Summer '69
Cambridge University: *The New Age of Astronomy,* 18 f., Spring '69
Cameras: *see also* Photographs; and Photography
solid state: *Electronically Speaking,* 36, Spring '69
in space program: *Apollo—Voyage to the Moon,* 16, Winter '68-'69; *Bridge to the Planets,* 26, Autumn '70; *Surveys From Space,* 29, Winter '69-'70
for TV color conversion: *Electronically Speaking,* 36, Summer '70
vidicon TV: *Electronically Speaking,* 36, Autumn '70
Campbell, Ed, author: *The Alphabet in the Electronic Age,* 6-9, Winter '68-'69
Campbell, Mary, author: *Leontyne Price: Portrait of a Prima Donna,* 26-30, Autumn '69
Canada: The Second Century: Leslie Roberts, 30-34, Autumn '70
Canadian National Telecommunications: *Alaska—Transportation and Communications,* 37, Spring '70
Caribbean: *Men Who Work in Remote Outposts,* 16, 19, Autumn '69
Carlson, Mary Jeanne, author: *Hope, Skills, and Self-Respect,* 24-28, Winter '68-'69
Cartography: *The Powerful Vision of Radar,* 30, Spring '69; *Surveys From Space,* 30 f., Winter '69-'70
Cartoonists:
Cork: *This Electronic Age . . . ,* 19, Winter '68-'69
Robert Day: *This Electronic Age . . . ,* 35, Summer '70
Dedini: *Is There Intelligence Out There?,* 12, Autumn '69; *This Electronic Age . . . ,*19, Winter '68-'69; 21, Spring '69; 31, Summer '69; 26, Winter '69-'70; 15, Spring '70; 17, Autumn '70
Joseph Farris: *This Electronic Age . . . ,* 21, Spring '69
S. Harris: *This Electronic Age . . . ,* 19, Winter '68-'69; 25, Autumn '69; 26, Winter '69-'70; 15, Spring '70; 35, Summer '70; 17, Autumn '70
H. Martin: *This Electronic Age . . . ,* 19, Winter '68-'69; 21, Spring '69; 31, Summer '69; 25, Autumn '69; 26, Winter '69-'70; 15, Spring '70; 35, Summer '70
J. Mirachi: *This Electronic Age . . . ,* 31, Summer '69; 17, Autumn '70
Richter: *This Electronic Age . . . ,* 21, Spring '69; 25, Autumn '69; 26, Winter '69-'70
B. Tobey: *This Electronic Age . . . ,* 21, Spring '69
B. Wiseman: *This Electronic Age . . . ,* 19, Winter '68-'69; 31, Summer '69; 15, Spring '70; 35, Summer '70; 17, Autumn '70
Cartoons:
on electronics: *This Electronic Age . . . ,* 19, Winter '68-'69; 21, Spring '69; 31, Summer '69; 25, Autumn '69; 26, Winter '69-'70; 15, Spring '70; 35, Summer '70; 17, Autumn '70
U.S.S.R.: *Computers in Russia,* 2, 6, Summer '69
Catalysis: *The World of Electronic Surfaces,* 25, Spring '69
CBS News: *The Huntley-Brinkley Bandwagon,* 24, 26, Summer '70; *TV Evening News: A Day in the Life of a Half Hour,* 16-22, Spring '70
Cecil, Robert, author: *Computer Time Sharing,* 2-7, Autumn '69
Central America: overfarming in: *Technology: Challenge and Promise,* 6, Summer '70
Cerf, Bennett: *A Publisher Looks at Publishing,* 4 f., Spring '70
Chancellor, John: *TV Evening News: A Day in the Life of a Half Hour,* 17, Spring '70
Chemicals: in biochemical evolution: *Is There Intelligence Out There?,* 11, Autumn '69
Choanoke Family Development Project: *Electronically Speaking,* 36, Autumn '69; *Hope, Skills, and Self-Respect,* 27 f., Winter '68-'69
Circuit sensors: *Electronically Speaking,* 36, Spring '69
Circuitry:
advances in: *Technology: Challenge and Promise* 5, Summer '70
computer aids in design of: *The Blue-Collar Computer,* 34 f., Winter '69-'70
integrated: *Computers in Russia,* 6, Summer '69; *The World of Electronic Surfaces,* 25, Spring '69
light sensitive computer card reader: *Electronically Speaking,* 36, Autumn '70
Cities, Canadian: *Canada: The Second Century,* 34, Autumn '70
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crisis of: *Is Urban America Out of Control?,* 10-15, Winter '69-'70
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Clark University: *Prophet of the Space Age,* 5, Winter '69-'70
Climate: *see* Weather
Clouds: *The Grand Tour of the Planets,* 10 f., Summer '69
Coleman, Elisabeth, author: *TV Evening News: A Day in the Life of a Half Hour,* 16-22, Spring '70
Coleman Report: *Technology in the School,* 13, Spring '70
Colleges: *see also* Education; and by specific title
use of computers at: *Computer Time Sharing,* 4 f., 7, Autumn '69
Color television: *see also* NBC; Programming; and Television
TV camera for color conversion: *Electronically Speaking,* 36, Summer '70
Columbia-Princeton Electronic Music Center: *Electronics and the Sound of Music,* 18, 20, Autumn '70
Comets: *The Grand Tour of the Planets,* 11, Summer '69
Coming: A Cashless Society?: Thomas J. Gradel, 30-34, Winter '68-'69
Command Module: design of: *Reflections on Apollo,* 23 f., Autumn '69
Commerce: *see* Economics; and Marketing
Communicating Science to Youngsters: David Dietz, 32-34, Spring '69
