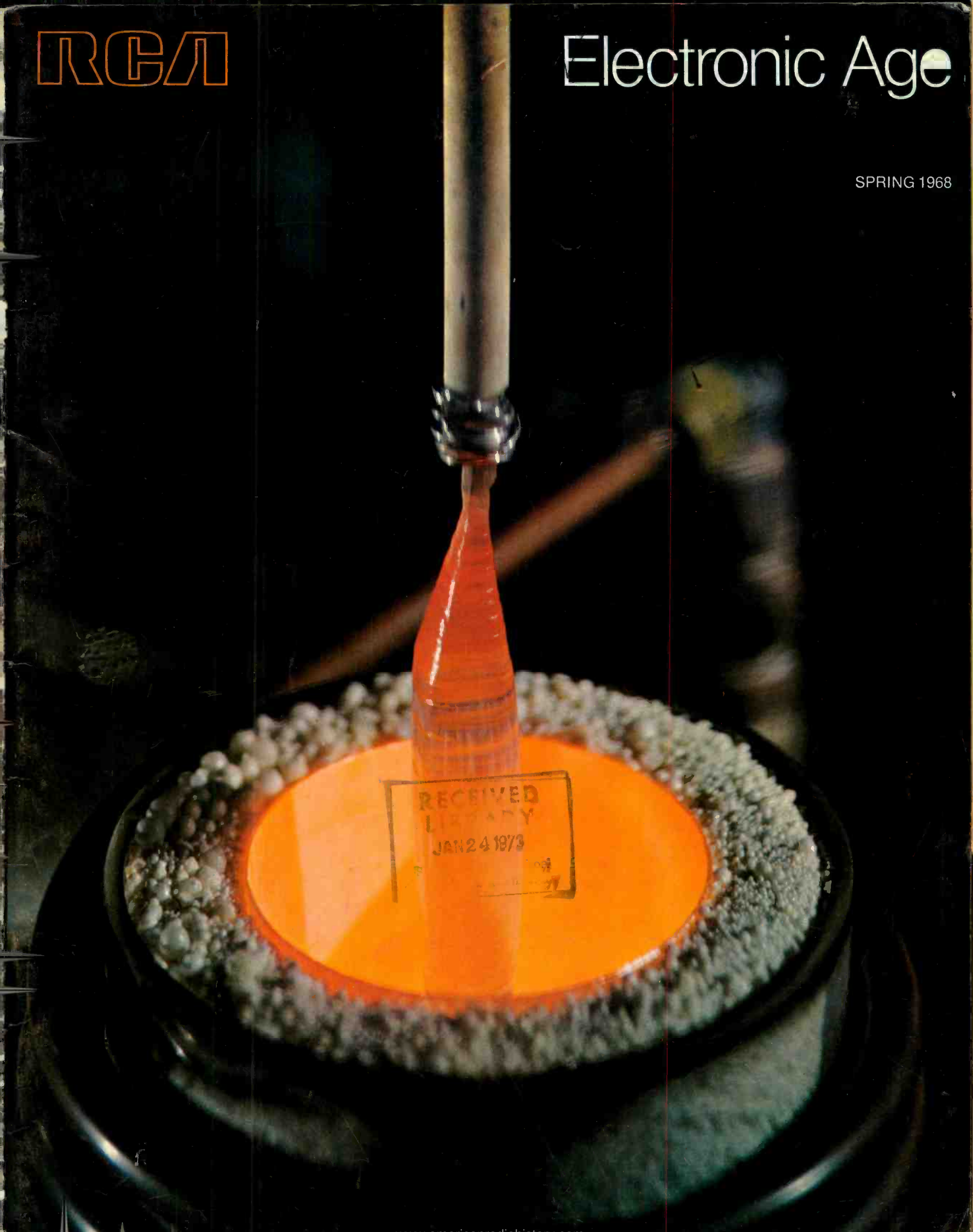
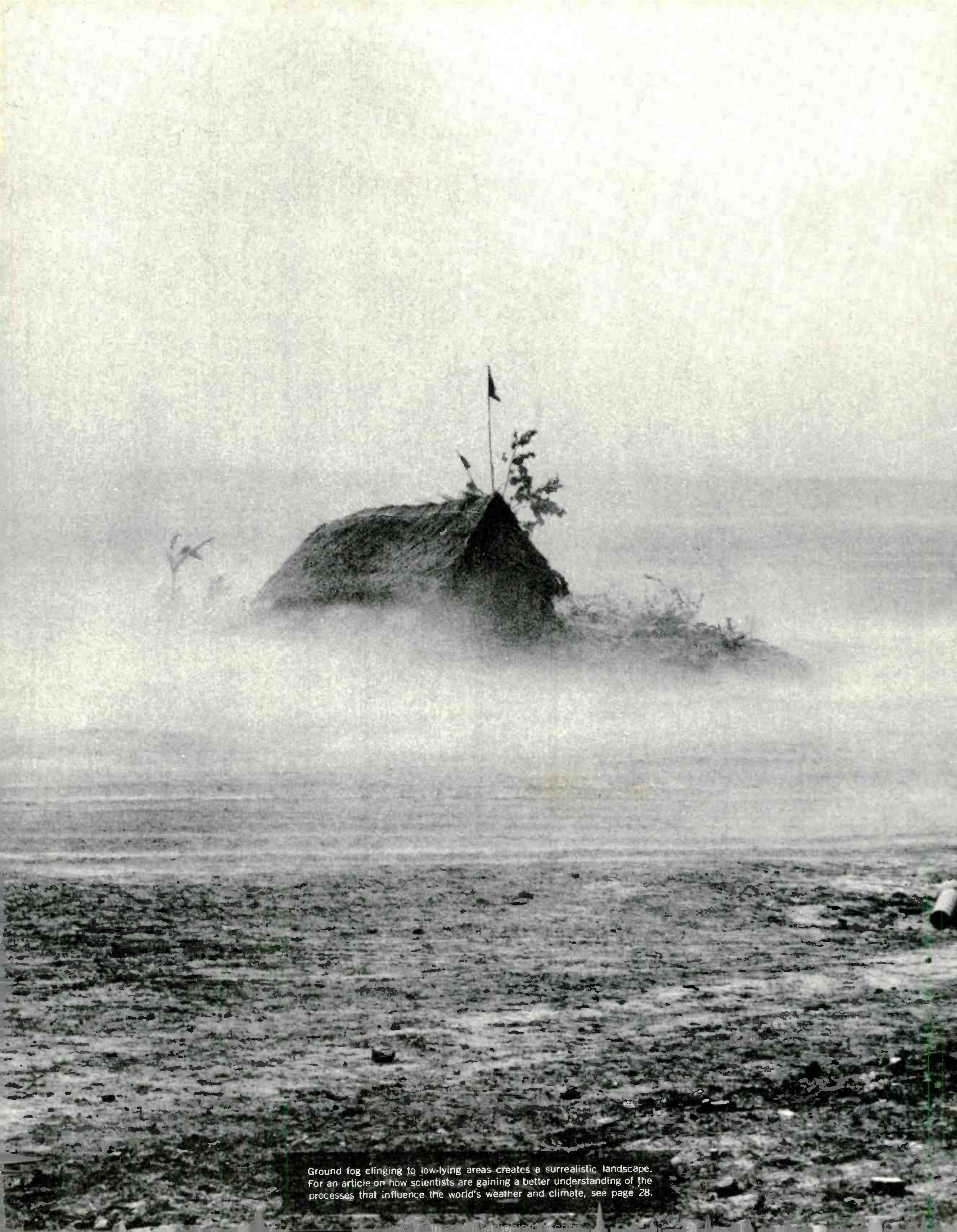
RCA

Electronic Age

SPRING 1968





Ground fog clinging to low-lying areas creates a surrealistic landscape. For an article on how scientists are gaining a better understanding of the processes that influence the world's weather and climate, see page 28.

Electronic Age

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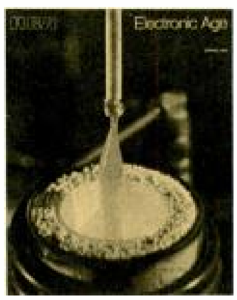
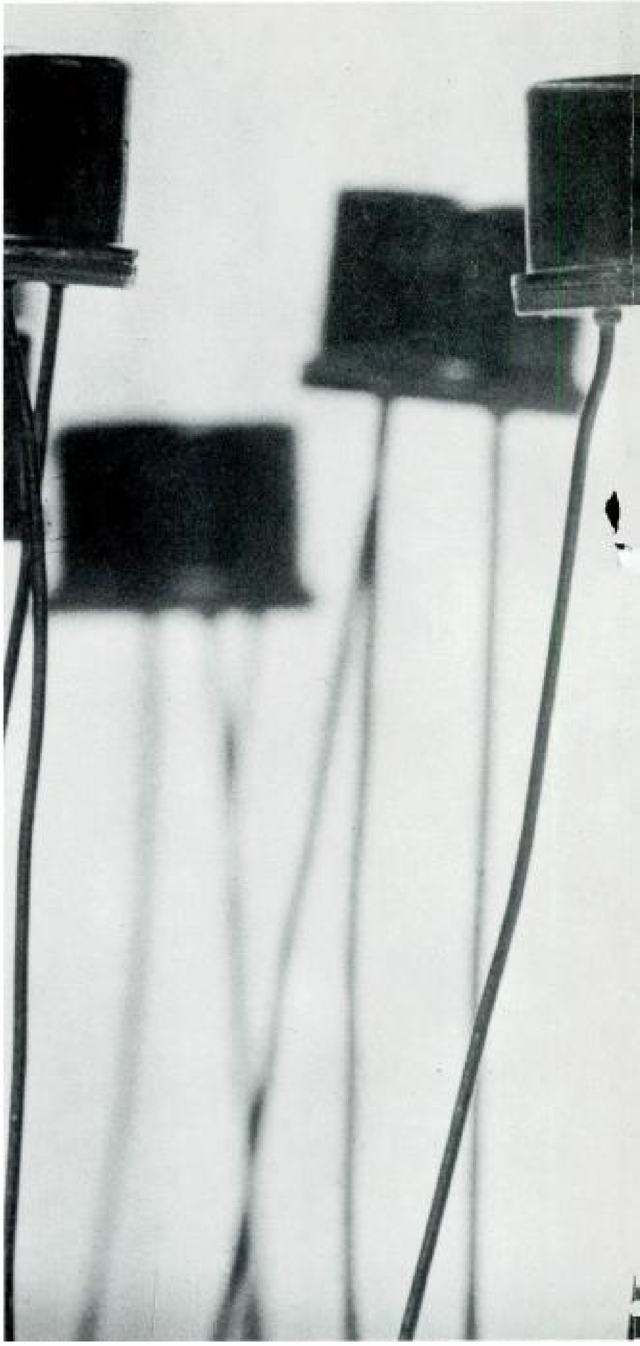


Cover: A single crystal of calcium tungstate grows gradually from a molten mass of raw materials contained in the platinum crucible below. The process of growth, known as "pulling from the melt," is one of several that scientists use to "culture" single crystals for use as electronic components. The crystal of calcium tungstate, when grown, will be machined, polished, and transformed into a solid-state laser that will produce a powerful and continuous beam of infrared light. For an article on the culturing of electronic components, see page 2.

Cultured Components



The electronic components industry is being transformed by a new kind of "farming"—cultivation and growth of single crystals in the laboratory.

by Bruce Shore

Increasing numbers of electronic components are no longer manufactured. They are cultured, instead, like so many electronic pearls.

What accounts for this fundamental change is the fact that materials scientists have recently learned to re-form many ordinary solids into single crystals whose purity and perfection surpass that of anything produced in nature from snowflake to Hope diamond. When suitably processed, it is these crystals that become the tiny, rugged, low-cost, solid-state devices that have remade the face of the electronics industry in the past 20 years.

Such is the nature of transistors for amplifying and switching electric currents in a circuit; semiconductor diodes for converting alternating to direct current and for producing high-frequency microwaves; and integrated circuits that perform the functions of whole assemblies of discrete components in fragments of silicon no bigger than the wing of a fly.

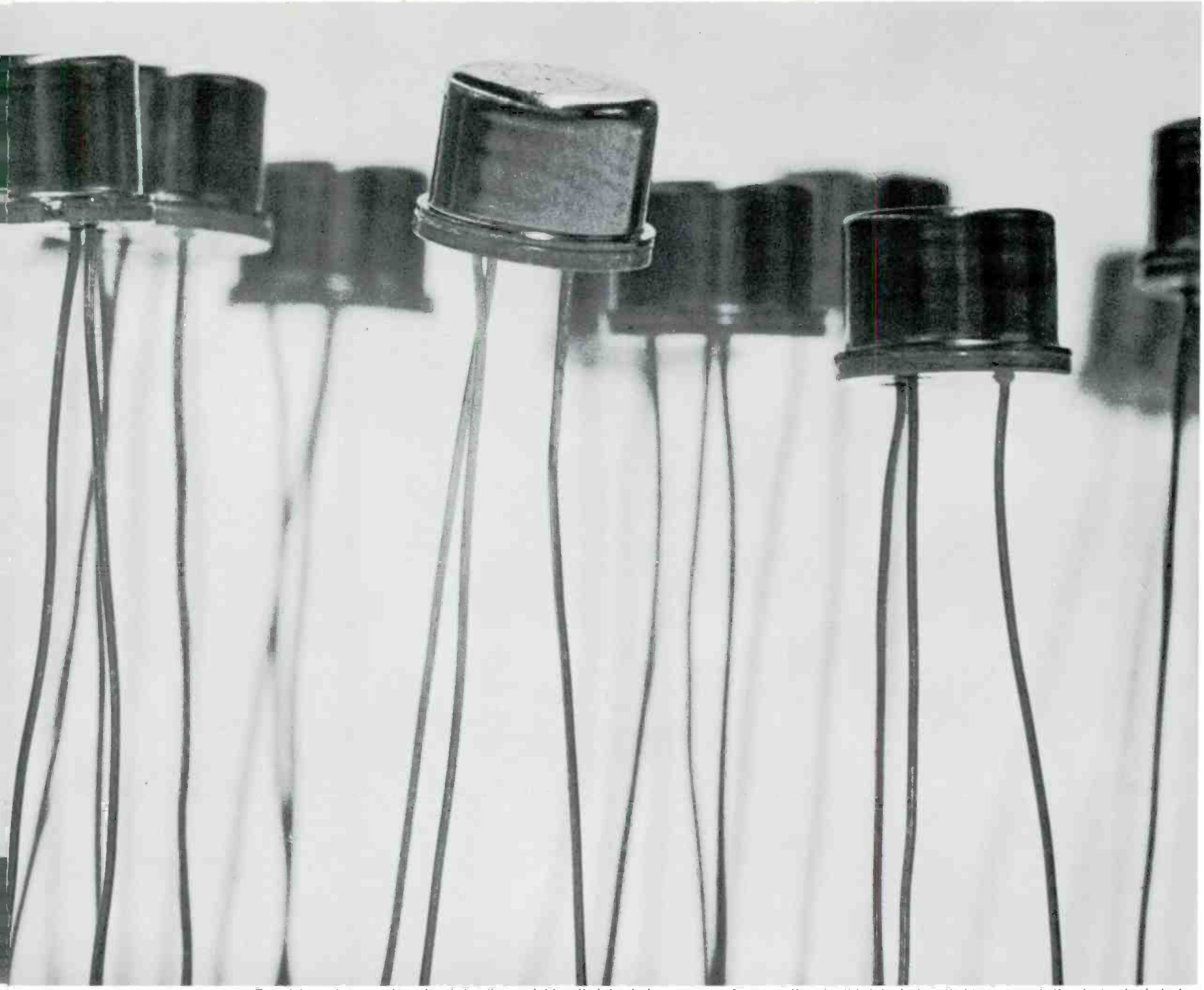
BRUCE SHORE is on the RCA Public Affairs staff.

Such, too, are solar cells that convert sunlight directly to electricity to power our nation's space vehicles; masers for use in amplifying the radio emissions of distant stars and galaxies for study by astronomers; and lasers for generating intense beams of coherent light which may one day be used in place of electric currents to carry information in advanced computers and communications systems.

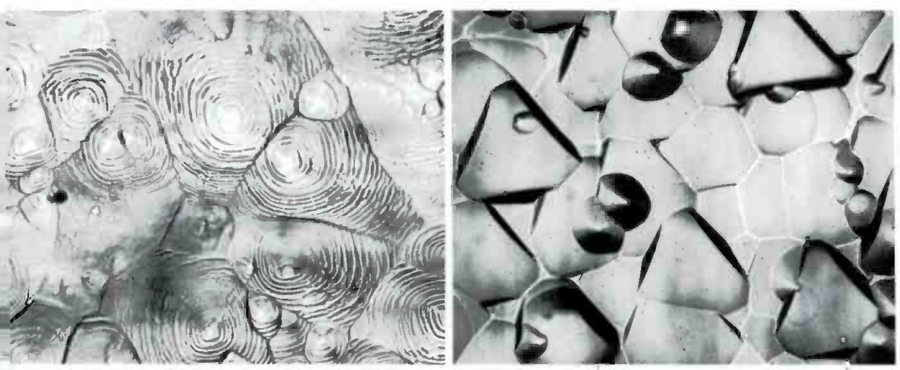
The reason these crystals have so transformed the electronics industry lies, at base, in the nature of the single-crystal state itself. In essence, single crystals are composed of atoms organized on a large scale in vast three-dimensional mosaics or "Tinker-Toy" structures whose architectural order, precision, and symmetry far exceed anything man has yet achieved in cathedral or skyscraper. By contrast, ordinary solids are a hodgepodge of ill-fitting atoms lumped together in jerry-rigged compounds shot through with fractures, holes, strains, and other architectural anomalies. Indeed, if they were buildings, they would be condemned!