Communication: and artists: *Information: An Exhibition,* 28-31, Summer '70
Communications: *see also* Electronics; and various forms of by specific title
in Alaska: *Alaska—Transportation and Communications,* 34-37, Spring '70
between man and machine: *Voice Recognition: Machines That Listen,* 2-5, Winter '68-'69
electronic clearinghouse for: *Electronically Speaking,* 36, Autumn '69
system for spacecraft: *Electronically Speaking,* 36, Spring '69, and 36, Summer '70; *Reflections on Apollo,* 22-24, Autumn '69
satellite system of: *Law, Order, and Outer Space,* 6, Autumn '70
Competition: among media: *A Publisher Looks at Publishing,* 4, 7, Spring '70
Components and devices: *see* Devices; and Instruments
Composers: of electronic music: *Electronics and the Sound of Music,* 18, Autumn '70
Computer Time Sharing: Robert Cecil, 2-7, Autumn '69
Computers: *see also* Electronic data processing; Electronics; and Technology
as airborne command post: *Electronically Speaking,* 36, Winter '69-'70
AIRCON system: *Electronically Speaking,* 36, Autumn '69
and alphabet design: *The Alphabet in the Electronic Age,* 8 f., Winter '68-'69
and art: *Art and the Computer,* 12-16, Summer '69; *Art and Technology,* 5, 7, Spring '69
card reader: *Electronically Speaking,* 36, Autumn '70
in education: *Technology in the School,* 13 f., Spring '70
effect of, on society: *Technology: Challenge and Promise,* 4 f., Summer '70
encroachment of, on privacy: *Crime and Computers,* 34, Summer '70; *The Future of Computers,* 16, Autumn '70
as financial tool: *Coming: A Cashless Society?,* 30-34, Winter '68-'69; *Electronically Speaking,* 36, Summer '69
future of: *The Future of Computers,* 12-16, Autumn '70
for international communications: *Electronically Speaking,* 36, Autumn '70
in law enforcement: *Crime and Computers,* 32-34, Summer '70; *Electronically Speaking,* 36, Winter '68-'69
memory cores: *Supercold,* 10, Autumn '70
multiaccess systems: *Computer Time Sharing,* 2-7, Autumn '69
in music: *Electronics and the Sound of Music,* 21, 24, Autumn '70
in real estate: *Electronically Speaking,* 36, Autumn '70
for remote computing: *Electronically Speaking,* 36, Winter '69-'70
in sports: *Switched-On Sports,* 27, Spring '70
time sharing systems: *Computer Time Sharing,* 2-7, Autumn '69; *Electronically Speaking,* 36, Winter '68-'69; and 36, Spring '69; *The Future of Computers,* 13, Autumn '70
in U.S. economy: *The Blue-Collar Computer,* 34 f., Winter '69-'70
use of, by U.S.S.R.: *Computers in Russia,* 2-7, Summer '69
Computers in Russia: Richard B. Rusch, 2-7, Spring '69
Comsat (Communications Satellite Corporation): *Law, Order, and Outer Space,* 6, Autumn '70
Construction: of Canadian civic and public buildings: *Canada: The Second Century,* 34, Autumn '70
Consumer:
book-buying habits: *The Best-Seller Phenomenon,* 17-20, Summer '69
reaction to pollution control: *Pollution in America,* 13, Summer '70
TV viewing habits: *The Rating Game,* 11-13, Winter '68-'69
youth market influence: *The Burgeoning Youth Market,* 13-16, Spring '69
Convissor, Samuel M., author: *Is Urban America Out of Control?,* 10-15, Winter '69-'70
Cornell University: *The Powerful Vision of Radar,* 30, Spring '69; *Technology: Challenge and Promise,* 6, Summer '70
Credit card plans: *Coming: A Cashless Society?,* 30-34, Winter '68-'69; *The Future of Computers,* 15 f., Autumn '70
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Crime and Computers: Richard B. Rusch, 32-34, Summer '70
Cronkite, Walter: *The Huntley-Brinkley Bandwagon,* 24, Summer '70; *TV Evening News: A Day in the Life of a Half Hour,* 16, 19, 21 f., Spring '70
Cryogenics: *Electronically Speaking,* 36, Winter '69-'70; *Supercold,* 7-11, Autumn '70
Cryonics Society: *Supercold,* 10 f., Autumn '70
Crystals: *Art, Technology, and the Creative Process,* 31 f., Spring '70; *Lasers in Transition,* 32-34, Autumn '69
Culture: *see also* Art; and Music
Canadian: *Canada: The Second Century,* 32-34, Autumn '70
early beliefs of mankind: *Is There Intelligence Out There?,* 8, Autumn '69
exhibitions: *Information: An Exhibition,* 28-31, Summer '70
union of art and science: *Art and Technology,* 2-7, Spring '69
Cybernetics: *Computers in Russia,* 5 f., Summer '69

Daly, John: *TV Evening News: A Day in the Life of a Half Hour,* 16, Spring '70
Dartmouth College: *Computer Time Sharing,* 5, 7, Autumn '69
Data processing: *see* Electronic data processing
David Sarnoff Research Center: *see* RCA Laboratories
DDT: *Pollution in America,* 11, Summer '70
Defense: *see also* various branches of armed forces under U.S.
advanced systems of: *The Powerful Vision of Radar,* 31, Spring '69
Derby, Joe, author: *The Huntley-Brinkley Bandwagon,* 22-27, Summer '70
Design:
problems of Lunar Module: *Reflections on Apollo,* 23 f., Autumn '69
of recording studios: *Evolution of the Recording Studio,* 22-25, Winter '69-'70
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youth market affects product: *The Burgeoning Youth Market,* 15 f., Spring '69
Devices: *see also* Instruments
new ceramic element: *Electronically Speaking,* 36, Winter '69-'70
NUMITRON digital: *Electronically Speaking,* 36, Autumn '69
voice-control: *Voice Recognition: Machines That Listen,* 3-5, Winter '68-'69
Dietz, David, author: *Communicating Science to Youngsters,* 32-34, Spring '69
Distance: measurement of: *Electronically Speaking,* 36, Autumn '69, and 38, Spring '70
Distant Early Warning System (DEW Line): *Men Who Work in Remote Outposts,* 17 f., Autumn '69
Dornbach, Dr. John E.: *Surveys From Space,* 29 f., Winter '69-'70
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Earth:
data on natural resources of: *Surveys From Space,* 27-32, Winter '69-'70
exploration of, from space: *Bridge to the Planets,* 26, Autumn '70
formation of: *Is There Intelligence Out There?,* 11 f., Autumn '69
statistics: *The Grand Tour of the Planets,* 11, Summer '69
Earth Day: *Pollution in America,* 11, Summer '70
Earth Resources Technology Satellite (ERTS): *Surveys From Space,* 27-32, Winter '69-'70
Ebel, Ian: *Computer Time Sharing,* 2, 4, 7, Autumn '69
Ecology: *see also* Environment
Arctic: *Canada: The Second Century,* 34, Autumn '70
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and oil transport in Alaska: *Alaska—Transportation and Communications,* 35, Spring '70
Economics: *see also* Marketing
Canadian development: *Canada: The Second Century,* 30-34, Autumn '70
computers in: *The Future of Computers,* 16, Autumn '70
crisis of U.S. cities: *Is Urban America Out of Control?,* 10-15, Winter '69-'70
potential of lasers: *Lasers in Transition,* 32-34, Autumn '69
production growth vs. environment: *Pollution in America,* 11, Summer '70
U.S. credit system: *Technology: Challenge and Promise,* 4 f., Summer '70
youth market: *The Burgeoning Youth Market,* 13-16, Spring '69
Edison, Thomas A.: *Electronics and the Sound of Music,* 21, Autumn '70; *Evolution of the Recording Studio,* 22, Winter '69-'70; *The World of Electronic Surfaces,* 25, Spring '69
Edison Electric Institute: *Supercold,* 9, Autumn '70
Education:
of computer personnel, U.S.S.R.: *Computers in Russia,* 4, Summer '69
computers in: *Computer Time Sharing,* 7, Autumn '69; *Electronically Speaking,* 36, Winter '68-'69, and 36, Spring '69; *The Future of Computers,* 15 f., Autumn '70
of migrant farm workers: *Hope, Skills, and Self-Respect,* 27 f., Winter '68-'69
modern technology in: *Communicating Science to Youngsters,* 32-34, Spring '69
nonphonetic alphabet for teaching: *The Alphabet in the Electronic Age,* 6-8, Winter '68-'69
problems of modern: *Technology in the School,* 10-14, Spring '70
reading needs in: *A Publisher Looks at Publishing,* 3, 9, Spring '70
tailor-made books for teachers: *Electronically Speaking,* 36, Spring '69
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Edwards, Douglas: *TV Evening News: A Day in the Life of a Half Hour,* 16, Spring '70
Egypt: ecology: *Technology: Challenge and Promise,* 6, Summer '70
Electric power: *New Sources of Electric Power,* 20-23, Winter '68-'69
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Electron tubes: *see* Tubes
Electronic data processing: *see also* Computers; Electronics; and Technology
cost decline of: *Coming: A Cashless Society?,* 34, Winter '68-'69
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increasing uses for: *The Blue-Collar Computer,* 34 f., Winter '69-'70
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Electronically Speaking . . . (recent RCA developments in electronics): 36, all issues from Winter '68-'69 through Autumn '70
Electronics: *see also* Computers; Electronic data processing; and Technology
Apollo ranging system: *Electronically Speaking,* 36, Autumn '69
composition systems: *The Alphabet in the Electronic Age,* 9, Winter '68-'69
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specialists: *Men Who Work in Remote Outposts,* 14-19, Autumn '69
and speech components: *Voice Recognition: Machines That Listen,* 4, Winter '68-'69
in sports: *Switched-On Sports,* 27, Spring '70
Electronics and the Sound of Music: Norman H. Solon, 18-24, Autumn '70
Electrons: behavior of: *The World of Electronic Surfaces,* 22-26, Spring '69
Elliott, Tom, author: *The Powerful Vision of Radar,* 28-31, Spring '69; *Surveys From Space,* 27-32, Winter '69-'70; co-author, *Bridge to the Planets,* 25-28, Autumn '70
Employees: *see* Personnel
Employment:
change in job types: *The Future of Computers,* 16, Autumn '70
computerized job bank: *Electronically Speaking,* 36, Winter '68-'69
equal opportunity programs: *Is Urban America Out of Control?,* 14, Winter '69-'70
RCA Laboratories recruiting program: *Young Scientists of Today,* 30, Summer '69
at remote outposts: *Men Who Work in Remote Outposts,* 16-19, Autumn '69
of seasonal farm workers: *Hope, Skills, and Self-Respect,* 24-28, Winter '68-'69
training of hard-core unemployables: *Electronically Speaking,* 36, Autumn '69
Energy: *see also* Power
atomic, as propellant: *Prophet of the Space Age,* 5, Winter '69-'70
for cargo spacecraft: *Man on the Moon,* 10, Spring '69
new sources of: *New Sources of Electric Power,* 20-23, Winter '68-'69
production technology: *Technology: Challenge and Promise,* 5, Summer '70
stars as source of: *Is There Intelligence Out There?,* 10, Autumn '69
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Engines: internal combustion: *Technology: Challenge and Promise,* 4-6, Summer '70
Environment: *see also* Cities, United States; Ecology; and Noise
pollution of: *Pollution in America,* 8-14, Summer '70; *Surveys From Space,* 32, Winter '69-'70; *Technology: Challenge and Promise,* 6 f., Summer '70
social ills: *A Publisher Looks at Publishing,* 9, Spring '70; *Technology: Challenge and Promise,* 4 f., Summer '70