Because of this difference, the same electronic, magnetic, optical, acoustical, and other properties inherent in a polycrystalline solid are invariably more pronounced, more accessible, and far more amenable to control when that solid is recast into single-crystal form.

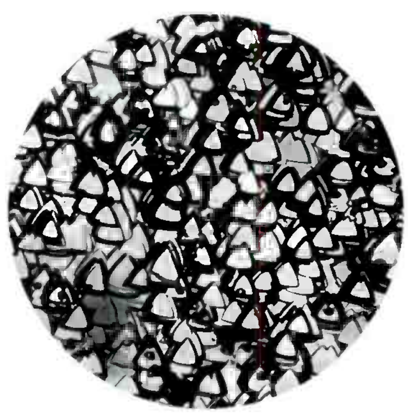
Another fact about single crystals is that they are not built. They are "grown." This occurs in the sense that a stalactite grows from a cave roof, or rock candy grows in a solution of sugar, or frost crystals grow on a windowpane in mid-winter. In fact, many of the most valuable constituents of the earth's crust have grown this way over the 4½-billion years since its formation.

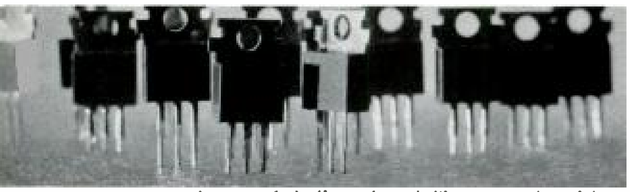


Transistors, shown packaged and standing upright on their lead wires, are one of many cultured solid-state devices that have remade the electronics industry.



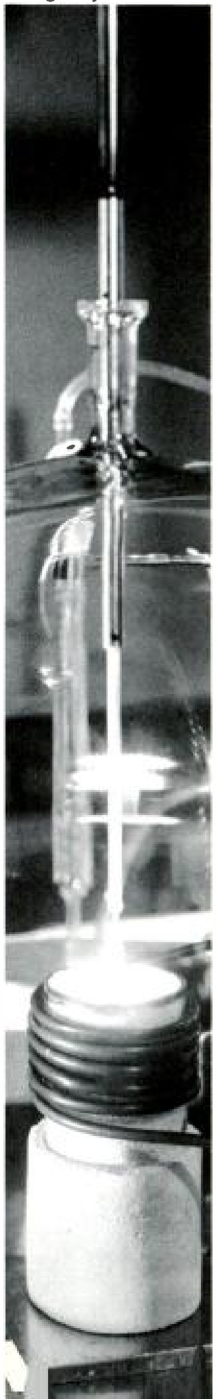
Various microscopic views of single crystals whose surfaces have been etched to reveal defects and structural details of importance to their electronic properties.





A group of plastic-packaged silicon power transistors.

A single crystal of calcium tungstate being drawn from a melt.



Finally, it is of interest, too, to realize that, with the exception of glasses, most atoms in the gaseous or liquid state prefer to organize themselves into single crystals, upon cooling, because such action represents the least line of resistance for them, in an energy sense.

Seen in this light, the growth of single crystals—whether in the macrocosm of nature or in the microcosm of the laboratory—is a matter of creating the right kind of climate and the proper "soil" conditions. Mother Nature takes care of the rest.

Full appreciation of this fact in the electronics industry followed invention of the transistor in 1948 and has led since to a novel form of agriculture in which materials technicians seed, grow, and harvest single crystals of a wide variety of materials that are then cleaned, chemically processed, and packaged for sale in plastic or can like so many fruits and vegetables.

The Johnny Appleseed of this latter-day agronomy is probably Johann Czochralski, a German physicist, who, in 1917, developed a crystal-growing technique that was used eventually to produce the first commercial transistors. Not that crystals had never been grown before. Alchemists had succeeded in growing copper sulfate cure-alls and alum astringents in single-crystal form early in the Middle Ages.

But, crystal-making did not become a serious business until 1902 when the French carborundum manufacturer, Auguste Verneuil, developed his famous "flame fusion" technique for growing rubies and sapphires of gem quality. What he did was to place a chip of sapphire on a ceramic spit and hold it under an intense flame through which sifted a powder of aluminum oxide (raw sapphire). The powder particles melted instantly in the flame and fell in molten droplets onto the sapphire chip where they solidified in accord with the atomic pattern on the surface of the chip. In so doing, they added to the structure of the chip in the same way that new bricks add to a brick wall. What Verneuil had done was to make the sapphire "grow." How this happened could not be explained, however, until 1912 and the discovery of X-ray diffraction by Max von Laue and others in Germany.

The very short wave lengths and enormous energies of X-rays made it possible for Laue to probe the surface and substructure of solid materials for the first time, and to reveal by X-ray reflections that single crystals are distinguished by an atomic order and purity undreamed of in the structure of ordinary solids. In fact, he found that single crystals are assembled according to a plan, as though from an architect's blueprint, and that each contains a fundamental unit or cell which is repeated again and again throughout its structure.

Furthermore, he learned that single crystals are built from no more than seven such units, the most common of which is the cube. Also, though these units frequently consist of atoms of one kind only—carbon, in the case of diamond—he discovered this did not have to be so. The basic unit of table salt crystals, for example, is a cube consisting of sodium and chlorine atoms stationed in alternate corners.

Armed with these insights and inspired by Verneuil's success, Czochralski decided to turn flame fusion on its head by inverting a "seed" crystal—corresponding to Verneuil's chip—so that it could be lowered to the surface of a hot magma or melt having the same composition roughly as the seed itself. He further arranged for the seed to be pulled up very slowly. As anticipated, the melt atoms clung to the seed and added to its structure continuously as it was raised. Thus was born the very powerful crystal-growing technique known as "pulling from the melt"—the technique employed by Drs. John Little and Gordon Teal, then at Bell Laboratories, to grow the single crystals of germanium that gave birth to the manufacture of "point-contact" transistors in 1949.

In time, however, pulling from the melt turned out to be too arduous and too demanding for use in mass production. Therefore, materials scientists soon resorted to an updated version of still another technique—one originated in 1925 by Dr. Percy Bridgman, a former Harvard professor and recipient of a Nobel prize. It entailed melting raw materials in an open "boat" which was drawn through a horizontal electric furnace from a hot to a cold region where the melt gradually "froze" into a single crystal. It proved to be simple, effective, and reliable, and was eagerly embraced by the fledgling semiconductor industry as the standard method for growing transistor-grade germanium crystals.

There were some drawbacks even to this technique, however, the most important being that the crystals it produced still contained too many impurity atoms—one in every 10 million to be exact.

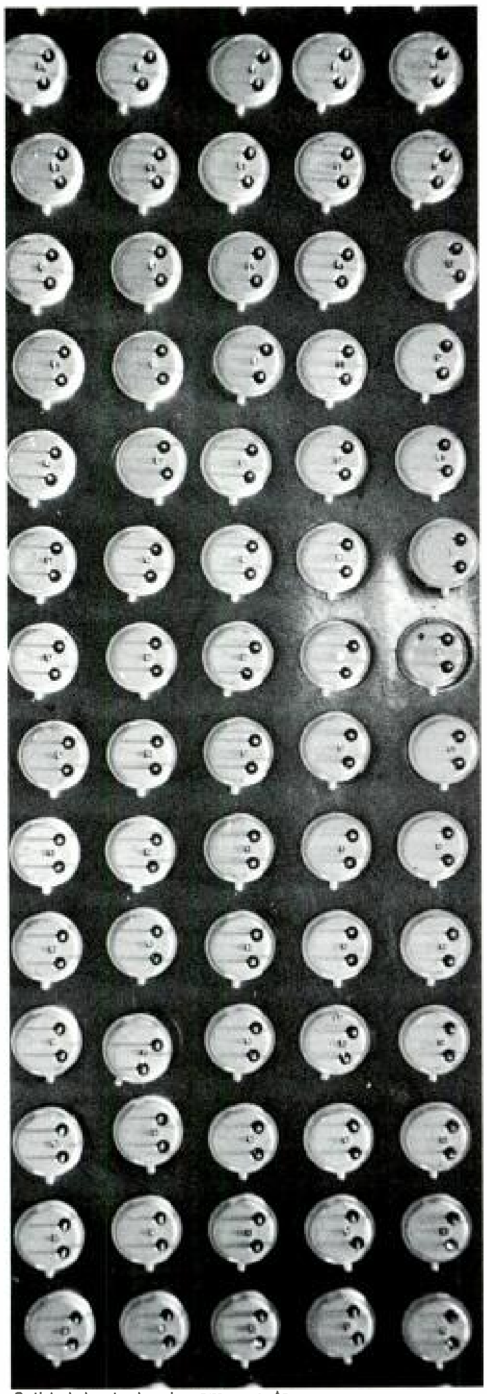
At this juncture, William Pfann of Bell Laboratories remembered a seemingly minor technique, now called "zone leveling," which he had stumbled upon as early as 1939 in a search for ways to spread small amounts of the element, antimony, uniformly through an ingot of lead. It had involved melting a narrow zone in the ingot near one end, by placing it at the center of a ring-shaped electric heater, and then slowly drawing the ingot through the heater so that it would melt and jell successively along its entire length. This had had the effect of leveling out the amount of antimony in the bulk of the ingot and, as Pfann now recalled, had even tended to sweep it out altogether since antimony has a lower freezing point than lead and wanted to remain in solution even while the lead was solidifying.

A reappraisal of this earlier technique now led Pfann to conclude that, with suitable modification, it might be used not only to level out impurities in a crystal but actually to remove them. This would be accomplished, he reasoned, if several melted zones were passed through the crystal in succession. On first try, he succeeded beyond his wildest dreams. The passage of several zones through the germanium crystals he was growing refined them to a level of one impurity atom in every 10 billion, yielding crystals a thousand times purer than the one used to make the first transistor. In addition to this immediate benefit, the technique—instantly dubbed "zone refining" to distinguish it from "zone leveling"—provided Dr. William Shockley, a coworker of Pfann's, with a material sufficiently pure to make possible a basic change in the structure of the transistor itself from the original "point-contact" to the far more subtle "junction" type that is standard today.

Though zone refining removed impurities as a limiting factor in the performance of transistors, it did not remove the problem of crystalline imperfections. In crystals generally, these included such *bêtes noires* as vacancies (missing atoms), interstitial defects (atoms out of position), and dislocations (whole layers of atoms that suddenly terminate halfway through a crystal instead of continuing to the other side). In transistor crystals, specifically, it was dislocations that gave the greatest trouble by snagging and diverting substantial fractions of the electrons that flowed through them when in operation.

An assembler attaches lead wires to a tiny solid-state device.

"The electronics industry is now engaged in a vast effort to reconstitute as many materials as possible in single-crystal form in a quest for newer and still more versatile components."



Solid-state electronic components in process of assembly.

In 1954, Dr. Fred Rosi, currently director of the materials research program at RCA's Laboratories, proposed and then proved that such defects could be greatly reduced, if not eliminated, by making certain that the growing crystal was kept continuously flat on the end where it touched the hot melt. Simple as this requirement seems, its discovery was a major step forward and did for dislocations what zone refining had done for impurities. In fact, when the two techniques were subsequently combined in the growth of germanium crystals, the resulting transistors easily out-performed the best electron tubes then available.

Germanium was not the only semiconducting material being grown and processed into transistors at this time. A strong effort was also being made in behalf of silicon. A major stumbling block here, though, was that molten silicon, at 2600° F., behaves like an acid. It attacks and erodes almost any container it touches and reacts with almost any atmosphere containing oxygen.

Many ingenious measures were evolved to circumvent these difficulties—high-temperature graphite pots were developed to contain the melt, the silicon crystals were grown via the Czochralski rather than the Bridgman technique to reduce chemical interaction with the sides of the pot, growth was accomplished in a closed argon or other inert environment—but all fell short. Then, in 1953, at the Fort Monmouth Research Laboratories of the U.S. Army Signal Corps, Paul Keck and Marcel Golay collaborated in the development of a method they dubbed the "floating zone" technique. It proved to be the long-sought breakthrough needed for growing single-crystal silicon of the highest purity.

The technique entailed use of a stick compacted out of raw silicon powders and clamped upright in an electric furnace. The stick was first converted to a single crystal by passing a molten zone up through it from bottom to top. (The zone did not collapse and leak down the sides of the stick, as might have been expected, because its surface tension was too great.) Then, it was zone-refined. The result was a long, single crystal of surpassing structural perfection and chemical purity.

It is this technique, coupled with such intrinsic features as high-temperature performance and an ability to be insulated by means of its own surface oxides (an important consideration for integrated circuits), that has helped to make silicon the dominant material in semiconductor devices today.

Based upon the materials knowledge and materials control achieved through this and other work over the past century, the electronics industry is now engaged in a vast effort to reconstitute as many materials as possible in single-crystal form in a quest for newer and still more versatile components. This effort is being prosecuted not only in the elemental solids but also in the endless variety of compounds and alloys into which these can be combined.

For example, at RCA's Laboratories, Dr. Chih-Chun Wang has grown large crystals of spinel (magnesium-aluminum oxide) for use in fashioning new forms of integrated circuits; Dr. Niel Yocom is working with exotic rare-earth solutions in which he has precipitated new crystalline phosphors for use in the screens of improved color TV receivers; and Dr. James Tietjen has mixed pure, vaporous compounds of arsenic and phosphorus with gallium and other elements to condense from them complete semiconductor lasers and cold-light sources that will never burn out.

More produce than product, transistors and their single-crystal progeny are today transforming the electronic components industry from a manufacturing to an agricultural activity whose bumper yields are feeding a growing population of new consumer, industrial, and military equipment. ■

In recording studios such as this RCA facility in Rome, rock musicians are creating a new kind of sound with electronics.

Revving Up the Rock Revolution

An arsenal of electronic devices in the recording studio has vastly expanded the range of today's rock musicians.

by Christopher Porterfield

Back in the days when they called it rock 'n' roll, the musicians would come into a recording studio, set up their gear, and twang their way through an arrangement that they might already have played dozens of times in live performances. The studio, with its microphones and tapes, was largely a passive agency. Its product was a record in the most literal sense of the word: a document, something that registered and preserved an objective event. That, as the pop music world measures time, was deep in the past—say, three or four years ago.

Since then, rock 'n' roll has developed into the expressive, flexible, and marvelously mongrelized genre called rock. The recording studio, steadily sprouting new electronic gadgets, has become a challenging frontier for adventurous-minded rock musicians. Today, the record does not merely document a rock performance, it shapes and transforms it as well. In a McLuhanesque metamorphosis, what was merely the medium has become the message, or at least a good part of it. "Records are no longer simply a showcase for performers," says Bob Cullen, a New York-based Artists and Repertory man who produces pop records for RCA. "Records are now a separate form in themselves."

The Beatles helped herald the new era in rock.

As such, records have created new molds for rock music while shattering some old ones. The very nature of long-playing records, for example, has encouraged musicians to break away from the two-to-three-minute time limit enforced by 45-rpm singles and attempt longer, more ambitious compositions. This is actually more dramatic than it sounds: record sales used to depend almost entirely on how often a particular release was played on the radio, and few disk jockeys would allow more than a three-minute musical interlude between commercials. Recently, recordings lasting up to a quarter of an hour by such groups as The Jefferson Airplane, The Cream, and The Doors have reached a wide audience without much air play. Their success, in turn, has spurred a scattering of radio stations—mostly FM outlets on the East and West coasts—to open up their programming to the new, longer pieces.

Even when a rock LP consists of shorter pieces, the increasingly sophisticated listeners who make up its market want it to adhere to the total-album concept. "An album used to be the group's latest singles plus whatever you had in the can," says Cullen. Now, it is expected to bring together individual songs that are "comfortable" with each other, and preferably that illustrate some over-all unity. John Sebastian, a member of The Lovin' Spoonful, says that an album like the Beatles' "Sgt. Pepper's Lonely Hearts Club Band" or the Mothers of Invention's "Absolutely Free" "has little shiny spaces there for bands, but those songs are movements to me. It is all one work." Rick Jarrard, an RCA Artists and Repertory man who produces pop records on the West Coast, has just finished working with a group called The Family Tree on an album in which every song tells a different part of the same story—the life of a spinster schoolteacher.

But more important than the artistic framework that recording provides for rock musicians is the fresh, fertile, musical vocabulary it gives them. The recording studio's burgeoning arsenal of electronic devices vastly expands the range of notes and noises open to today's experimental groups. More and more, rock records are projecting not only the sound of music but also the music of sound—nearly any sound.

Tape alone offers a whole spectrum of possibilities. It can be speeded up, slowed down, run backwards, dubbed, or manipulated to achieve a variety of reverberations and repeater effects. And now that RCA and several major recording firms are using eight-track tape in their studios, their records can be pieced together by a highly adaptable "layer-cake" method: each musical element recorded on a separate track, then combined, mixed, and equalized as the producer sees fit. Filters can be used to blank out certain portions of a sound, the Leslie speaker can be plugged in to lend its peculiar, quavery vibrato, and there is even a device called a "fuzz," which distorts tones into the kind of buzz that a bad phonograph needle produces.