space: *Bridge to the Planets,* 28, Autumn '70; *Law, Order, and Outer Space,* 2-6, Autumn '70
Evolution: *Is There Intelligence Out There?,* 10-12, Autumn '69
Evolution of the Recording Studio: Robert Angus, 22-25, Winter '69-'70
Exhibitions: *Canada: The Second Century,* 34, Autumn '70; *Information: An Exhibition,* 28-31, Summer '70
Exploration:
of Mars: *Assault on Mars,* 16-20, Winter '69-'70
mineral: *Surveys From Space,* 32, Winter '69-'70
of moon: *Apollo—Voyage to the Moon,* 14-18, Winter '68-'69; *Man on the Moon,* 8-12, Spring '69
of space: *Bridge to the Planets,* 25-28, Autumn '70; *The Grand Tour of the Planets,* 8-11, Summer '69; *Law, Order, and Outer Space,* 2-6, Autumn '70

Farming: *see* Agriculture
Federal Aviation Administration (FAA): *Aviation: On the Threshold of a New Era,* 24, 26 f., Summer '69
Films: *Canada: The Second Century,* 34, Autumn '70; *A Publisher Looks at Publishing,* 7, Spring '70; *TV Evening News: A Day in the Life of a Half Hour,* 21, Spring '70
Finance: *Coming: A Cashless Society?,* 30-34, Winter '68-'69
Fishing: *Surveys From Space,* 32, Winter '69-'70
Flood, Robert: *The Blue-Collar Computer,* 34 f., Winter '69-'70
Flying saucers: *Is There Intelligence Out There?,* 12, Autumn '69
Food:
freezing of: *Supercold,* 9 f., Autumn '70
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For the Records . . . (new RCA recordings): 35, Winter '68-'69; 35, Spring '69; 21, Summer '69; 35, Autumn '69; 21, Winter '69-'70; 23, Spring '70; 15, Summer '70; and 35, Autumn '70
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Frank, Reuven: *The Huntley-Brinkley Bandwagon,* 24, 26, Summer '70; *TV Evening News: A Day in the Life of a Half Hour,* 17, Spring '70
Franklin and Marshall College: *Computer Time Sharing,* 7, Autumn '69
Frequency bandwidth: *Voice Recognition: Machines That Listen,* 4 f., Winter '68-'69
Fuller, Buckminster: *Technology: Challenge and Promise,* 5-7, Summer '70

Future of Computers, The: Richard B. Rusch, 12-16, Autumn '70

Gallium arsenide: *The World of Electronic Surfaces,* 25, Spring '69
Galloway, Eilene, author: *Law, Order, and Outer Space,* 2-6, Autumn '70
Garagiola, Joe, author: *Life in the Press Box,* 32-34, Summer '69
Gardiner, Frank J., co-author: *Reflections on Apollo,* 20-24, Autumn '69
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as power source: *New Sources of Electric Power,* 20-23, Winter '68-'69
research on: *Supercold,* 7-11, Autumn '70
Gasoline: *Pollution in America,* 13, Summer '70
Gemini program: *see under* Spacecraft
Generators: *Supercold,* 9, Autumn '70
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Geology: *Man on the Moon,* 11, Spring '69
Germanium: *The World of Electronic Surfaces,* 22, Spring '69
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Gradel, Thomas J., author: *Coming: A Cashless Society?,* 30-34, Winter '68-'69
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Graphic arts: *see* Typography
Greenland: *Men Who Work in Remote Outposts,* 16-18, Autumn '69
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Heilbroner, Robert L.: *Technology: Challenge and Promise,* 7, Summer '70
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Hillier, Dr. James: *Coming: A Cashless Society?,* 34, Winter '68-'69
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Houbolt, Dr. John C.: *Reflections on Apollo,* 22 f. and inside back cover, Autumn '69
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Huntley-Brinkley: *The Huntley-Brinkley Bandwagon,* 22-27, Summer '70; *TV Evening News: A Day in the Life of a Half Hour,* 16-18, 21 f., Spring '70
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Illustrations:
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by Flora: *Switched-On Sports,* 24-26, Spring '70
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Indiana: *Is Urban America Out of Control?,* 11 f., Winter '69-'70
Industry: *see* Economics; and Marketing
Information: An Exhibition: 28-31, Summer '70
Infrared radiation: *Electronically Speaking,* 36, Spring '69; *The Grand Tour of the Planets,* 11, Summer '69; *The New Age of Astronomy,* 20, Spring '69
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Instruments: *see also* Devices
aboard satellites: *Bridge to the Planets,* 28, Autumn '70
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for Mariner spacecraft: *Electronically Speaking,* 36, Summer '70
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Integrated circuits: *see under* Circuitry
Intelsat (International Telecommunications Satellite Consortium): *Crime and Computers,* 32-34, Summer '70; *Law, Order, and Outer Space,* 6, Autumn '70
Interferometry: *The New Age of Astronomy,* 19 f., Spring '69
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computer art: *Art and the Computer,* 14 f., Summer '69
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TV: *The Huntley-Brinkley Bandwagon,* 22-27, Summer '70
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Lachenbruch, David, author: *The Burgeoning Youth Market,* 13-16, Spring '69
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in education: *Communicating Science to Youngsters,* 33, Spring '69
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scanner as safety aid: *Electronically Speaking,* 36, Summer '69
in study of moon: *Electronically Speaking,* 38, Spring '70
Lasers in Transition: Bruce Shore, 32-34, Autumn '69
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computer technology in: *Crime and Computers,* 32-34, Summer '70
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Lewis, Anthony: *Technology: Challenge and Promise,* 5, Summer '70
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possibilities of, on other planets: *Is There Intelligence Out There?,* 8-13, Autumn '69
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from lasers: *Lasers in Transition,* 32-34, Autumn '69
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Lockheed: *Aviation: On the Threshold of a New Era,* 25 f., Summer '69
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Man on the Moon: Norman H. Solon, 8-12, Spring '69