"While we're in the studio with tapes and things," says the Beatles' Paul McCartney, "why ignore them? You can make them a part of it. They're the instruments now." Adds Mick Jagger, lead singer for the Rolling Stones: "We're playing with sound, and we're all still learning. The recording studio, with all the things it has in it, is another form of art, of music."

Playing with sound, using electronic equipment as instruments, the rock groups have replaced, or at least supplemented, the old, thumping guitars-drums-bass formula with what pop critic Richard Goldstein calls "collages of sound images." In so doing, they have left behind the debate about whether recorded sound sometimes misrepresents performances by enhancing and boosting them. Recordings of electronic rock no longer purport to represent live performances. They are no longer reproductions but productions—studio events, self-contained and self-referring. As Paul McCartney puts it, "To do these things a few years ago was a bit immoral. But electronics are no longer immoral."

CHRISTOPHER PORTERFIELD is a contributing editor of *Time* magazine.

Jerry Corbitt
of the rock group,
The Youngbloods.

The change in recording approaches and attitudes is summed up by George Martin, who acts as record producer, arranger, instrumentalist, and electronic midwife for the Beatles' recording sessions. "Making records," says Martin, "has been until recently rather like painting from the beginning of the Greeks to the Dutch school. The main aim was to be as lifelike as possible. But now in painting we have impressionism, cubism, all sorts of abstractionism. And just now in records we have reached the stage where we are working with pure sound. We are building sound pictures."

As in some abstract painting, electronic rock has occasionally been so taken up with the technique of its new idiom that it has failed to communicate. But the best groups, points out RCA's John Pfeiffer, an executive producer of Red Seal (classical) Artists and Repertory, "use whatever sound material is available not as an end in itself but as a means of projecting their oral urgency." In short, some of the sound pictures being built in recording studios are richly expressive, and can be deeply stirring.

The best examples of this, as of so many other things in rock, are the Beatles. Their "Sgt. Pepper" album, released last summer, heralded the electronic era in rock. On track after track, special effects reinforce superior lyrics and melodies in a way that gives most listeners psychic shivers. The county fairground noises in the title song, the fantastic echoes and distortions in the psychedelically inspired "Lucy in the Sky With Diamonds," the mystical melange of fluid, swooping sounds in the Indian-flavored "Within You, Without You"—all impressively document Martin's assertion that the Beatles "place far greater demands on the studio than any other group."

When the results sound like "Sgt. Pepper," the demands seem worth while. That album's "A Day in the Life" is perhaps the finest song yet produced in the rock form, and it would have been possible only in a recording studio. Its electronic dimension not only supports the music but actually seems to distill the essence of the song's imagery and emotion: at the end, the refrain "I'd love to turn you on" leads to a hair-raising crescendo of orchestral cacophony, followed by a 40-second electronic hybrid of a chord that suggests a trance of escape, or perhaps resignation.

Dominant as they are, the Beatles are far from the only group to tune in successfully on electronic rock. The latest album by the Rolling Stones, "Their Satanic Majesties Request," comprises the Stones' distinctive charting of the same galaxy of sounds opened up by "Sgt. Pepper." The Jefferson Airplane's newest release, "After Bathing at Baxter's," uses none of the "imported" sounds so common in the Beatles' work, but it does put the Airplane's own voices and instruments through an elaborate set of electronic permutations; woven into the opening segment called "Streetmasse," for example, is a kaleidoscope of feedback from amplifiers, spoken words, and instrumental sounds (including some by the Gary Burton quartet, a jazz group that visited the studio while the recording was being made).

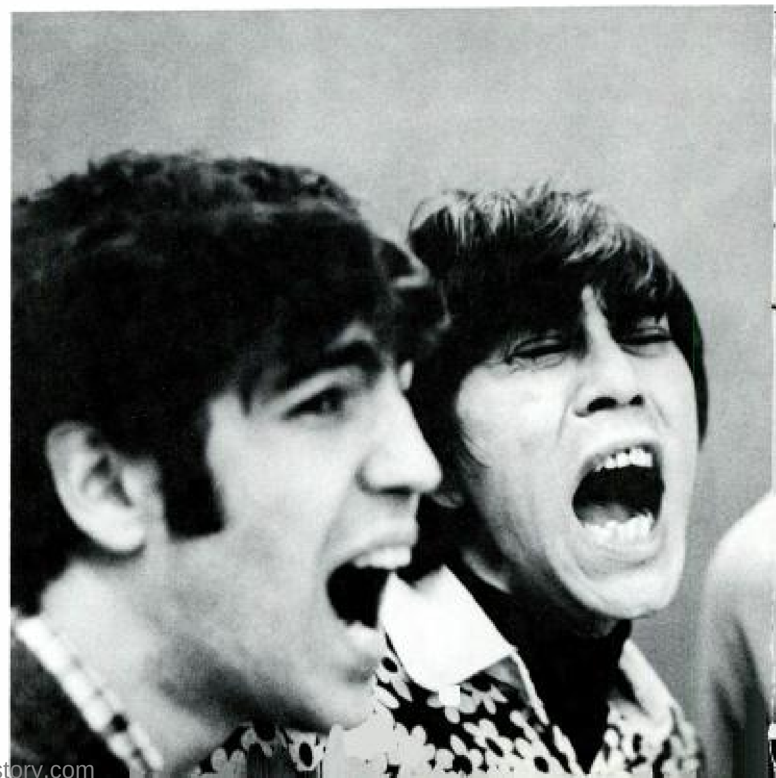
Besides such direct products of electronic recording techniques, there are a number of general by-products. For one thing, rock albums have become much more time-consuming and expensive to produce than they were a few years ago. "Sgt. Pepper" cost three months of work and $56,000, five times as much as an ordinary classical album costs in England. Bob Cullen says that where an album used to be tossed off in four days, he now counts on a siege of six weeks or two months in the studio whenever he embarks on a new recording. And Rick Jarrard points out that the conscientious producer spends nearly as much time on an album outside of the studio as inside, mostly on preparation.

Inevitably, the growing length and complexity of recording sessions increase the importance of the producer. Working with a group in a studio day after day from 10:00 A.M. to 10:00 P.M., he must be, as Cullen puts it, "in complete 'sync' with the group" —a combination of catalyst, cheerleader, and confessor. This is why so many of the rock producers turn out to be young men themselves, intuitively keyed into the life and times—and music—of the rock musicians they work with. Jarrard, for example, is 27 and a former rock 'n' roll singer; Cullen is 28 and a former drummer as well as a singer. "In the studio," Cullen says, "you're the fifth member of the group—even the leader."

On the other hand, the producer must be able to separate himself enough from the group to distinguish between the good and bad in their ideas and performances. He must also know enough about the new electronic techniques to be able to bring the group's sometimes fuzzy initial concepts to life. Watching a producer in action in a control booth—directing the musicians, molding the arrangement and sound effects, conferring with his engineer in an arcane vocabulary of phrases like "ping-ponging" and "punching in"—there can be no doubt that he is a creator in his own right.

Another by-product of the electronics explosion is a new attitude among rock musicians toward recording, which many of them used to regard as a cold, commercial necessity. The Mamas and the Papas have gone so far as to build their own recording studio, and Mama Michelle now speaks of recording as "one of the greatest parts of the business." Guitarist Mike Bloomfield, leader of the Electric Flag-American Music Band, is fascinated by the potential in the studio for "creating new sounds by turning the knobs certain ways." He views the studio as the setting where he can most fully develop himself and his group: "I've got a million ideas, and I want to see how many colors I can get out of this band."

For a while, it even appeared that rock groups might have to choose between the beckoning studios and their accustomed round of in-person appearances. A year ago the Beatles gave up touring in order to concentrate on recording and other ventures, and thereafter it became fashionable to



Members of the cast of "Your Own Thing," a current off-Broadway hit rock show.

Electronic composers are also finding rock a vitalizing current to stir into their "serious" mixes.

"Until now, most of the electronic sounds in rock have been actual musical sounds—a guitar, a voice—processed and altered by electronic equipment. Today, more and more of the original sounds are coming from the electronic equipment itself."

A rock group that calls itself Group Therapy during a recording session.

"Records of electronic rock no longer purport to represent live performance. They are no longer reproductions but productions—studio events, self-contained and self-referring."

categorize groups as either live bands or recording bands. Since it was impossible to do in person what could be done in the studios, the argument went, groups would simply have to decide which kind of music they wanted to make.

But the split never really developed, partly because most groups were stimulated by the cross-fertilization between the two activities. Now, in fact, some of the newer, more electronically oriented groups are taking what has been learned in the studio and putting it to work on the stage and in the night club. The live performances of an English group called The Pink Floyd incorporate elements of *musique concrete* and avant-garde electronics. A far-out, new Los Angeles group called The United States of America carries an imposing array of electronic equipment—much of it specially designed for the group—which enables it to do almost anything in person that it could do in a recording studio.

The music of a group like The United States of America also illustrates another important point. Until now, most of the electronic sounds in rock have been actual musical sounds—a guitar, a voice—processed and altered by electronic equipment. Today, more and more of the original sounds are coming from the electronic equipment itself: oscillators, synthesizers, and the like.

Last year, The Byrds recorded a piece titled "CTA-102" (the name of an asteroid) in which they evoked a space journey with an assortment of weird electronic soundmakers, among them an oscillator and a Theramin, which nonmembers of the rock generation may recall from the soundtrack of the 1940s Hitchcock movie *Spellbound*. The Youngbloods, in a recent recording session at RCA under Cullen's supervision expanded their instrumentation to include a Moog synthesizer, a sort of electronic keyboard instrument that ripples out tones of the blip-bleep variety.

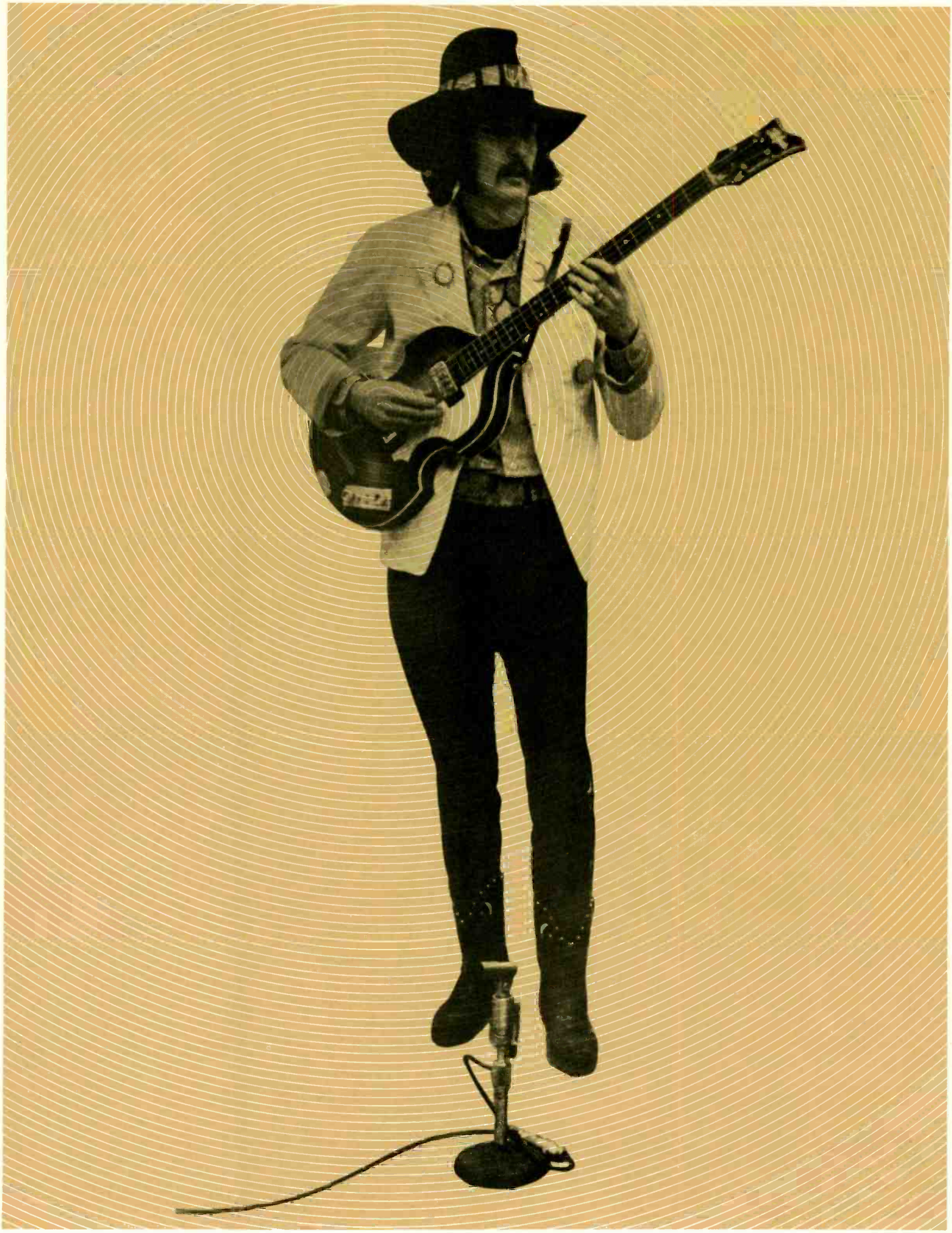
In other words, experimental rock musicians are rapidly appropriating the methods of avant-garde composers who deal in electronic music, and in this way are bidding, consciously or not, to close the gap between "serious" and popular music. Paul McCartney spends hours studying the records of Cologne-based electronic composer Karlheinz Stockhausen. Mike Bloomfield's dictum, "Music is sound and sound is music," shows a complete—if unwitting—rapport with the thought of that elder statesman of the far out, John Cage. Thousands of young listeners who disdain "longhair" music unknowingly welcome its devices—when smuggled into rock recordings—with open ears and minds.

Professor Robert Tusler of the Music Department, the University of California at Los Angeles, an admirer of The Jefferson Airplane, the Beatles, and The Byrds, thinks the Beatles, especially, "have taken over many of the electronic concepts of serious composers like those of the Cologne group or of the Italian Guigini Nono. They've made an enormous contribution to electronic music."

The influence flows the other way too. Younger electronic composers, especially, are finding rock a vitalizing current to stir into their "serious" mixes. RCA's John Pfeiffer, himself an electronic composer, has already obtained "weird and interesting results" by adding electronic effects to a rock song in one of his pieces, and he plans to keep probing the possible combinations of the two forms.

If there should ever be a marriage between classical and pop electronic music, the ceremony would unquestionably be held in the recording studio. Cullen, noting the trend toward larger groups and more elaborate arrangements, predicts that rock may "take on a classical robe" within the next five years through the evolution of big bands in the studios. Not big bands like Glen Miller's, or even Stan Kenton's, but big rock bands bristling with electronic equipment and literally humming with a powerful potpourri of noises, distortions, tape tricks, and so on.

Even if the wedding never comes off, the romance is bound to produce daringly new and unusual explorations that should be, in every sense, electrifying. "The approach of these forms to each other," says Pfeiffer, "will provide the rock groups with a means of growth and establishing their identity. Beyond that, it will push the recording studios to make more things available to the groups, and it will put more of the burden of popularity on the studios. All in all, it means an exciting, stimulating time for the groups, A and R men, engineers—and the recording companies." ■



Skip Boone, member of the Auto Salvage rock group.

Simulation—

Preparing for the Game of Life

From its origins in military war gaming, the practice of simulation has expanded to become a useful tool for decision-making in business, science, and government.

by Tom Shachtman

An astronaut is looking about for a parking place on the moon. Suddenly his navigator shouts that the calculations are off, that they are coming down too fast. Before he can react, the spaceship crashes into the moon. Disaster. But the astronaut merely closes his eyes for a moment to regain his composure and walks away from a huge electronic machine in Langley, Va., that had simulated an emergency on a future flight to the moon.

Electronic simulation is a rapidly growing science that encompasses activities that take place in outer space or the inside of the body, with waystops in the fields of education, business, medicine, engineering, and the military. The reason for the rapid rise of simulation is simple: the real world—where astronauts can crash into the moon, or businessmen can drop several million dollars on a wrong decision—is an exciting, ever-changing, dangerous, and expensive place. Adequate preparation for problems that arise in the real world, by means of simulation, can serve to make people better players in the game of life.

The modern practice of simulation has roots in military war gaming. A relevant example is a game developed during the 18th century by a Prussian military writer named Georg Vinturinus. Different types of battle terrain were represented by 3,600 squares, which could be arranged into a playing board. A 60-page rule manual was given to the players. Factors for logistics and supplies were carefully included in the game to make it realistic. A later version, in 1840, quantified and codified the game more, giving political information and intelligence reports to the participants and introducing "chance" factors into it. The primary purpose was to educate young officers in the arts and sciences of war and to give them experience in decision-making. War gaming continued to develop sophistication as a training device in the 20th century, reaching the status of a unique art during World War II, when invasions such as Midway and Normandy were played out on huge boards at Allied command headquarters—before being executed.

During the war, gaming became the province of men concerned with operations research—a technique used to break down events or operations into their component parts and then rebuild them with a surer knowledge of the components. This led to simulations of increasingly complex character. During the war as well, another parallel development came into its own: the Link Trainer. This early simulator allowed pilots to experience the feeling of flying a plane without leaving the ground—training them (as the generals and admirals were trained by war games in a more grandiose way) for tasks they would have to accomplish in the future.