Manufacturing: possible operations on moon: *Man on the Moon,* 8-10, Spring '69
Maps: *see* Cartography
Marine ecology: *Technology: Challenge and Promise,* 6, Summer '70
Mariner program: *see under* Spacecraft
Marketing: *see also* Economics
of books: *The Best-Seller Phenomenon,* 20, Summer '69; *A Publisher Looks at Publishing,* 3, 8, Spring '70
influence of youth on: *The Burgeoning Youth Market,* 13-16, Spring '69; *Pop Music—Hit Sound of the Recording Industry,* 18, Summer '70
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exploration of: *Assault on Mars,* 16-20, Winter '69-'70; *Bridge to the Planets,* 28, Autumn '70; *The Grand Tour of the Planets,* 8-11, Summer '69
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travel to, predicted: *Prophet of the Space Age,* 4 f., Winter '69-'70
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Martinot, Maurice: *Electronics and the Sound of Music,* 22, Autumn '70
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Mathematics:
and art: *Art and the Computer,* 12-16, Summer '69
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in research: *The World of Electronic Surfaces,* 26, Spring '69
for sound values: *Electronics and the Sound of* Music, 21, Autumn '70
teaching of new: *Communicating Science to Youngsters,* 33, Spring '69
Matson, Dr. Leslie: *Reflections on Apollo,* 22, Autumn '69
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Medicine:
computers for: *The Future of Computers,* 15, Autumn '70
cryogenic liquids for: *Supercold,* 9-11, Autumn '70
lasers as tools for: *Lasers in Transition,* 32-34, Autumn '69
moon and medical uses: *Man on the Moon,* 10, Spring '69
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and problems of prolonged flight: *Bridge to the Planets,* 26, 28, Autumn '70
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Mercury (planet): *The Grand Tour of the Planets,* 9-11, Summer '69; *The New Age of Astronomy,* 20, Spring '69
Metals: *Man on the Moon,* 10, Spring '69; *Supercold,* 9, Autumn '70
Meteoroids: *The Grand Tour of the Planets,* 10 f., Summer '69
Metropolitan Opera House: *Leontyne Price: Portrait of a Prima Donna,* 26, 28, 30, Autumn '69
Michigan: *Crime and Computers,* 34, Summer '70; *Pollution in America,* 11, Summer '70
Micklin, Robert, author: *Pop Music—Hit Sound of the Recording Industry,* 16-20, Summer '70
Microphones: *Evolution of the Recording Studio,* 24 f., Winter '69-'70
Microwave systems: *Alaska—Transportation and Communications,* 37, Spring '70
Middle Atlantic Educational and Research Center (MERC): *Computer Time Sharing,* 7, Autumn '69
Midgley, Leslie: *TV Evening News: A Day in the Life of a Half Hour,* 16-22, Spring '70
Minerals:
Canadian shortage of: *Canada: The Second Century,* 34, Autumn '70
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study of moon: *Man on the Moon,* 9 f., Spring '69
Miniaturization: *Bridge to the Planets,* 28, Autumn '70; *Technology: Challenge and Promise,* 5, Summer '70
Mining: *Man on the Moon,* 10, Spring '69
Minority groups:
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migrant farm workers: *Hope, Skills, and Self-Respect,* 24-28, Winter '68-'69
Negroes in music: *Leontyne Price: Portrait of a Prima Donna,* 26-30, Autumn '69
scientists' attitude on: *Young Scientists of Today,* 30, Summer '69
urban problems of: *Is Urban America Out of Control?,* 14, Winter '69-'70
Missiles: *Electronically Speaking,* 36, Autumn '69; *Men Who Work in Remote Outposts,* 16-19 *passim,* Autumn '69; *The Powerful Vision of Radar,* 31, Spring '69
Moog, Robert A.: *Electronics and the Sound of Music,* 20, Autumn '70
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exploration of: *Apollo—Voyage to the Moon,* 14-18, Winter '68-'69; *Man on the Moon,* 8-12, Spring '69
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statistics: *The Grand Tour of the Planets,* 11, Summer '69
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Motion pictures: *see* Films
Mott, Dr. Frank Luther: *The Best-Seller Phenomenon,* 19 f., Summer '69
Mott-Smith, John: *Art and the Computer,* 14, Summer '69
Mount Palomar Observatory: *The New Age of Astronomy,* 18, Spring '69
Museum of Modern Art: *Electronics and the Sound of Music,* 24, Autumn '70; *Information: An Exhibition,* 28-31, Summer '70
Museums: *Art and Technology,* 2-7, Spring '69
Music: *see also* RCA Records; and Records
electronics in: *Electronics and the Sound of Music,* 18-24, Autumn '70; *Voice Recognition: Machines That Listen,* 5, Winter '68-'69
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Murrow, Ed: *The Huntley-Brinkley Bandwagon,* 24, Summer '70

National Academy of Engineering: *Pollution in America,* 9, Summer '70
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National Crime Information Center: *Crime and Computers,* 34, Summer '70
National Research Council: *Pollution in America,* 9, Summer '70
Natural gas: *Supercold,* 10, Autumn '70
Navigation: *Electronically Speaking,* 36, Autumn '69, and 38, Spring '70; *The Powerful Vision of Radar,* 30, Spring '69
NBC (National Broadcasting Company): *see also* Broadcasting; Color television; Radio; and Television
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New Jersey: Newark riots: *Is Urban America Out of Control?,* 15, Winter '69-'70
New Sources of Electric Power: Bruce Shore, 20-23, Winter '68-'69
New York City: problems: *Is Urban America Out of Control?,* 12, 14, Winter '69-'70
New York State:
computers for law enforcement in: *Crime and Computers,* 34, Summer '70
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best-seller lists: *The Best-Seller Phenomenon,* 17, 19 f., Summer '69
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Noise:
abatement research: *Aviation: On the Threshold of a New Era,* 24 f., Summer '69
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Nossen, Ed: *Reflections on Apollo,* 24, Autumn '69
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Olson, Dr. Harry F.: *Electronics and the Sound of Music,* 20 f., Autumn '70; *Voice Recognition: Machines That Listen,* 5, Winter '68-'69
Opera: *Leontyne Price: Portrait of a Prima Donna,* 26-30, Autumn '69
Opinion polls: *The Best-Seller Phenomenon,* 17-20, Summer '69