Added sophistication in simulators and simulation had to wait, however, for the development of the computer. Capable of juggling great, unwieldy masses of numbers and numerical probabilities, of examining the possible effects of many alternative programs of action, and of translating simple decisions (such as to move a plane up or down) into the reactions of component systems, the computer revolutionized the simulation field. At the Rand Corporation, mathematicians, physicists, sociologists, and other scientists calculated the possible horrors of a future atomic war in great detail. They simulated the destructive effects of a bomb exploding on a city, estimated the probability of our attacking force wiping out an enemy from the air, and mulled mathematically the sociological aftereffects of a nuclear holocaust. The results of these simulations were used to make recommendations that led directly to the development of defense systems like NORAD, SAC, and the DEW line.

Although most simulations educate by giving experience in that vague capacity we call the ability to make decisions, the uses of simulation in education are more specific. At a Yorktown Heights, N.Y., school, elementary-school children make believe they are the kings of the ancient kingdom of Sumer. The simulation lets the king—in the person of the individual child—play against a computer which takes the part of the chief steward and top adviser to Sumer. Half a dozen children play the same king simultaneously, since the computer is fast and facile enough to do all the computations necessary for several reigns at once. The computer gives the ramifications of decisions that the "king" chooses—such as not rationing the grain in a year of famine—and offers the young monarchs advice on choices they must make among alternative strategies for administering their kingdoms

TOM SHACHTMAN has reported extensively on electronics as a writer for television.


USA
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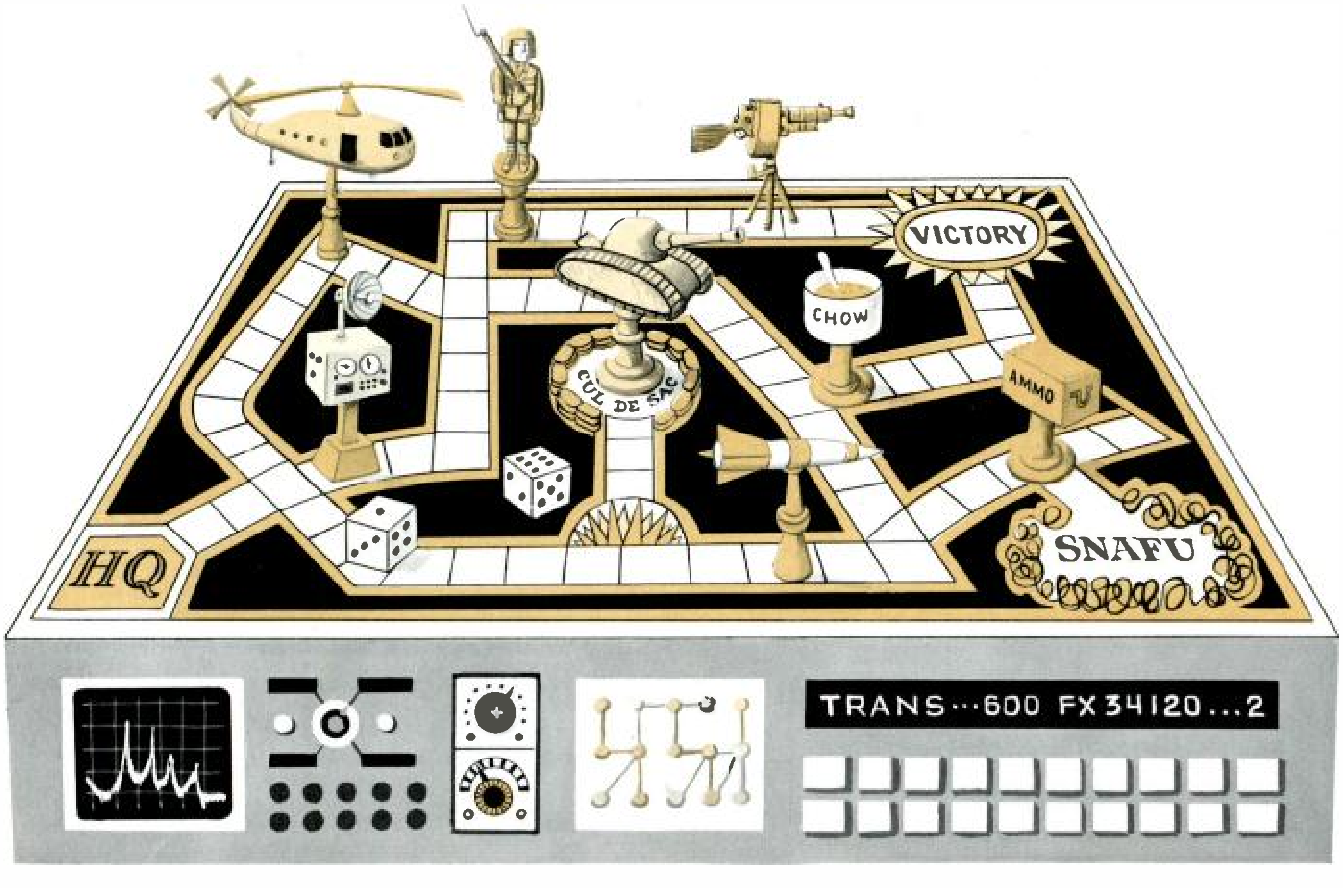
"By using the computer to compress time and to calculate the effects of supply decisions, Army students compress 48 months of logistics decisions into 48 hours of simulation time."

well. Thus, the computer becomes a fund of information, a suggester of alternatives, a tally machine for decisions, a consequences reporter—and an excellent and challenging programmed learning device. After the students have finished a simulation, they understand a very great deal about what Sumer and its kings must have been like.

Simulation for decision-making training and for other educational purposes is widespread. But simulation can also be used in ways that presage a new era in original research. With the aid of a computer, scientists can now simulate many areas of life not previously accessible to detailed work. One obvious boon is to medical research. Many things about the human body are still unknown—for example, what happens to the body when the heart is weakened. John McLeod, scientist and editor of the magazine *Simulation*, has built a computer model of the bloodstream, a simulation in which oxygen, carbon dioxide, nutrients, wastes, heat, chemicals, and radioactive tracer elements are quantified and then manipulated as they might be in a pathological condition such as that of a weak heart. Rand hydrodynamicists are studying blood flow in the minute capillaries of the eye, simulating by computer methods a small body system in hopes of finding out what happens to that system—say, in the eyes of a man watching a radar scope for approaching enemy planes—under stress. Researchers in many drug companies make a computer model of a part of the human body. Then, they make numerical equivalents of the chemical actions a new drug might have on a body system—before they compound the new drug in the laboratory.

Companies in other fields can try out designs for airplane structures or revised marketing and pricing practices with simulation. A numerical model of the system to be tested is made up and put into the computer's memory. Then individual factors within the numerical model are manipulated and the effects on the total model are calculated. Whether your concern is a hypersonic aircraft of a special design collapsing at 60,000 feet or a new pricing policy for a breakfast cereal that will lower or raise your share of the market for that product, the results of the simulation are valuable. Simulation allows for mistakes to be made before they become too costly. In the words of a Rand researcher, they let the person using the simulation learn from bitter experience without suffering the consequences of those experiences.

But military matters are not always so spectacular as trying to outguess a future nuclear war. Logistics, supply—factors that concerned even Vinturinus in the 18th century—have multiplied in importance, and in headaches, as well.



Managing logistics and supplies for an army whose bases are spread around the world and whose expenses run to many billion dollars a year is a mammoth job. Logistics managers for the U.S. Army are now being trained for their complex tasks by the use of computer simulation methods. At Fort Lee, Va., where the U.S. Army Logistics Management Center has its headquarters, an RCA 501 computer is used solely for training army and civilian personnel from all over the world in logistics management. Approximately 4,000 students annually do simulations on the computer.

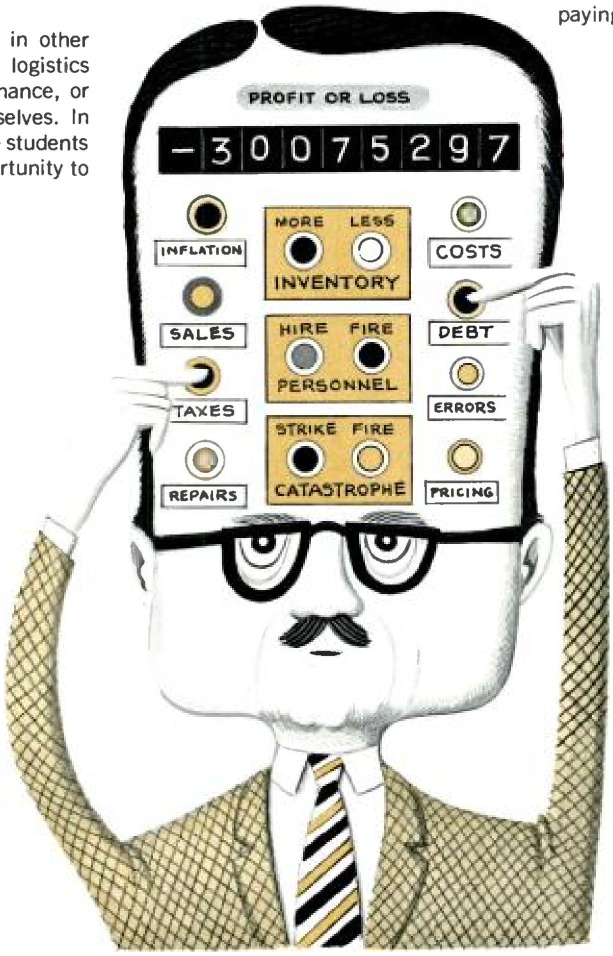
Computer Assisted Logistics Simulation, or CALOGSIM, is one of seven exercises developed and used at the Center as capstones of regular courses in management required for logistics people throughout the Army. In CALOGSIM, the students play the roles of commodity managers at an Army National Inventory Control Point (NICP). All the data used in the simulation are taken from real NICP data, and the students perform functions done by real-life NICP managers. They control 50 principal items—such as tanks or radio sets—and 450 secondary items and repair parts ranging from nuts and bolts to helicopter rotor blades. By using the computer to compress time and to calculate the effects of supply decisions, the students compress 48 months' worth of logistics decisions into 48 hours of simulation time. They undertake all the normal problems of phasing in new items, scheduling repairs, redistributing stock, obtaining funding, and so forth that face real-life, real-time managers. They also are confronted with funding cutbacks, strikes, floods, increased demands caused by limited wars—in other words, all the things that make supply managers go gray at an early age.

The other six simulations, used in other courses, deal with more specific logistics activities such as repair, maintenance, or disposal as specialties in themselves. In these, as well as in CALOGSIM, the students are presented with a unique opportunity to make decisions and manage supplies in an environment where the effect of a bad decision is only a student's chagrin—not a million-dollar supply mistake. Both the teachers and the students feel that the objectives of the simulations are achieved: to give the participants "accelerated experience" and make them better managers.

The world of business has adopted simulation, too. People must be trained to make good business decisions. As part of a top-level course in training executives, the American Management Association (AMA) in New York City has developed an elaborate exercise model called Top Management Decision Simulation. Several years of activity by a fictional company are compressed—by computers and careful planning of alternatives by AMA representatives—into a few days. The participants are forced to make decision after agonizing decision as executives of the fictional company making a fictional product. The computer calculates the impact of decisions to add to inventory, increase the number of salesmen, make a large bank loan, and so forth. Carefully planned "monkey wrenches" are dropped by the AMA into the proceedings at preset intervals—an unexpected surcharge on taxes, a faulty computer that makes exasperating mistakes, an untimely resignation of a key man. The participants go through professional purgatory for a week—but take back to their own companies a reinforced capability for decision-making that they can apply to real companies in a real world.

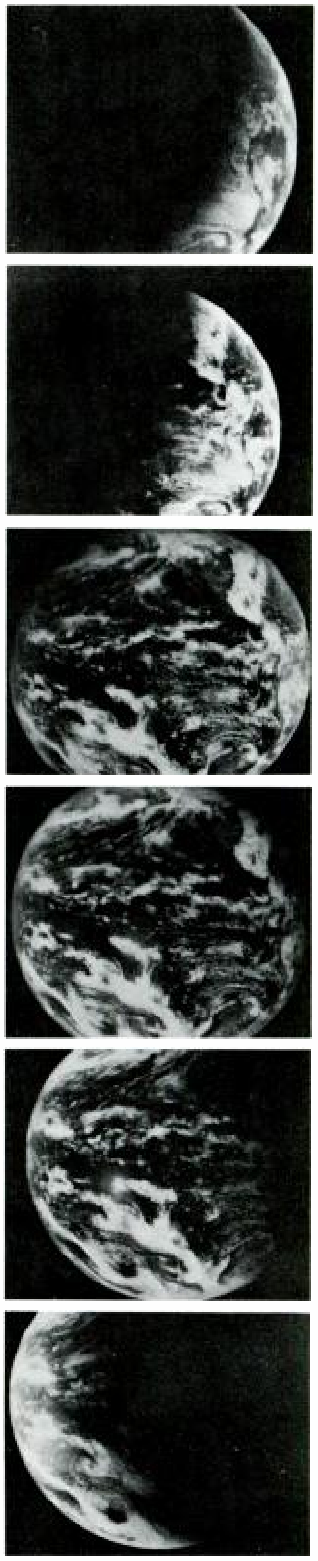
The most tantalizing and most difficult assignment for simulation is reproducing the conditions found in outer space. We need to be prepared for it, yet there are relatively few ways to create artificially the experience of space for the men who need it. But, with today's simulation, scientists can construct an experience no one has been through to date. Three great computers run an Apollo Mission Simulator at Clear Lake, Tex., near the Manned Space Flight Center in Houston. Astronauts training for descent to the moon sit in a capsule surrounded by a battery of television and motion picture screens and planetarium projection equipment. Added realism is provided by the sound of rocket engines being ignited. Every detail of the entire multi-day mission can be simulated, except weightlessness. In other simulators used by NASA, weightlessness too is duplicated.

For the final stages of descent to the moon, a huge simulator—the marvelous grandchild of a Link Trainer and a computer—is used. It stands 250 feet high, 400 feet long, and 300 feet wide at the Langley Research Center. The Lunar Module is within it. Cables counteract five-sixths of its weight while the astronaut maneuvers the crucial 200 feet from lowest point in orbit to landing on the moon. If he crashes here—and there are some inexperienced drivers—he can shake it off. There is time and equipment for him to practice on before the real trip into real space has to be made. He has the opportunity to make mistakes without paying dearly for them. ■



"Simulation allows a person to learn from bitter experience without suffering the consequences of those experiences."

Economic Growth Via Satellite



A series of photos taken by NASA's Applications Technology Satellite (ATS) show the changing cloud pattern over the earth for an entire day.

A searching inquiry into the practical applications of space technology points to enormous economic benefits for mankind.

by Louis F. Slee

Late one evening in February, 1966, three men met for dinner in San Diego to review the events surrounding a three-day meeting of the American Astronautical Society. The men were Dr. Larry Kavanau, then a vice-president of North American Aviation; Courtland D. Perkins, associate dean of the School of Engineering and Applied Science at Princeton University; and B. William Miller, market development manager, RCA Astro-Electronics Division. The meeting, on "the utilization of space technology to satisfy the needs of mankind," excited the imagination. But, to the three at dinner, it was only the first step in what they foresaw would be a long series of events.

The use of spacecraft and space technology to improve the quality of human life would require, they believed, a systematic, well-organized approach. Going over the problem, they came up with the idea for a space applications study program. A letter outlining this idea later was drafted and sent to the National Aeronautics and Space Administration and the National Academy of Sciences. The idea was accepted, and in the summer of 1967 the program was initiated at Woods Hole, Mass., under the sponsorship of these two organizations. It will continue this summer.

The space applications study is a searching inquiry into the practicality of using space systems to meet the existing and future needs of mankind. Under the chairmanship of Dr. W. Deming Lewis, president of Lehigh University, 90 eminent scientists, engineers, and selected experts from many fields were organized into panels for the 1967 half of the program. These panels, augmented by approximately 100 consultants from government, industry, and universities, dealt with 10 areas of investigation: meteorology, hydrology, oceanography, forestry-agriculture-geography, geology, geodesy, cartography, point-to-point communications, broadcasting, and navigation-traffic control.

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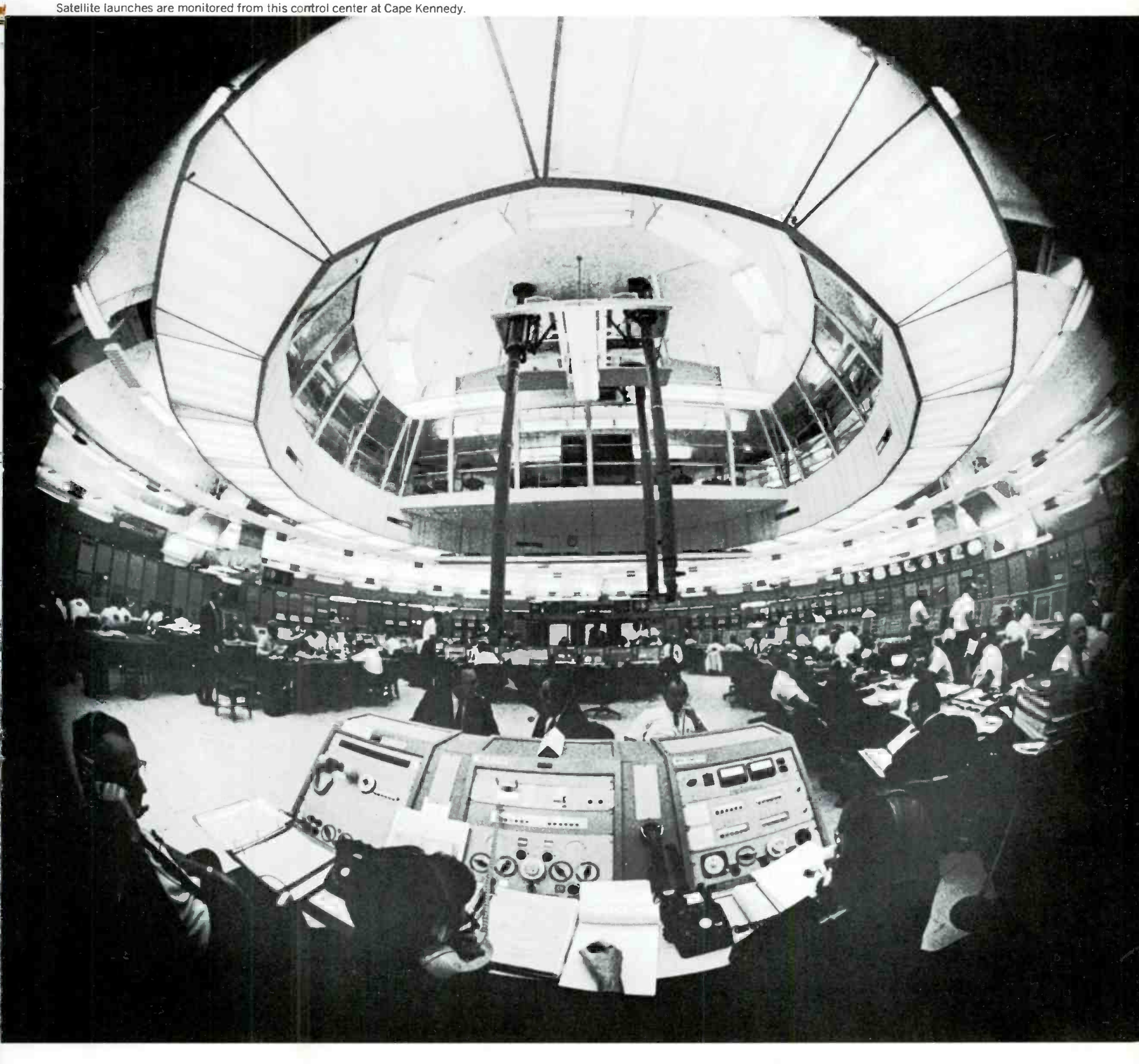
Nearly every major institution of higher learning in the nation was represented by panel members as were leading "new technology" companies such as RCA, IBM, AT&T, and General Electric. NASA, the Departments of Agriculture, Interior, and State along with institutions such as the Rand Corporation, Aerospace Corporation, Carnegie Corporation, and even chemical and insurance companies also participated.

Using the work of the panels as a basis, a Central Review Committee drew up a series of recommendations and conclusions that summarize the 1967 effort. The first general conclusion is "that the potential economic benefits to our society from space systems are enormous. They may amount to billions of dollars per year to many diverse elements of our industry and commerce and thus to the public." The Review Committee also recommended an intensive program of research, development, and engineering to achieve the large benefits that satellites can provide and that the $100-million NASA budget for practical space programs be doubled in the next fiscal year.

"The possible uses of satellites for earth-resource management and communication applications should be pursued not only within the United States but also internationally," the Committee further recommended. "Possible patterns for international cooperation in satellite-application systems should be explored by those experienced in the international arena. The National Academy of Sciences should strongly emphasize the international aspects of space applications in the 1968 continuation of this study."

The Committee's study was made against a background of considerable practical experience that had been gained from satellites built and launched by the United States. Weather, communications, and navigation satellites already are performing useful tasks in space. They afford new and better ways of doing things on earth with considerable savings in time and money. Weather and communications satellites, in particular, have become a permanent part of our way of life.

Satellite launches are monitored from this control center at Cape Kennedy.



Future weather satellites will make significant contributions to long-range forecasting. Equipped with lasers, infrared, and ultraviolet sensors in addition to TV cameras, they will provide continuous information about our atmosphere which, when combined with ground observations, will enable meteorologists to predict the weather for several weeks in advance. The National Academy of Sciences/National Research Council has recently estimated that improved long-range forecasting would result in an annual savings of $2 billion in operating costs to U.S. farmers, fuel producers, public utilities, builders, and water companies. The effect on the world's developing nations would be incalculable.

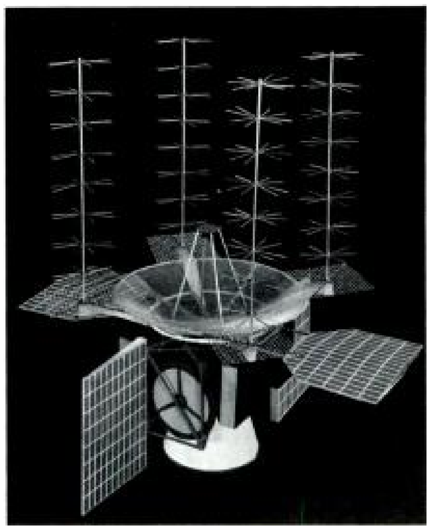
Also capable of making a substantial contribution to economic development would be a system of navigation satellites to serve both commercial shipping and air transport. Currently, the U.S. Navy operates the world's only navigation satellite system. Recently, receiving equipment was released by the government so that commercial ship operators may take advantage of the Navy's navigation satellites.

The Navy system has three principal elements: ground tracking stations, shipboard receivers, and the satellites. The ground stations program and control a "constellation" of four satellites, with one of these stations computing the projected path of each satellite. These data, sent to the satellite, are stored aboard and broadcast back to earth every two minutes. As the satellite passes over a ship, the broadcast signal is picked up by the ship's special radio receiver and associated computer. The change in frequency of the signal from the moving satellite (called a Doppler shift) is observed on the ship and measured. Broadcast with the satellite's position, the signal and its measurement are fed to the computer which then calculates the ship's position on the ocean to an accuracy of about 600 feet.

Navy navigation satellites provide ship position information with greater accuracy than can be obtained from any other navigation system. The system is immune to the weather and so efficient that commercial ship owners can realize important savings in operating costs and ship utilization by lessening the time required for ocean crossings. Other potential users of the Navy system are offshore oil exploration companies, fishing fleets, oceanographic researchers, salvage companies, cable-laying and repair ships, buoy tenders, and deep-sea yachtsmen.

Improvements to the existing navigation satellite system are projected in studies being made by the Navy, the Applied Physics Laboratory of Johns Hopkins University, and RCA, which is building the satellites. Improved satellites and receiving equipment, for example, could make possible over-ocean air traffic control and more accurate aircraft navigation. An industry study for NASA has shown that for aircraft operations the potential savings would range from $33 million to $84 million a year with the use of an optimized navigation satellite system. In addition, the safety and search and rescue functions of such a system would minimize to a degree never before possible the hazards to human life inherent in long-distance travel.

Communications satellites, the most commonplace of applications satellites, transmit television, telephone, and data messages over transoceanic distances. A communications satellite operates like a shortstop taking a throw from the outfield and relaying it to home plate. Instead of a baseball, it "catches" a microwave signal, amplifies it, and "throws" it to a receiver.



A model of an advanced communications satellite.

There are three types of communications satellites in use today: those of the military, NASA experimental spacecraft, and the commercial satellites of the International Telecommunications Satellite consortium (Intelsat). The Communications Satellite Corporation, a U.S. company founded by an act of Congress, is the manager and operator of the commercial satellite system. Regularly operating satellites are Syncom II and III, Early Bird, the Intelsat 2 series, the IDSCP (Initial Defense Satellite Communications Program) satellites, and NASA's Applications Technology Satellites.

Early Bird, referred to as "Public Satellite No. 1," is in stationary orbit over the Atlantic. The Intelsat 2 satellites, larger than Early Bird, were launched last year. Three are now in commercial service, one over the Atlantic and two over the Pacific. Intelsat 3, a global network of four satellites, is scheduled for launch during 1968.

The NASA Applications Technology Satellites are directed toward the development of experiments and concepts in meteorology, communications, and spacecraft technology. Two of the three in orbit have performed a number of communications experiments. Weather maps have been sent to small ground stations in the United States, Japan, and Australia. Two-way VHF voice communication between a ground station and aircraft in flight has been demonstrated. Experimental directional antennas have been tested, and simultaneous voice communications have been transmitted between several ground stations. In addition, one of the ATS satellites is taking high-resolution color photos of the earth for meteorologists and has performed a number of navigation experiments. In the future, NASA will provide the services of a versatile ATS satellite for an experiment in educational TV transmission for the government of India.

On the horizon are more powerful communications satellites which, space scientists say, could broadcast TV programs directly to the home. A number of studies by RCA, General Electric, and others have indicated the technical feasibility of direct broadcast satellites. However, their economic value is

"There is no lack of enthusiasm nor of ideas concerning the use of applications satellites for the improvement of living conditions. The problems that still seek solution, however, are not in space but on the ground."

still a matter of discussion. Some communications experts, such as Dr. S. W. Spaulding of RCA, believe a satellite that distributes TV programs to local network stations will precede a direct broadcast satellite.

For the developing nations, a national domestic satellite or a regional satellite shared by nations with a common language would stimulate economic growth and help to raise living standards. At a meeting of the American chiefs of state in Punta del Este, Uruguay, in April, 1967, President Lyndon B. Johnson proposed such a program for the Latin-American nations. The plan adopted by the chiefs of state called for economic integration of Latin America through a vigorous and sustained effort to modernize the physical plant, equipment, and communications structure of the region. A communications satellite network to provide continent-wide TV and telephone service is to be investigated as part of this program. The underlying premise is that economic growth, such as the United States has experienced, is based on communications.

In the early 1970s, a new spacecraft, the Earth Resources Observation Satellite, will be orbited. Although an accurate study of all the potential economic benefits of such a satellite has not been made, there is general agreement that the benefits will exceed those of all other satellites combined. One $5-million EROS satellite, for example, could map land areas of the entire earth in less than a year. By comparison, it has been estimated by the government that more than $1 billion is spent each year to map small areas of the earth by aerial surveys.

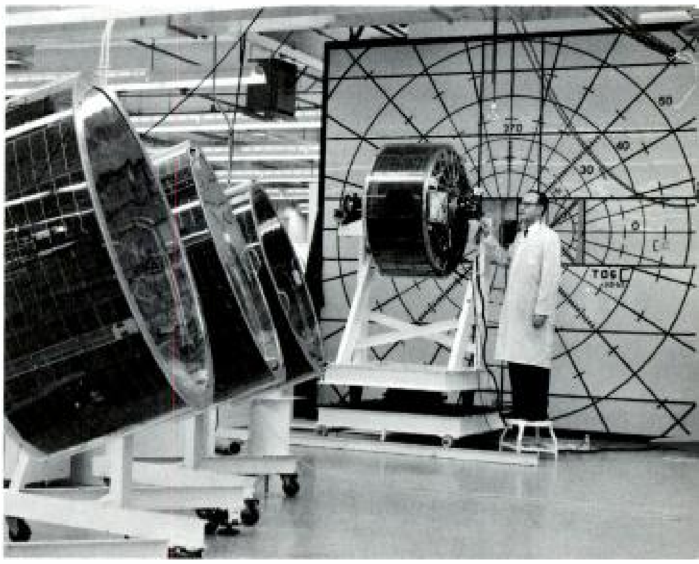
The newest ATS, which is now taking color pictures of the earth.

There is no lack of enthusiasm nor of ideas concerning the use of applications satellites for the improvement of living conditions. Space technology has made it possible to use all of the satellites collectively as tools for this purpose. The problems that still seek solution, however, are not in space but on the ground.

The ground problems are those of societies and cultures, government and law. They involve national economies and national pride. They cannot be resolved by physical scientists nor can they be resolved without the contributions of physical scientists. One answer may be found in a provocative suggestion made by Alvin M. Wenberg, director of the Oak Ridge National Laboratory. He advocates the establishment of "national socio-technological institutes" staffed with social and physical scientists. They would "home in" on the great social problems of our age, working in a daily give-and-take, exchanging views, and bringing to bear their expertise so as to produce a synergistic effect. "Above all, the institutes would have a coherence in their attacks on these profoundly difficult questions," he says.

Another suggestion has been put forth by RCA and is called the Technation concept. This calls for the orderly direction of human and natural resources through the systems management technique of the aerospace industry, but applied to the economic and social structure of a developing nation. Applications satellites would have a major role in such a program.

In the final analysis, effective action and results will depend upon the translation of human energy into organized work to achieve clear-cut goals. If men can build the complex satellites, then they certainly ought to be capable of solving the ground problems. The cooperative efforts of literally thousands of individuals go into the construction of a satellite. With similar cooperative effort on the ground, the satellite truly can become a tool for economic growth. ■



TIROS weather satellites, shown at RCA's Astro-Electronics Division. The satellites transmit continuous pictures of the earth for analysis by meteorologists.

Upward Bound at Keystone

The economic prospects and the self-images of hundreds of young women are being elevated through intensive vocational training at the Keystone Job Corps Center in Pennsylvania.

by Robert E. Tolles

Officials at the Keystone Job Corps Center for Women near Hazelton, Pa., were somewhat apprehensive when they said good-by to 460 Corpswomen bound for a three-week Christmas vacation and their first extended stay away from the Center since its opening in March, 1967. The question nagging them was how many of the young women from deprived backgrounds would not return when classes were resumed at the Center after the holidays.

"Realistically, I suppose we could have expected a 10 per cent dropout," said Joseph R. Corcoran, Center director. "Back in their home environments, the girls would again be subjected to family pressures and the temptations and distractions that marked their lives before coming here. These are powerful influences, and we just couldn't be sure how much of the Center program had rubbed off on them in the few months they had been here."

The officials need not have worried. They lost a few girls, but, by January 10, more than 95 per cent had either returned or had called to ask for a few days' extension. In fact, the question of dropping out was remote for many of them. "I knew I needed more help so I had to come back," said a young Corpswoman from Virginia.

The passage of the Christmas vacation shoals was but another in what has been until now, at least, an untroubled voyage for Keystone. The dropout rate of 4.5 per cent is one of the lowest of the more than 100 Job Corps centers in the country. A number of graduates, some 32 to date, have gone on to well-paid jobs in private industry. One girl who spent six months at the Center is now working for IBM at $125 a week. This past January, 15 girls had advanced sufficiently to take their College Board examinations. And although some of the girls have minor police records and others are unwed mothers, there has not been a single arrest and only a few incidents have required disciplinary action in 10 months of Center operation.

The reasons for this success are varied. It is partly due to the quality of the staff that was recruited after the RCA Service Company was awarded a $3.1-million contract by the Office of Economic Opportunity to run the Center in July of 1966. It is also due to the educational program, which is designed to remedy the girls' educational deficiencies as well as give them a marketable vocational skill. But most of all, it is due to the spirit of the girls themselves, who realize that this is perhaps their last opportunity to break out of an environment that might otherwise condemn them to lives of poverty, ugliness, and despair.

ROBERT E. TOLLES is on the RCA Public Affairs staff.