Optics: *Lasers in Transition,* 32-34 *passim,* Autumn '69
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Patents: Goddard: *Prophet of the Space Age,* 8 f., Winter '69-'70
Pennsylvania:
time-sharing network in: *Electronically Speaking,* 36, Spring '69
water pollution in: *Pollution in America,* 13, Summer '70
Personnel: *Men Who Work in Remote Outposts,* 14-19, Autumn '69; *Young Scientists of Today,* 28-30, Summer '69
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Photoemission: *The World of Electronic Surfaces,* 25 f., Spring '69
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of early currency: *Coming: A Cashless Society?,* 32 f., and inside back cover, Winter '68-'69
of earth from space: *Surveys From Space,* 27-31, Winter '69-'70
electronic "snapshots": *Electronically Speaking,* 36, Autumn '70
of electronically active surface: *The World of Electronic Surfaces,* 22-25, Spring '69
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of technologically oriented art: *Art and Technology,* 2-7, Spring '69
Photography: *see also* Cameras; and Photographs
laser light for: *Lasers in Transition,* 33, Autumn '69
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of moon: *Electronically Speaking,* 36, Summer '70; *Man on the Moon,* 8 f., 12, Spring '69
of planets: *The Grand Tour of the Planets,* 10, Summer '69
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space views of earth: *Surveys From Space,* 27-31, Winter '69-'70
of stars: *The New Age of Astronomy,* 17-19, Spring '69
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development of life on: *Is There Intelligence Out There?,* 8, 10-13, Autumn '69
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Political parties:
broadcast of campaigns of: *The Huntley-Brinkley Bandwagon,* 24-26, Summer '70
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Pollution in America: Kenneth B. Platnick, 8-14, Summer '70
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Printing: *see* Typography
Products: *The Burgeoning Youth Market,* 13-16, Spring '69
Programming:
of recorded radio music: *Pop Music—Hit Sound of the Recording Industry,* 20, Summer '70
role of ratings in: *The Rating Game,* 13, Winter '68-'69
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Propulsion: for space travel: *Prophet of the Space Age,* 5, Winter '69-'70
Public opinion: *see* Consumer
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Canadian network: *Canada: The Second Century,* 33 f., Autumn '70
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Railroads: laser scanner for: *Electronically Speaking,* 36, Summer '69
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RCA Global Communications, Inc., *Electronically Speaking,* 36, Winter '68-'69; 36, Summer '69; 36, Autumn '69; and 36, Autumn '70
RCA Laboratories: *Electronically Speaking,* 36, Summer '70, and 36, Autumn '70; *Voice Recognition: Machines That Listen,* 5, Winter '68-'69; *Young Scientists of Today,* 28-30, Summer '69
RCA Limited (Canada): *Communicating Science to Youngsters,* 33, Spring '69
RCA Missile and Surface Radar Division: *The Powerful Vision of Radar,* 30, Spring '69
RCA Pollution Control Committee: *Pollution in America,* 13, Summer '70
RCA Records: *For the Records . . .* (new recordings), all issues from Winter '68-'69 through Autumn '70; *Leontyne Price: Portrait of a Prima Donna,* 30, Autumn '69; *Pop Music—Hit Sound of the Recording Industry,* 18, Summer '70
RCA Service Company: *Electronically Speaking,* 36, Autumn '69; *Hope, Skills, and Self-Respect,* 27 f., Winter '68-'69
Reading: *The Alphabet in the Electronic Age,* 9, Winter '68-'69
Real estate: computer for: *Electronically Speaking,* 36, Autumn '70
Recording: *Evolution of the Recording Studio,* 22-25, Winter '69-'70
Recording Industry Association of America: *Pop Music—Hit Sound of the Recording Industry,* 19 f., Summer '70
Records: *see also* RCA Records
new recordings: *For the Records . . .* , all issues from Winter '68-'69 through Autumn '70
sales of: *The Burgeoning Youth Market,* 15, Spring '69; *Pop Music—Hit Sound of the Recording Industry,* 16-20, Summer '70
by synthesizer: *Electronics and the Sound of Music,* 20, Autumn '70
Reflections on Apollo: Frank J. Gardiner and Sam Holt as interviewed by Norman H. Solon, 20-24, Autumn '69
Refrigeration: *Supercold,* 9 f., Autumn '70
Reiback, Earl, author: *Art, Technology, and the Creative Process,* 28-32, Spring '70
Research: *see also* RCA Laboratories; and Science and Scientists
on cryogenics: *Supercold,* 7-11, Autumn '70
in detection of underwater targets: *Men Who Work in Remote Outposts,* 19, Autumn '69
on earth's resources: *Surveys From Space,* 27-32, Winter '69-'70
lasers in: *Lasers in Transition,* 32-34, Autumn '69
marketing: *The Burgeoning Youth Market,* 13-16, Spring '69; *Pop Music—Hit Sound of the Recording Industry,* 18, Summer '70
personnel: *Young Scientists of Today,* 28-30, Summer '69
on radar: *The Powerful Vision of Radar,* 30 f., Spring '69
satellite: *Electronically Speaking,* 38, Spring '70
on surface phenomena: *The World of Electronic Surfaces,* 22-26, Spring '69
on type legibility: *The Alphabet in the Electronic Age,* 9, Winter '68-'69
on voice recognition: *Voice Recognition: Machines That Listen,* 3-5, Winter '68-'69
Reynolds, Frank: *TV Evening News: A Day in the Life of a Half Hour,* 18, 20-22, Spring '70
Ripley Company: *Coming: A Cashless Society?,* 32, 34, Winter '68-'69
Roads: *Alaska—Transportation and Communications,* 35, Spring '70; *The Future of Computers,* 15, Autumn '70
Roberts, Leslie, author: *Canada: The Second Century,* 30-34, Autumn '70
Rockets: *Apollo—Voyage to the Moon,* 16-18, Winter '68-'69; *Bridge to the Planets,* 26, Autumn '70; *Prophet of the Space Age,* 3-5, 8 f., Winter '69-'70; *Reflections on Apollo,* 20-23, Autumn '69
Rowan, Steve: *TV Evening News: A Day in the Life of a Half Hour,* 17, Spring '70
Rubinoff, Dr. Ira: *Technology: Challenge and Promise,* 6, Summer '70
Rusch, Richard B., author: *Computers in Russia,* 2-7, Summer '69; *Crime and Computers,* 32-34, Summer '70; *The Future of Computers,* 12-16, Autumn '70
Russia: *see* U.S.S.R.