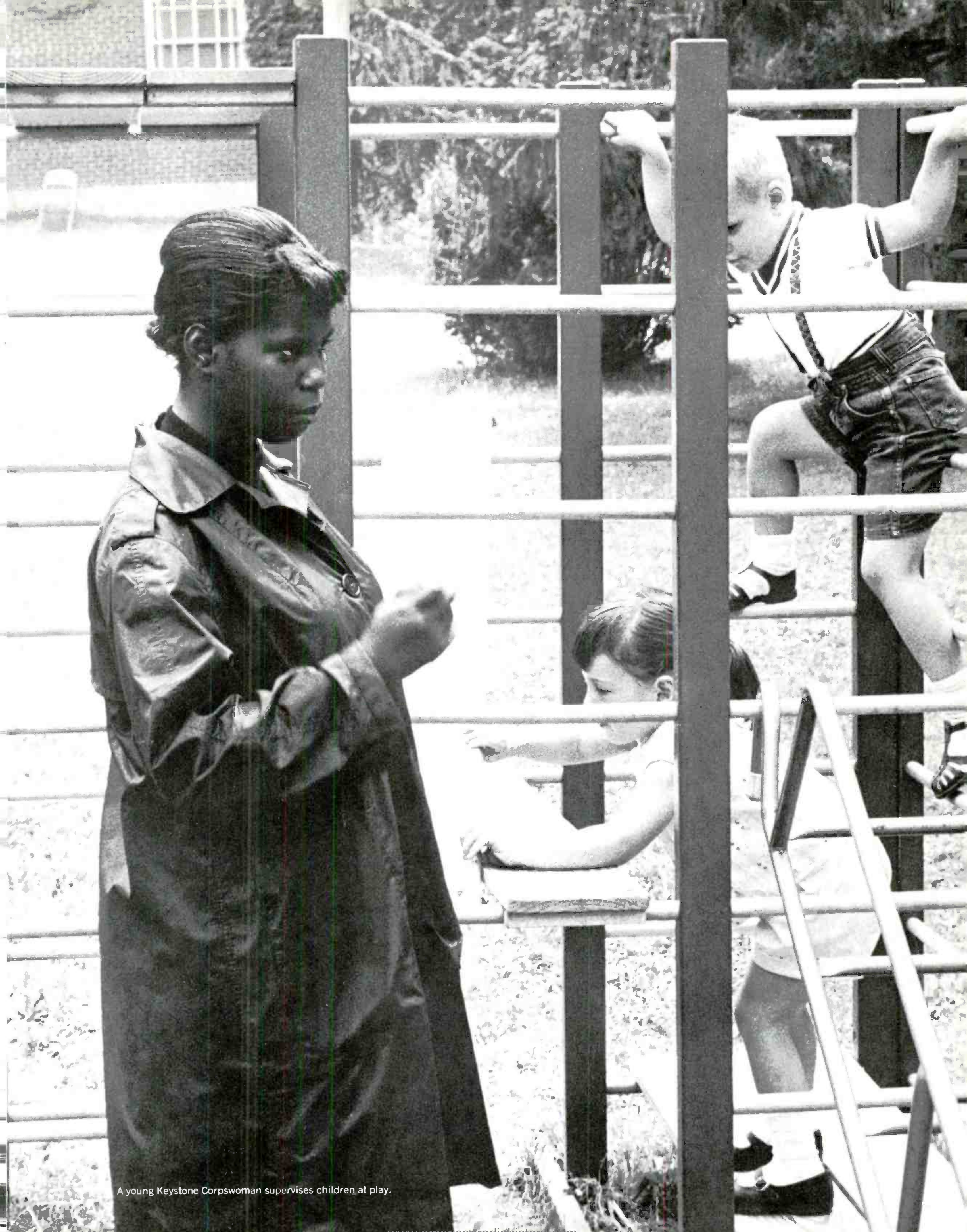
This spirit is evidenced in a number of ways. It can be seen, for instance, in a Negro girl from a Harlem ghetto walking arm in arm and chatting gaily with a white girl from a rural community in Tennessee. Or it can be seen in the eyes of Lillian Randolph, a 19-year-old girl from Newark, N.J., as she describes how her life has been given new meaning in working with retarded children in Hazelton.

Or it can be seen in a project that involved the 56 Corpswomen in Washington Dormitory, one of the campus-like living quarters that dot the spacious Keystone site. A few months ago, the Washington girls decided they would like to have a wall-to-wall carpet to dress up their downstairs recreation room. They successively held a car wash, a baked-goods sale, and a bazaar to earn enough money for a $100 down payment on a $480 carpet. Washington is now the envy of Keystone's 10 other dormitories.

Corcoran describes in this way the special *esprit* that pervades Keystone: "Many of our girls arrive here with a sense of hopelessness and frustration. In one way or another, their homes, their schools, and their communities have let them down. Very few have had any real success at anything they've tried. Their first reaction when they get here is to ask, 'Is this for real?' They find it hard to believe that the sole purpose of Keystone is to help them. Once they are convinced of our sincerity and once this hopelessness has been relieved, they respond beautifully."

Nationwide, more than 40,000 young men and women are in training with the Job Corps, although this number will be reduced by 6,000 because of cuts and reallocations in the OEO budget. The centers, of which 15 are for women, are operated under contracts with business firms, universities, and educational and social service agencies.

There is no standard profile for a Keystone girl, but a number of elements appear frequently in their backgrounds. Ranging in age from 16 to 21, they usually have less than a high-school education and have shown an inability to hold even menial jobs. They come from 32 eastern and southern states, Puerto Rico, and the Virgin Islands. Fathers are not present in many of the families, and the mothers are usually employed in low-income jobs or are on public welfare. They frequently share bedrooms with several other children and have never had a physical or dental examination. Although they are average in intelligence, they exhibit verbal and mathematical skills several years below their age levels.



A young Keystone Corpswoman supervises children at play.

The most important "attitudinal" objective of the Keystone program is to raise the poor self-image that troubles many of the girls. This is done through frequent counseling, through testing to identify their interests and talents, and through the maintenance of an environment of helpfulness, kindliness, and sincerity. Self-expression is encouraged through individual and group sessions with the Center's 10 counselors and one psychologist. Resident advisors live in the dormitories to provide off-hour guidance and to act as models for the attitudes and standards the Center seeks to instill.

Among these standards are such basic ones as not being late to classes, neatness and cleanliness, proper speech, and respect for others. The Corpswomen themselves assume much of the responsibility for maintaining the proper disciplinary environment. A code of conduct, proposed and adopted by the Center Student Council, lists seven rules of behavior and appearance that range from not smoking while walking in public to a prohibition against wearing mini-skirts or slacks to class. Corcoran says he has not heard a single curse word since the opening of the Center.

Living up to a rigid code of conduct generates pride in the girls—and great disappointment when they suffer momentary backsliding. The Center posts a weekly honor roll of Corpswomen who have displayed exemplary behavior, and some have cried when their names were not listed. The pride of being a successful Corpswoman is shared by the parents, as well. "My mom was so proud of me," said Kathy Berry, 18, of Bath, Me., after she returned from Christmas vacation, "that I didn't mind washing the dishes at all."

The prime educational goal of the Center is to prepare the girls for the world of work. Toward this end, the Corpswomen attend classes for six hours a day in secretarial training, data processing, sales training, design arts and drafting, nurses-aide training, electronic assembly, and banking procedures. These courses are sampled during a three-week orientation period after a girl arrives, but then she is expected to concentrate on those that most closely suit her talents and interests.

The physical setting of Keystone is conducive to learning. It occupies some 175 acres of rolling northeastern Pennsylvania countryside 22 miles south of Wilkes-Barre and was once a correctional institution for boys. Facilities are ample and include an administration building, a gymnasium-auditorium, recreation hall, student store, cafeteria, post office, an infirmary, a swimming pool, and athletic fields.

The training is intensive, and a girl is encouraged to go as far as her potential will take her. This potential can be considerable. Some girls have already been identified as college material. In the data processing course, instructor Joseph Lescavage believes that 10 per cent of his students show sufficient analytical ability to warrant training in computer programming.

The girls also receive instruction in reading, writing, mathematics, and other academic subjects so that they may, if they are able, take a high-school equivalency examination on graduation. A third aspect of the Keystone program, besides the vocational and academic, is what Center personnel call social adjustment; this involves training in personal grooming, good manners, and poise. Music, dancing, arts and crafts, and sports complete the instructional program.

Corpswomen are selected by screening committees in their home communities, and they remain at the Center for as long as their counselors and instructors feel they will benefit. For a few, this period may be quite brief. However, the majority will spend at least a year and, in some cases, two years before they return home. A girl may leave voluntarily at any time.

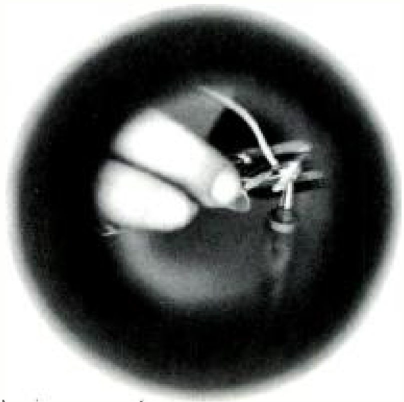
A delicate problem for any Job Corps Center is its relationship to the surrounding community. A particular problem posed by Hazelton, when the site was under consideration, was that only one Negro family resided in the town. A majority of the Keystone girls and a substantial portion of the staff, who would reside in the town, would be Negro.

The problem vanished, however, with an unusual demonstration of good will. Liaison was quickly established with the constructive forces in the community. An 18-member Keystone Community Relations Council, representing the area's religious, legal, medical, political, and service organizations, was formed to advise the Center on methods of avoiding conflict with the community. The Hazelton YWCA has thrown open its facilities to the Corpswomen. The Center drill team marches in line with the Boy and Girl Scouts and school groups in community parades. The Center chorus has been invited to sing before community groups in Hazelton and surrounding towns. Girls participate in young people's activities sponsored by church groups and visit in area homes.

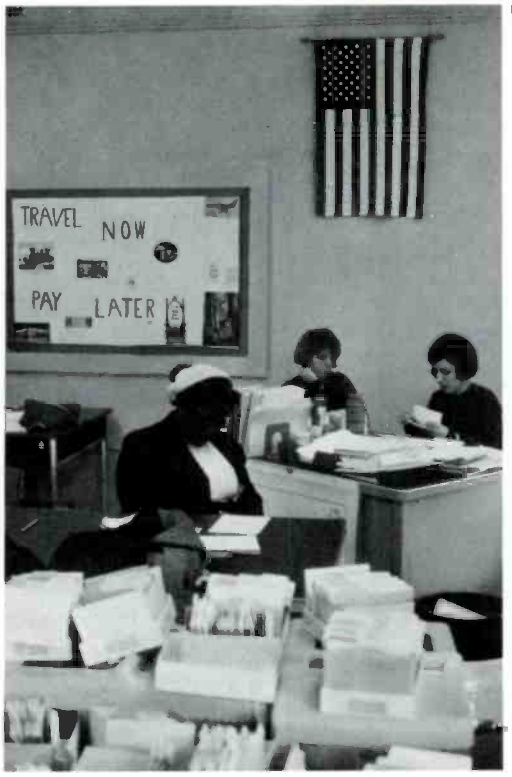
To acquaint the community with the objectives of the Center, a constant speaking schedule is maintained by Corcoran and other members of the staff, especially Frank Pataki, the Center's community relations specialist and a 27-year veteran of the Pennsylvania State Police. He has set up an "early warning" system with local stores and places of public congregation to call the Center if trouble involving any of the girls starts to brew. Fiercely loyal to his charges, Pataki says that "these girls are not delinquents; they just have had more than their share of bad breaks."

Corpswomen are permitted to have dates, and from time to time visits are exchanged with the Corpsmen at Camp Kilmer in New Jersey. It is made clear, however, that the girls are to be treated with respect. Once, a young man wearing a T-shirt drove up in a dirty car for a date with a girl. He was sent home to wash his car and put on a shirt and tie.

Keystone officials do not deny that their program is costly, nor do they claim they can achieve results quickly and effortlessly. To maintain a Corpswoman requires $5,600 a year or, as some critical Congressmen have said, more than the cost of a Harvard education. The Job Corps points out, however, that the cost to society of maintaining a person on welfare for a normal 40-year working span is $100,000.



Training includes wiring of electronic components.



Instruction includes training in office procedures.

A class in homemaking.

A group of Corpswomen receive instruction in knitting.

"To maintain a Corpswoman requires $5,600 a year, or more than the cost of a Harvard education. The cost to society of maintaining that person on public welfare, however, would be $100,000 over a normal 40-year working span."

Much of the cost of maintaining a Corpswoman goes toward staff salaries. Keystone has 170 professional and nonprofessional personnel; the ratio of students to instructors is 10 to 1. A Corpswoman also receives a salary of $30 a month plus $50 a month readjustment allowance that is held in escrow until she leaves the Center.

Staff is selected as much for its missionary spirit as its professional competence. Corcoran looks for a genuine concern and sympathy for others in applicants and warns that, if they look upon the work as just another job or place their personal convenience above the interests of the girls, they do not belong at Keystone. "The girls are number one here," he says.

Corcoran first came to Keystone to organize the community relations program and then took over the directorship when Dr. William A. Shine resigned to become superintendent of schools of Burlington County, N.J. Although he considers himself primarily a businessman—his major experience during 12 years with the RCA Service Company was in governmental marketing—he came to Keystone in order to satisfy a long-standing desire to engage in direct social action. "Years from now, I know I will consider it a high point of my working career."

"Many of our girls arrive here with a sense of frustration. Very few have had any real success at anything they've tried. In one way or another, their homes, their schools, and their communities have let them down."

Representative of the resident advisors is Joan Shingles, a comely, former elementary-school teacher who was recruited after a picture describing her as one of the most eligible "bachelorettes" in Buffalo, N.Y., appeared in *Ebony* magazine. "Your hours never end here, but it has been the most exhilarating experience in my life."

Among others on the staff are a former superintendent of vocational instruction in a large New Jersey city, a former Peace Corps volunteer who served in Ethiopia, and a minister who took a leave of absence from his suburban congregation because he felt he wasn't making a sufficient contribution to the elimination of poverty.

Pataki describes in this way the tug that Keystone exerts: "When I come home late for supper, my wife sometimes asks why I spend such long hours on the job. I tell her that I've been working, but then again maybe it isn't work. This place sort of grows on you after a while."

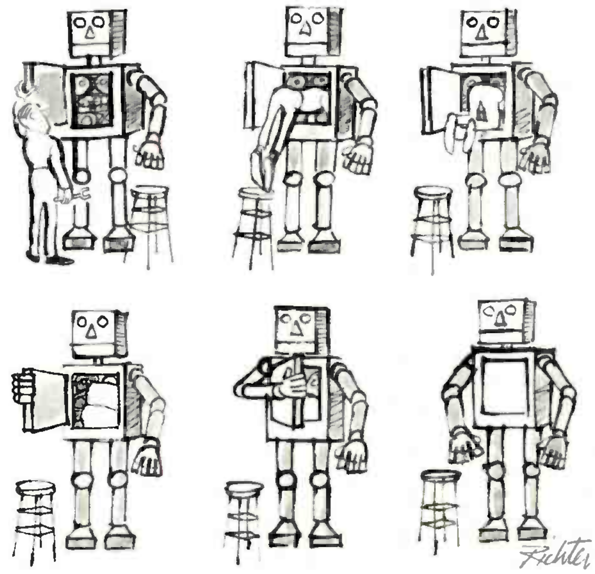
Such comments describe only in part the spirit of Keystone. The girls themselves are the most eloquent spokesmen for their experience. Linda McMillian is an 18-year-old Corpswoman from Nashville, Tenn., with a taste and talent for poetry. She wrote this verse, entitled "The Soul," for the *Keystone Courier*, an eight-page newspaper that the girls write and print themselves.

"God given!
Mysterious
Lovely-ugly
Destroyed
Reproduced—

"Yet—
Individual—never static
A glory in itself
Only God given." ■

This Electronic Age...

"I don't mind the close-up lens,
but this is going too far!"



"Ooooh? I thought you said
'a life of *computation!*'"

"Air! Air!"

Weather and Climate

Accurate weather prediction for periods of up to three weeks is the far-reaching goal of a global atmospheric research program.

by Lowell Krawitz

For many years, meteorologists have known that the number of factors that need to be dealt with in producing a weather forecast depend on the period for which the forecast is made. Predicting the weather for a short period, say 12 to 24 hours, is a relatively simple matter. The forecast will be mostly determined by observations of existing atmospheric conditions taken over a specified area, for instance, all of North America. It can be assumed that there will be no large-scale changes of energy in the atmosphere, and what is there at the start will simply be redistributed.

The task of weather prediction becomes increasingly difficult as the length of the forecast period is extended. For forecasts of one to two days, the internal atmospheric processes that result in the creation and dissipation of energy are no longer negligible. Observations must be made over a much wider area, at least half a hemisphere.

LOWELL KRAWITZ is a meteorologist on the staff of RCA's Astro-Electronics Division.

For predictions covering longer periods of time, the meteorologist's data needs are greatly increased. He must know atmospheric conditions not only over continental land masses and over the oceans but the state of the ocean circulations themselves. Full global observations of the atmosphere up to at least 100,000 feet and of the oceans to depths of approximately 100 meters are necessary. If such comprehensive observations could then be combined with a full understanding of all the dynamic, thermodynamic, and physical processes of the atmosphere and oceans, it is theoretically possible to predict the weather for periods up to three weeks.

To achieve this goal is an enormously difficult and costly undertaking, but the nations of the world have decided to take the preliminary steps toward its realization. At its Fifth Congress in Geneva in the spring of 1967, the World Meteorological Organization, a specialized agency of the United Nations, agreed to proceed with implementation of the World Weather Program during its 1968–1971 budgetary period. This program will probably be the most dramatic and far-reaching development in the history of the atmospheric sciences.

If the achievement of long-range weather prediction is an enormously complex task, the advantages that will accrue from this effort are also enormous. Dr. Glenn T. Seaborg, chairman of the Atomic Energy Commission, has estimated that the ability to forecast accurately the weather over all the earth for *three* days in advance would be worth $60 billion each year to all the peoples of the world—quite apart from the human lives saved and human suffering avoided.

Provided with an accurate three-week forecast, farmers could easily schedule seeding and harvesting so as to minimize the loss of crops to adverse weather conditions. Power companies could take full advantage of available water supplies for the generation of electrical power, confident that safe water levels would be maintained in reserve. Optimum routes for transoceanic sailings could be planned well in advance to assure minimum passenger discomfort and minimum damage to ships and cargoes. Airline companies could essentially eliminate the costly and troublesome problems of diverted passenger flights. Businessmen could anticipate unusual local demands for specific "weather sensitive" products, such as antifreeze or umbrellas, while construction companies could adjust work schedules to take full advantage of suitable working conditions and minimize the cost of labor and material losses.

All property damage from severe weather phenomena would not be avoided. Hurricanes, tornadoes, lightning, and floods will always be damaging. But certain adequate preventative measures could greatly reduce property damage and restrict the loss of human life.

The problem of forecasting the weather that will occur at a given time or place is one of first determining what the present weather conditions are, and second, properly evaluating the myriad of dynamic, thermodynamic, and physical processes whose integrated effects, infinite in variety, determine specific weather events.

The second task is by far more difficult. The daily patterns of wind and weather that are experienced over the earth, and, in the long term, the variations of the climate over the earth, are a reflection of the general circulation, i.e., the large-scale pattern of winds throughout the atmosphere. The general circulation, in turn, is the result of many complex processes within the atmosphere and of the interactions of the atmosphere with the surface of the continents and oceans and of the circulations within the oceans themselves. None of these processes is very well understood by meteorologists.

In general terms, it is known that solar energy impinges on the outer reaches of the atmosphere and is absorbed, reflected, or transmitted by the various constituents of the atmosphere. Sunlight reaching the lower atmosphere is also reflected, transmitted, or absorbed by the different types of clouds and further reflected or absorbed at the earth's surface, in a manner contingent upon the nature of the surface.

Some of the solar energy received at the earth's surface serves to evaporate water into the atmosphere. Together with the atmosphere's carbon dioxide, water vapor represents the principal absorber of the energy reradiated by the earth. It is by this mechanism that the amosphere "captures" the bulk of the energy needed to drive its circulations.

The balance between incoming solar energy and energy reradiated by the earth is such that equatorial regions receive more energy than they lose while polar regions lose more than they receive. If this pattern of excesses and deficits of radiant energy persisted for any length of time without any compensating mechanism, the equatorial regions would become progressively warmer until the oceans boiled while the polar regions would become progressively colder until they froze solid. The compensating mechanisms are the atmospheric and ocean circulations, which transport heat away from the equator and into the polar regions.

As air begins to move toward the poles, it is deflected by the rotation of the earth and disrupted by the distribution of land and water. Over the oceans, which comprise about 71 per cent of the earth's surface, the air is heated or cooled from below, water is evaporated into the air or rain falls back into the ocean, and the winds stir up surface waves and drive the surface currents of the ocean—a continual exchange of energy, mass, and momentum. Over the continents, there are similar complex air-surface interactions. Air is deflected by or forced over mountain ranges, heated and cooled from below, and water added or taken away according to the nature of the terrain and the occurrence of evaporation or precipitation. All of these factors influence the generation and dissipation of storm and cloud systems, which act to redistribute water vapor and heat throughout the lower atmosphere. These systems, in turn, influence the radiational energy balance of the earth and atmosphere that is the basic driving force of the global wind systems. So the circle of influences is completed and proceeds to repeat itself, although never is the sequence of events and interactions quite the same.

A comprehensive program of fundamental research on the general circulation of the atmosphere is one of the key elements of the World Weather Program. These theoretical studies, grouped under the title of the Global Atmospheric Research Program (GARP), will be directed toward the development of physical/numerical models that will simulate the complex interactions of the atmosphere. With these models, scientists will be able to consider large-scale weather and climate modification.

Computer experiments have already shown that major circulation disturbances propagate throughout the entire atmosphere. The alteration of the surface boundary conditions at some point on the earth that could result in a change of climate in that location would have widespread effects throughout the world. Thus, given a valid mathematical model of the general circulation, scientists could calculate the total effects on the climate everywhere on earth resulting from an intentional alteration of the character of the earth's surface in a specific region.

For example, it has long been proposed, by virtue of their engineering feasibility, that the cold ocean current off the west coast of North America be eliminated by erecting a dam across the Bering Straits or that a huge lake be created in Central Siberia as a means of ameliorating the climate there. At this point in time, meteorologists could not determine whether such an alteration of the surface boundary conditions of the atmosphere would be beneficial or detrimental to the climate elsewhere on earth, or, for that matter, where the major impact of these changes would be felt. As such, it would be the epitome of irresponsible action for any nation to conduct such experiments before a full theoretical explanation for general circulation is derived.

To provide the theoreticians with the data they need to conduct their computer experiments, GARP will include a series of major data-gathering efforts. The first of these—the Barbados Oceanographic and Meteorological Experiment (BOMEX)—will be carried out in the summer of 1969 over an area of the South Atlantic east of Barbados. This experiment will involve measurements of the ocean and the free atmosphere and will utilize a concentration of men, ships, planes, conventional weather observation tools, as well as meteorological observation satellites and other specialized instruments. The results of this and other field experiments will provide theoreticians with the bulk of the data they need to accomplish the research goals of GARP.

The other key element of the World Weather Program is the World Weather Watch, described by Dr. Richard Hallgren, director of the Office of World Weather Systems of the Environmental Sciences and Services Administration, as "an international system to regularly observe the global atmosphere, to communicate and process the data quickly and effectively, and to disseminate the results to the nations of the world."

The Watch is an operational system whose function will be to provide existing World Meteorological Centers in Washington, Moscow, and Melbourne with full global observations of the atmosphere up to 100,000 feet. Global weather analysis and forecast charts will be produced at the centers and disseminated to all the weather services of the world. Various steps will be taken to improve weather coverage. The existing network of observation stations that use balloons to sound the upper atmosphere will be expanded. The number of ocean station vessels—ships that remain at a fixed location to make weather observations—will be increased. Weather observers and upper air sounding instruments will be placed on board selected merchant ships and observations periodically made while the ships ply their normal commercial routes. In addition, the Environmental Survey Satellites (known as ESSA satellites) will continue to provide global cloud-cover pictures and infrared data.

Although it is an operating system, the World Weather Watch will not, by any means, be static and unchanging. The World Weather Program provides for the evolutionary growth and improvement of the Watch through a major and continuing effort of technological development. This effort will span the spectrum of needs, including new observation devices and platforms, new communication tools and techniques, as well as new computers and computer models for analysis and prediction.

Technological development is now well underway. The United States is actively developing new sensors with the capability of measuring remotely from orbiting satellites the vertical distribution of temperature, humidity, and ozone in the atmosphere. Many of these new sensors will be tested on flights of the Nimbus weather satellites this year and next.

A system for using horizontal sounding balloons for obtaining upper-air measurements is under development at the National Center for Atmospheric Research in Boulder, Colo. This system employs small constant-volume balloons, which drift with the winds at essentially a constant altitude above the earth. Systems for tracking and interrogating these balloons from satellites are being developed.

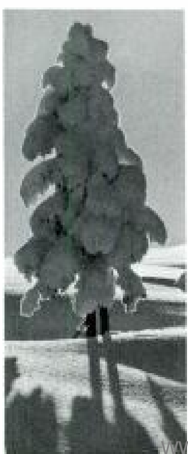
In both the United States and England, automatic weather stations are under development for use in remote or inaccessible continental areas. Several nations, including the United States, are continuing to work on the development of small, long-life, economical buoys that will be capable of providing surface weather observations and oceanographic data outside the well-traveled shipping routes. Both the automatic weather stations and the meteorological buoys will also be capable of being interrogated from satellites.

The United States is also well along toward the realization of communications satellites for the global relay of meteorological observations and weather analyses and forecasts. The development of more powerful digital computers to handle the increasing amount of data and of more complex and sophisticated atmospheric models for weather analysis and prediction is also underway in this country.

Beyond the technical complexities is an array of political and economic problems that will make implementation of the World Weather Program even more difficult. The operational and research aspects of the program will require a concerted effort throughout the world to train the technical manpower to operate the World Weather Watch and the scientists and engineers necessary to produce the new observation tools, the new computers, and the new scientific concepts and theories.

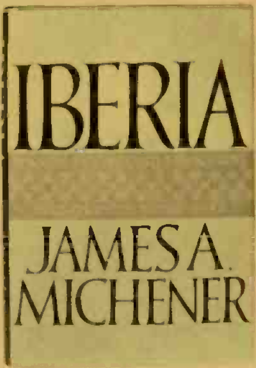
Moreover, the costs, complexity, and global nature of the World Weather Program preclude its execution by one nation alone. The accomplishment of its objectives will require a level of international cooperation unparalleled in the history of mankind. Its success will bring not only such benefits as long-range weather forecasts and some degree of climate modification but could very well introduce a "golden age" in international relations.

The benefits of the World Weather Program are great; the objectives are clear. It remains for the nations of the world to apply the astounding technological accomplishments of our age to this purpose. ■



"Given a valid mathematical model of the general circulation of the atmosphere, scientists could calculate the total effects on the climate everywhere on earth resulting from an intentional alteration of the character of the earth's surface."

Books at Random...

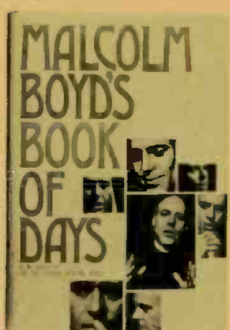


IBERIA: SPANISH TRAVELS AND REFLECTIONS
by James A. Michener
(Random House)

Described by the author as "a nineteenth-century English travel book with much personal observation, much reflection, and much affection," this volume includes a wealth of information about Spain. Discussed are its history, development, and the characteristics of its people; its government and politics—past, present, and future; its religion and the problems connected with it; architecture, sculpture, and painting; music and dance; literature; food; entertainment and sports; and bullfighting, including the great toreadors of yesterday and today. Each of 10 chapters centers on one city, with numerous side trips. There are chapters on The Bulls and on the great wildlife preserve, Las Marismas. The book is illustrated with about 150 photographs by Robert Vavra and with maps.

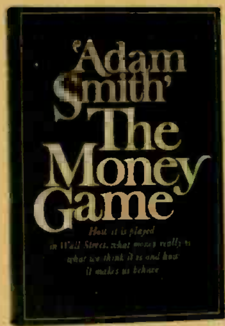
HEAVEN HELP US!
by Herbert Tarr
(Random House)

Herbert Tarr's new novel is about a young rabbi, Gideon Abel (26 and still unmarried), and his adventures with his first congregation. Determined to show his new flock the way to religion, he finds they are more interested in such non-religious events as the temple musical comedy and fund-raising for a new kitchen. The comic battle lines are drawn between the parishioners and Gideon, who is always insecure in the knowledge that they can fire him at the end of the year. Rabbi Tarr is also the author of *The Conversion of Chaplain Cohen.*



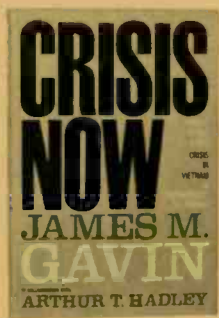
MALCOLM BOYD'S BOOK OF DAYS
by Malcolm Boyd
(Random House)

Malcolm Boyd, author of *Are You Running with Me, Jesus?* and *Free to Live, Free to Die!*, is one of today's best-known religious figures. This volume is a modern version of the traditional thought-a-day book. For these prayers, meditations, quotations, and commentaries, he has chosen such timely subjects as the underground church, Vietnam, civil rights, and religious hypocrisy. Father Boyd's new book speaks eloquently of his beliefs that there is no separation between "sacred" and "secular" and that the church must break the shackles of formal religion.



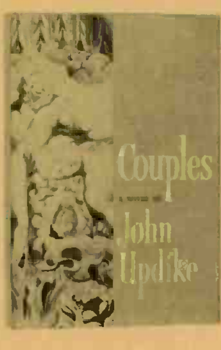
THE MONEY GAME
by 'Adam Smith'
(Random House)

"Adam Smith" has had a fanatical following among the professional money managers since his articles began appearing in the *New Yorker* magazine. In this book, he reveals how the money game really works and how investors get in on it. Mr. Smith fills "The Street" with such characters as the Gnome of Zurich, who is buying up the world's gold, and Poor Grenville, caught with $25 million in cash to invest. There are three parts to *The Money Game:* "You," which explains the market and what kind of people do well at it; "It," which examines various systems—and finds them wanting; "They," which portrays various operators and affords a glimpse of how the pros do it.



CRISIS NOW
by James M. Gavin
(Random House)

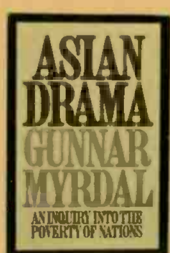
General Gavin, former chief of Army research and development who resigned his commission in 1958 in opposition to the Eisenhower Administration's policy of massive nuclear retaliation, is perhaps the foremost challenger of military and administrative thinking on Vietnam. In *Crisis Now*, Gavin argues why and how the United States should get out of Vietnam and presents a blueprint for a dramatic new war on the ills of domestic society.

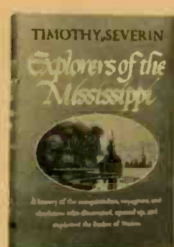


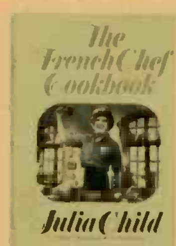
COUPLES
by John Updike
(Alfred A. Knopf)

John Updike's fifth novel concerns the relationships of 10 couples in an out-of-the-way New England community called Tarbox. The circle of acquaintances is felt as a magic circle, with ritual games, religious substitutions, a priest, and a scapegoat. The action runs from the spring of 1963 through the following spring. Mr. Updike is also author of *The Poorhouse Fair, Rabbit, Run, The Centaur*, and *Of the Farm.*

OTHER RECENT RANDOM HOUSE BOOKS







Space Hams

The modern-day counterpart of the radio amateurs of the early 1900s is the growing fraternity of hams who use makeshift equipment to receive pictures from space.

by Maurice M. Lewis, Jr.

Early in this century, fledgling radio amateurs fiddled with receiving sets made of such items as empty oatmeal boxes, curtain rods, and spent rifle shells. Hovering over their makeshift rigs to pluck faint signals from the airwaves, they were in the vanguard of a movement that has seen radio electronics bloom into a sophisticated science typified by worldwide communications and interplanetary space probes.

Yet, this progress has by no means stunted amateur pioneering. The modern-day counterpart of the radio hams of the early 1900s is the growing coterie of "space hams" in several countries of the world who use rolling pins, inexpensive electric motors, and similar makeshift gear to receive pictures of the earth from TV-equipped TIROS, ESSA, and Nimbus weather satellites orbiting hundreds of miles overhead.

MAURICE M. LEWIS, JR., is on the staff of the Philadelphia *Evening Bulletin*.

On a single pass of a satellite over the eastern United States, for example, space hams now receive pictures covering areas from northern Greenland to the Yucatan Peninsula in Mexico. Many of these amateur-produced space pictures contain startling detail, showing weather phenomena such as hurricanes and terrestrial features such as the St. Lawrence River, Long Island, and the Florida Peninsula.

The originator of this new space-age hobby is Wendell G. Anderson, a veteran radio amateur and an engineer on the staff of RCA Defense Electronic Products in Moorestown, N.J. Anderson received his first space pictures in the fall of 1964 on what he describes as "relatively crude equipment" hastily assembled in the basement of his split-level home in Moorestown. The photographs were good enough to spur him on to further experimentation.

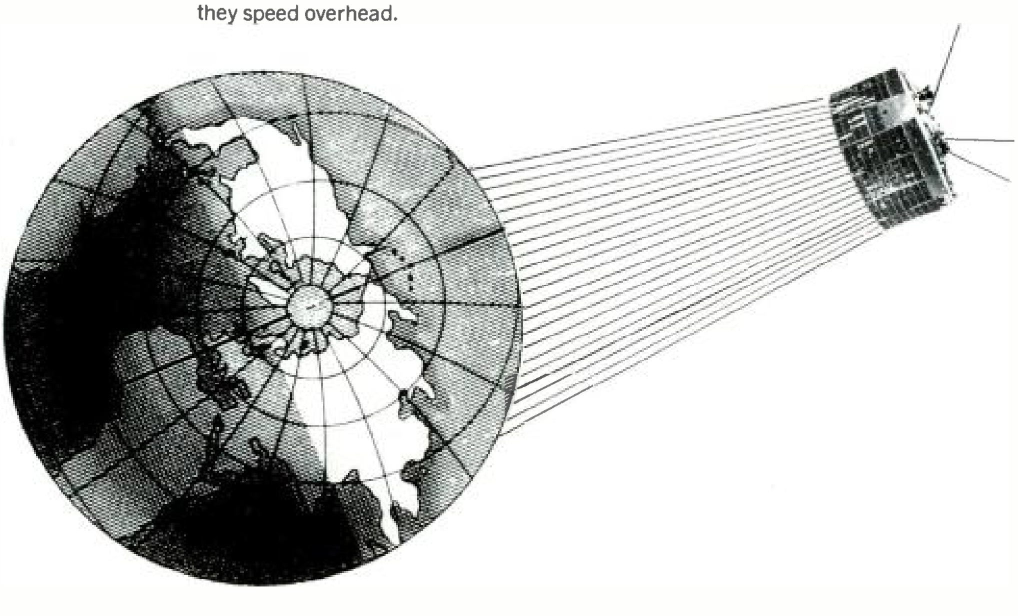
The basement receiving station was put together primarily from a 30-year-old ham radio set plus the usual store of surplus equipment accumulated by most hams. Also among the components were a common kitchen rolling pin, two electric motors costing $10 each, a second-hand microscope costing $15, and an argon electric light bulb. The total outlay was about $200.

The antenna was fashioned from a piece of wire mesh and a 30-foot length of copper tubing held in place by wooden dowels and fastened to a clothesline pole in the backyard. Its vertical movements are controlled by commercial TV antenna rotators that allow the antenna to follow the satellites as they speed overhead.

By reporting on his early successes in a magazine for amateur radio operators, Anderson launched an entirely new hobby for radio amateurs around the world. He now corresponds regularly with more than 150 individuals in the United States, Canada, India, Italy, the Netherlands, South Africa, Turkey, and West Germany.