Rutherford, Ernest: *Prophet of the Space Age,* 5, Winter '69-'70

Safety:
computer used to predict: *The Blue-Collar Computer,* 34, Winter '69-'70
lasers an aid to: *Electronically Speaking,* 36, Summer '69; *Lasers in Transition,* 33, Autumn '69
precautions for Arctic: *Men Who Work in Remote*

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for astronomy: *The New Age of Astronomy,* 20, Spring '69
in communications: *Electronically Speaking,* 36, Winter '68-'69, and 36, Summer '69
cooling equipment for: *Electronically Speaking,* 36, Winter '69-'70
costs of news footage by: *TV Evening News: A Day in the Life of a Half Hour,* 21, Spring '70
energy for: *New Sources of Electric Power,* 20, Winter '68-'69
law governing: *Law, Order, and Outer Space,* 2-6, Autumn '70
operated by space shuttle: *Bridge to the Planets,* 28, Autumn '70
radar technique for: *The Powerful Vision of Radar,* 30, Spring '69
research by: *Electronically Speaking,* 38, Spring '70; *Surveys From Space,* 27-32, Winter '69-'70
system of Neptune: *The Grand Tour of the Planets,* 11, Summer '69
weather: *Electronically Speaking,* 38, Spring '70
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Saturn (rocket): *Apollo—Voyage to the Moon,* 16 f., Winter '68-'69; *Bridge to the Planets,* 26, Autumn '70
Schools: *see* Colleges; and Education
Science and scientists: *see also* RCA Laboratories; and Technology
Apollo project cooperation by: *Reflections on Apollo,* 22-24, Autumn '69
education: *Communicating Science to Youngsters,* 32-34, Spring '69
experiment with computer art: *Art and the Computer,* 16, Summer '69
image of: *Young Scientists of Today,* 28-30, Summer '69
pioneers in rocketry: *Apollo—Voyage to the Moon,* 16, Winter '68-'69
Script writing: *The Alphabet in the Electronic Age,* 8 f., Winter '68-'69
Scuba divers: *Supercold,* 10, Autumn '70
Sculpture: *Art, Technology, and the Creative Process,* 28-32, Spring '70
SEARCH (System for Electronic Analysis and Retrieval of Criminal Histories): *Crime and Computers,* 34, Summer '70
SECANT: aircraft control system: *Electronically Speaking,* 36, Summer '70
Secondary emission: *The World of Electronic Surfaces,* 25 f., Spring '69
Security: *see* Defense
Selenium: *The World of Electronic Surfaces,* 25, Spring '69
Semiconductors: *New Sources of Electric Power,* 23, Winter '68-'69; *The World of Electronic Surfaces,* 26, Spring '69
Sensors: *Electronically Speaking,* 36, Spring '69
Shachtman, Tom, author: *Art and the Computer,* 12-16, Summer '69; *Art and Technology,* 2-7, Spring '69; *Technology: Challenge and Promise,* 2-7, Summer '70
Ships: *see also* Boats; and Navigation
radar for: *Electronically Speaking,* 36, Autumn '69
tanker opens Northwest Passage: *Canada: The Second Century,* 34, Autumn '70
Shore, Bruce, author: *Lasers in Transition,* 32-34, Autumn '69; *New Sources of Electric Power,* 20-23, Winter '68-'69; *The World of Electronic Surfaces,* 22-26, Spring '69
Shortal, Robert G., author: *Apollo—Voyage to the Moon,* 14-18, Winter '68-'69
Signature analysis: *The Powerful Vision of Radar,* 30, Spring '69
Silicon: *Electronically Speaking,* 38, Spring '70; *The World of Electronic Surfaces,* 22-26, Spring '69
Singer Company, L. W.: *A Publisher Looks at Publishing,* 9, Spring '70
Skylab: *Bridge to the Planets,* 26-28, Autumn '70
Smith, Roger, author: *The Best-Seller Phenomenon,* 17-20, Summer '69
Smithsonian Tropical Research Institute: *Technology: Challenge and Promise,* 6, Summer '70
Social ills: *see* Environment
Solar cells: *New Sources of Electric Power,* 23, Winter '68-'69
Solar energy propulsion: *Prophet of the Space Age,* 5, Winter '69-'70
Solar system: *see also* Space
exploration of: *The Grand Tour of the Planets,* 8-11, Summer '69
life forms: *Is There Intelligence Out There?,* 8-13, Autumn '69
Solids and solid state: *see also* Devices; and Transistors
research on: *The World of Electronic Surfaces,* 25 f., Spring '69
techniques: *The Powerful Vision of Radar,* 31, Spring '69
Solon, Norman H., author: *Aviation: On the Threshold of a New Era,* 22-27, Summer '69; *Electronics and the Sound of Music,* 18-24, Autumn '70; *Man on the Moon,* 8-12, Spring '69; *Switched-On Sports,* 24-27, Spring '70; co-author, *Voice Recognition: Machines That Listen,* 2-5, Winter '68-'69; interviewer, *Reflections on Apollo,* 20-24, Autumn '69
Sommer, Dr. Alfred: *The World of Electronic Surfaces,* 26, Spring '69
Sound: *see also* Acoustics
control of: *Evolution of the Recording Studio,* 22-25, Winter '69-'70
and electronics: *Electronics and the Sound of Music,* 18-24, Autumn '70
use of, to control inanimate objects: *Voice Recognition: Machines That Listen,* 4 f., Winter '68-'69
Soviet Union: *see* U.S.S.R.
Space: *see also* Astronauts; Astronomy; Satellites; and specific planets
cryogenic technology for: *Supercold,* 11, Autumn '70
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Apollo space suit: cover, Spring '69; *Man on the Moon,* 12, Spring '69
cargo craft: *Man on the Moon,* 10, Spring '69
ERTS research and development program: *Surveys From Space,* 27-32, Winter '69-'70
for exploration: *Assault on Mars,* 16-20, Winter '69-'70; *Bridge to the Planets,* 25-28, Autumn '70
Gemini program: *Bridge to the Planets,* 26, Autumn '70; *Surveys From Space,* 29 f., Winter '69-'70
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Viking program: *Assault on Mars,* 17 f., 20, Winter '69-'70; *Reflections on Apollo,* 24, Autumn '69
voice controller for: *Voice Recognition: Machines That Listen,* 5, Winter '68-'69
Spectrometry: *Surveys From Space,* 32, Winter '69-'70
Speech: *see also* Voice
and the alphabet: *The Alphabet in the Electronic Age,* 8, Winter '68-'69
recognition system: *Coming: A Cashless Society?,* 34, Winter '68-'69
translator to convert: *Voice Recognition: Machines That Listen,* 5, Winter '68-'69
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activities at remote outposts: *Men Who Work in Remote Outposts,* 18 f., Autumn '69
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Stanford Research Institute: *Technology: Challenge and Promise,* 5, Summer '70
Stars: *The Grand Tour of the Planets,* 11, Summer '69; *Is There Intelligence Out There?,* 8, 10 f., Autumn '69; *The New Age of Astronomy,* 17-19, Spring '69; *Prophet of the Space Age,* 5, Winter '69-'70
Stereo:
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Stock market: electronics in: *Computer Time Sharing,* 4, Autumn '69; *Electronically Speaking,* 36, Spring '69, and 36, Summer '69
Stokowski, Leopold: *Electronics and the Sound of Music,* 22, Autumn '70; *Evolution of the Recording Studio,* 24, Winter '69-'70
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statistics: *The Grand Tour of the Planets,* 11, Summer '69
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Superconductivity: *Supercold,* 9 f., Autumn '70
Surveys From Space: Tom Elliott, 27-32, Winter '69-'70
Switched-On Sports: Norman H. Solon, 24-27, Spring '70
Synthesizers: musical: *Electronics and the Sound of Music,* 19-21, 24, Autumn '70

Tactical Satellite Communications (TACSATCOM): *Electronically Speaking,* 36, Summer '69
Tape players and recorders: *The Burgeoning Youth Market,* 16, Spring '69; *Electronics and the Sound of Music,* 23 f., Autumn '70
Technology: *see also* Electronic data processing; Electronics; and Research
aerospace: *Aviation: On the Threshold of a New Era,* 24 f., Summer '69; *Bridge to the Planets,* 28, Autumn '70; *Surveys From Space,* 27-32, Winter '69-'70
for Apollo program: *Reflections on Apollo,* 24, Autumn '69
and art: *Art and Technology,* 2-7, Spring '69; *Art, Technology, and the Creative Process,* 28-32, Spring '70
of communication between man and machine: *Voice Recognition: Machines That Listen,* 3-5, Winter '68-'69
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effect of, on alphabet: *The Alphabet in the Electronic Age,* 9, Winter '68-'69
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and problems of cities: *Is Urban America Out of Control?,* 12 f., Winter '69-'70; *Pollution in America,* 13, Summer '70
radar: *The Powerful Vision of Radar,* 28-31, Spring '69
of recording: *Evolution of the Recording Studio,* 22-25, Winter '69-'70; *Pop Music—Hit Sound of the Recording Industry,* 20, Summer '70
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Technology: Challenge and Promise: Tom Shachtman, 2-7, Summer '70
Technology in the School: Gene Wyckoff, 10-14, Spring '70
Telegraph: *Alaska—Transportation and Communications,* 36 f., Spring '70
Telephones: *Alaska—Transportation and Communications,* 37, Spring '70; *Electronically Speaking,* 36, Summer '69; *TV Evening News: A Day in the Life of a Half Hour,* 17, 21 f., Spring '70
Telescopes: *Bridge to the Planets,* 26, Autumn '70; *The Grand Tour of the Planets,* 10, Summer '69; *Lasers in Transition,* 34, Autumn '69; *Man on the Moon,* 9, Spring '69; *The New Age of Astronomy,* 18-20, Spring '69
Television: *see also* Broadcasting; Color television; NBC; and Programming
closed-circuit: *Electronically Speaking,* 36, Spring '69
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educational: *Communicating Science to Youngsters,* 32-34, Spring '69; *The Future of Computers,* 15, Autumn '70; *Technology in the School,* 12, Spring '70
effect of, on reading: *A Publisher Looks at Publishing,* 3, Spring '70
for emergency control: *Electronically Speaking,* 36, Spring '69
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Telstar (satellite): *Law, Order, and Outer Space,* 6, Autumn '70
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Thermionic emission: *The World of Electronic Surfaces,* 25, Spring '69
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Tracking stations: *Law, Order, and Outer Space,* 5, Autumn '70
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Treaties: on outer space: *Law, Order, and Outer Space,* 4-6, Autumn '70
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United Aircraft Corporation: *Lasers in Transition,* 34, Autumn '69
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policy on space exploration: *Law, Order, and Outer Space,* 2-6, Autumn '70
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technical superiority of: *Reflections on Apollo,* 24, Autumn '69
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U.S. Air Force: *Alaska—Transportation and Communications,* 37, Spring '70; *Bridge to the Planets,* 28, Autumn '70; *Electronically Speaking,* 36, Autumn '70; *Men Who Work in Remote Outposts,* 19, Autumn '69; *New Sources of Electric Power,* 20, Winter '68-'69
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U.S. Naval Hospital: *Supercold,* 10, Autumn '70
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U.S. Post Office Department: *Voice Recognition: Machines That Listen,* 4 f., Winter '68-'69
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Urey, Harold C.: *Man on the Moon,* 8, Spring '69
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Voice: *see also* Speech
communication by laser: *Lasers in Transition,* 33, Autumn '69
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-record circuit: *Electronically Speaking,* 36, Summer '69
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Aswan Dam: *Technology: Challenge and Promise,* 6, Summer '70
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Westin, Av: *TV Evening News: A Day in the Life of a Half Hour,* 16-22, Spring '70
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Women:
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Ylvisaker, Paul: *Is Urban America Out of Control?,* 14 f., Winter '69-'70
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