A recent letter from an Italian correspondent contained a satellite view of southern Europe, including the Italian "boot" and Sicilian "football." The photo was received on makeshift electronic equipment coupled with a camera costing less than $20.

The range of persons and groups interested in building their own satellite picture receivers runs from hams who have retired from their regular jobs to high-school students. In fact, students at one technical school—the Upper Bucks County Technical High School in Bedminster, Pa.—blend academic training with space-age interest by building a receiver each year as part of their electronics course.



Anderson estimates that there are now about 50 amateur stations in operation with a similar number under construction. These generally follow his original plan or contain some slight modification, such as replacing old-fashioned tubes with transistors.

To receive a picture from the satellite, Anderson tunes in the signals and records them on an ordinary home tape recorder. The impulses are used to activate the argon bulb, and the resulting beam is put through the "wrong end" of the microscope to focus it to a sharp point. The beam is then aimed at unexposed photographic film affixed to the rolling pin, which is rotated by one of the electric motors.

The rolling pin makes one revolution for each of the 800 TV lines that make up the satellite pictures. The exposed film is then processed in Anderson's darkroom. (He is also an amateur photographer.)

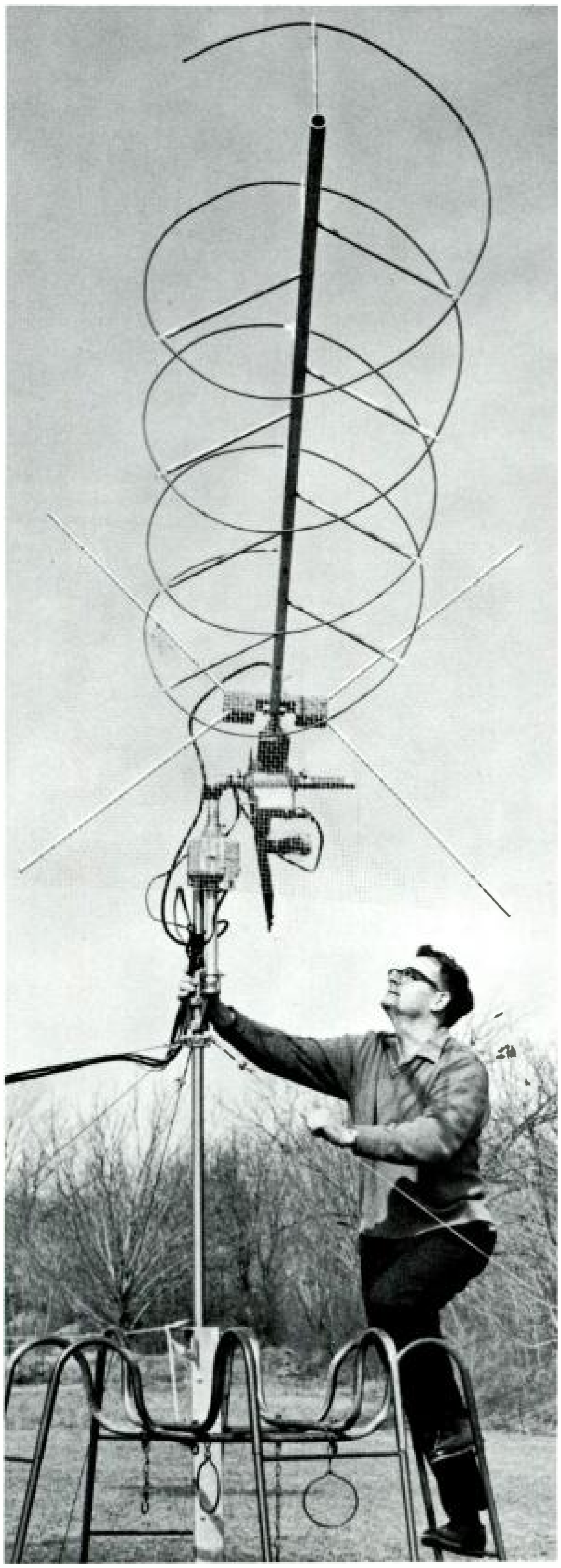
Many of the newer space hams bypass the darkroom process by using Polaroid cameras to record the pictures directly from an electronic scope. The recorder is not necessary if the picture is produced directly on film or the Polaroid positive as it is received from the satellite. Most hams prefer, however, to tape the signals so additional pictures can be produced from them.

To practice the hobby, space hams require a good background in electronics plus a certain degree of ingenuity. Some high school students who have attempted to build sets for their science fairs have found the project beyond their limited know-how.

Pictures can be received only from those satellites equipped with Automatic Picture Taking (APT) equipment, such as the ESSA 6 launched in November, 1967. The APT equipment was specially designed by NASA and the Environmental Science Services Administration of the U.S. Department of Commerce to allow direct transmission to relatively simple receiving equipment.

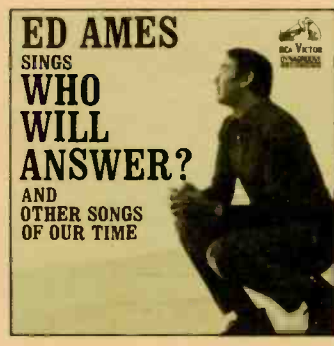
A second type of weather satellite carries more complex cameras that store pictures for later transmission to highly sophisticated ground stations. These cameras, called advanced vidicon camera systems, provide professional meteorologists with a global view of the world's weather.

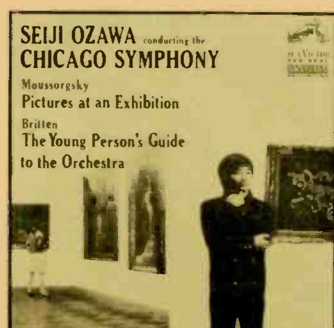
Recently, a third type of satellite, the ATS series, has gone into orbit and is beaming pictures from a stationary or synchronous position 22,000 miles above the earth. By tuning to the ATS frequency, amateurs can receive pictures that show the weather over an entire hemisphere—a fact that seems sure to stimulate even further interest in a hobby uniquely keyed to the space age. ■



Wendell Anderson, originator of do-it-yourself space pictures, adjusts the antenna in the backyard of his home.

For the Records...





THE HAPPY TIME

The Original Broadway Cast Recording

(RCA LOC/LSO 1144)

This RCA recording of David Merrick's hit Broadway show, with a score by John Kander and Fred Ebb, features Robert Goulet as the internationally renowned photographer who discovers the life he has been seeking is back in his Canadian home town and David Wayne as his living-life-to-the-end father. Among the memorable songs are "A Certain Girl," "I Don't Remember You," and "Life of the Party."

VERDI RARITIES

Montserrat Caballe

(RCA LM/LSC 2995)

Following her Metropolitan Opera performance and RCA Red Seal recording as Violetta in Verdi's "La Traviata," Montserrat Caballe turns to a number of the composer's lesser known works in this recording. Irving Kolodin said of "Verdi Rarities" in *Saturday Review:* "Considering the variety of singing styles required and the sound manner in which she responds to their challenges, credit must be accorded Caballe for one of her best achievements to date."

THE YOUNG HOROWITZ

Vladimir Horowitz

(RCA LM 2993)

Of interest to music historians, music lovers, and serious musicians is this "new" RCA Red Seal release. The album commemorates the 40th anniversary of the virtuoso's debut in this country and his initial Victor recordings. Included are selections from Horowitz's first sessions, in 1928, at Camden, N.J. Of equal interest is the inclusion of four recorded performances which have never before appeared on LP and the premiere recording of Kabalevsky's Sonata No. 3, Op. 46.

PETER NERO PLAYS "LOVE IS BLUE" AND TEN OTHER GREAT SONGS

(RCA LPM/LSP 3936)

The unusual stylings of Peter Nero embrace the world of contemporary pop music and the current film and Broadway scene. In his newest collection for RCA, he combines many of today's rhythmic blendings with the Baroque influence. Included are the title song and "Who Will Answer?", both of which were popular successes in Europe as well as in this country. From the stage comes the title tune from the musical "The Happy Time" and "Try to Remember" from "The Fantasticks." Songs from the movies include the theme from "The Fox" and "The Glory of Love," currently being revived in the film, "Guess Who's Coming to Dinner."

"WHO WILL ANSWER?"

Ed Ames

(RCA LPM/LSP 3961)

The Ed Ames collection of the songs of our time represents a generous cross-section of the world of contemporary music. In addition to his own recent RCA hit single, "Who Will Answer?", written by Spanish composer L. E. Aute, Ed Ames sings such current favorites as "Cherish," "Yesterday," "Monday, Monday," "Can't Take My Eyes Off You," and "Massachusetts." This album is the singer's first in the message vein.

YOUR OWN THING

The Original Cast Recording

(RCA LOC/LSO 1148)

One of the biggest hits off-Broadway this year is a rock musical called "Your Own Thing," based loosely on Shakespeare's *Twelfth Night*. The RCA Original Cast Recording offers yet another example of the label's search for fresh ideas in the world of music. The two young composers of the musical, Hal Hester and Danny Apolinar, have fashioned a contemporary score to the book by Donald Driver, who also directed the show. *The New Yorker* summed up its reaction with this statement: "...as original as anything you're likely to see this season."

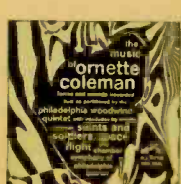
MOUSSORGSKY: PICTURES AT AN EXHIBITION and BRITTEN: THE YOUNG PERSON'S GUIDE TO THE ORCHESTRA

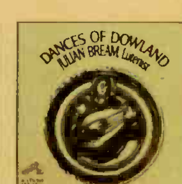
Seiji Ozawa conducting the Chicago Symphony Orchestra

(RCA LM/LSC 2977)

Among the handful of young symphony conductors currently receiving a great deal of attention in the nation's press is Seiji Ozawa, presently conductor of the Toronto Symphony. Recently named to a similar post with the San Francisco Symphony beginning in 1970, Ozawa chose the Chicago Symphony Orchestra to make his first orchestral recording without a soloist for RCA Red Seal. The Britten work is a first recording for the Chicago Symphony, but "Pictures at an Exhibition" is an old friend, having been recorded twice before by the Orchestra.

OTHER CURRENT RCA RELEASES





Electronically Speaking...

NEWS IN BRIEF
OF CURRENT DEVELOPMENTS
IN ELECTRONICS

MICROWAVE TUBE REDUCES COOKING TIME

A microwave cooking tube has been introduced that produces enough energy to bake a cake in four minutes, fry bacon in 50 seconds, or roast a 16-pound turkey in 70 minutes. The tube operates by generating microwave energy that excites molecules throughout the food, so that only the food gets hot while the oven and utensils remain cool.

The new tube, developed by RCA's Electronic Components Division in Lancaster, Pa., uses the same energy that brings TV pictures into the home, puts police cars in contact with headquarters, and detects enemy aircraft or missiles in flight—and it operates at a much lower frequency than most standard microwave cooking tubes.

The advantage of the lower frequency is that it provides deeper penetration of the microwave energy into foods and assures uniform cooking in a minimum of time. In addition, a unique "load-leveling" circuit, particularly developed for use with the tube, enables the microwave energy to be concentrated with equal efficiency into foods of greatly varying size and mass, permitting uniform cooking of thin foods like bacon strips as well as larger items such as roasts or fowl with equally satisfactory results.

There are additional advantages to this new system: a warm-up time of only 20 seconds before cooking starts, maximum power for the widest range of oven loads, and greater visibility through the oven window because the lower frequency permits larger spacing in the window's microwave shield.

ADVANCE REPORTED IN LASER TECHNOLOGY

An advance in laser technology has made it possible for the first time to produce true, three-dimensional pictures, or "holograms," of scenes up to six feet deep when illuminated by laser light. Until now, most holograms have been limited to objects and depths of field measured in inches.

The advance, reported by scientists at RCA Laboratories, Princeton, N.J., enhances prospects for using holography to simplify the manufacture of integrated circuits, to record large documents for storage, to achieve optical computer memories with very high information capacity, and to produce window-size displays that would appear three-dimensional to the naked eye.

The inability of lasers to produce light of sufficient purity and uniformity had previously limited the object size and field depth used in the making of holograms. This lack of what scientists call "perfect coherence" does not show up over short distances but becomes increasingly evident as the laser light moves farther and farther from its source.

Since the making of holograms depends critically on the coherence of the light used, it is impossible to make them of objects whose size or distance is greater than the "coherence length" of the laser beam—the distance over which its waves remain in step.

To overcome this restriction, RCA scientists have devised a technique for purifying the light produced by an argon laser to essentially one wave length, which assures that it will remain coherent over long distances. This achievement removes laser coherence length as a present limiting factor in making holograms. Thus, the upper limit in the present experiments is not laser coherence length but the size of the vibration-free platforms or "stable tables" required to make holograms.

COMMUNICATIONS SYSTEM FOR ASTRONAUTS

A spacesuit communications system, weighing only about six pounds and roughly the size of a cigar box, is currently under development for the National Aeronautics and Space Administration. The extra-vehicular communications system (EVCS) will be carried as part of the astronaut's portable life support system on the moon and will permit two or more astronauts to explore the lunar surface at the same time.

As conceived by RCA's Defense Communications Systems Division in Camden, N.J., the EVCS will allow both astronauts in the Lunar Module to leave the spaceship yet still maintain communications contact with each other and, through a relay system aboard the Module, with mission directors on earth. Earlier NASA plans had allowed for only one astronaut at a time to leave the Module after it landed on the moon.

As a unit in the life support system, the EVCS will transmit biomedical telemetry data on the condition of the spaceman and will also have an alarm that will activate itself should the pressure in the spacesuit begin to drop. In all, 19 systems will be developed by RCA for NASA's Manned Spacecraft Center, with the first flight-qualified equipment scheduled for delivery this October.

LASER SYSTEM TO AID LUNAR EXPLORATION

An engineering model prototype, now under development for the National Aeronautics and Space Administration, will test the feasibility of using a laser-beam tracking system on the moon. Its purpose will be to pinpoint the position of an exploring astronaut or vehicle and to aid in surveying the lunar surface.

This system will be an extension of work already done by RCA's Astro-Electronics Division under a company-sponsored program. For this project, an experimental laser tracking system was built and then tested in the Arizona desert in conjunction with simulated lunar exploration exercises carried out by the U.S. Geological Survey's Astrogeology Branch.

The system will be known as a Laser Tracking and Ranging System and, when fully developed, could be used for moon missions of the Apollo Applications Program (AAP) after the initial manned lunar landing.

The engineering model will have an initial range of 700 meters, with provision made to extend this to 8,000 meters with modifications. However, in both cases the performance would be better on the moon since no atmosphere is present there to interfere with the laser light beam.

The system will be designed to locate a point to within less than one meter at ranges adequate to reach the lunar horizon—approximately five miles. However, this range could be primarily for locating a manned roving vehicle since an astronaut on foot would not likely venture more than a few hundred yards from his landing vehicle.

As presently conceived, the system could be attached to a landing vehicle or roving vehicle to fill functions similar to those performed by instruments used by land surveyors on earth. An astronaut departing the vehicle could carry a staff having a special reflector. The laser system would lock on to the exploring astronaut and follow his movements.

NEW ELECTRONIC TYPESETTER FOR PRINTING INDUSTRY

A new all-electronic typesetter has been developed that can generate characters at a rate of up to 6,000 per second, or a thousand times faster than manual typesetting machines. Called the Videocomp 70/830, and developed by the RCA Graphic Systems Division in Dayton, N.J., the new typesetter is destined to become an important tool in both the printing and information industries.

In printing, Videocomp can be used to set type in almost every format conceivable—from full-page tabloid newspaper composition to directories or parts manuals. For example, it could set the text for *The Autobiography of Benjamin Franklin* in only 10 minutes, with all folios, rules, and footnotes automatically in place, or it could set a typical four-column suburban telephone directory in less than one hour.

The new unit also makes possible quality typeset printout of computer information at speeds well in excess of the 1,100 lines per minute typical of high-speed printers now used for computer readout. This could result in easier handling and reading of the business and scientific data now being processed by computers.

In addition, the typesetter can store and write any special character, including scientific, mathematical, and engineering symbols, foreign alphabets, ideographs, or trademarks.

"CLASSROOM OF TOMORROW" AT HEMISFAIR '68

A demonstration of a computer-based instructional system, in which large numbers of students can be drilled simultaneously and individually in such subjects as reading, mathematics, and science, is taking place at HemisFair '68, the international exposition in San Antonio, Tex.

The demonstration features an RCA Instructional System, which utilizes an advanced Spectra 70 computer linked to student consoles and displays. After the close of HemisFair next October, the system will become the nucleus of the first state-wide computer complex for schools. It will aid in the education of 180,000 pupils in a 14-county Texas school region and assist in handling the region's administrative functions.

The RCA HemisFair pavilion, covering 7,500 square feet, includes graphic displays, audio-visual techniques, and live demonstrations to show how electronics technology is helping teachers bring better education to more students. Outside the central building is a cluster of architectural cubes on which the changes facing today's students—from the information explosion to space travel—are graphically displayed.

Among the computerized teaching programs being demonstrated are elementary-grade drills in reading, mathematics, and science, tailored to the learning rates of individual students. Selected lessons also will be provided both in English and Spanish to reflect the bilingual characteristic of San Antonio's school population.

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A young Job Corps trainee receives speech therapy.
For an article on the Keystone Job Corps Center for Women, see page 22.

Electronic Age

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