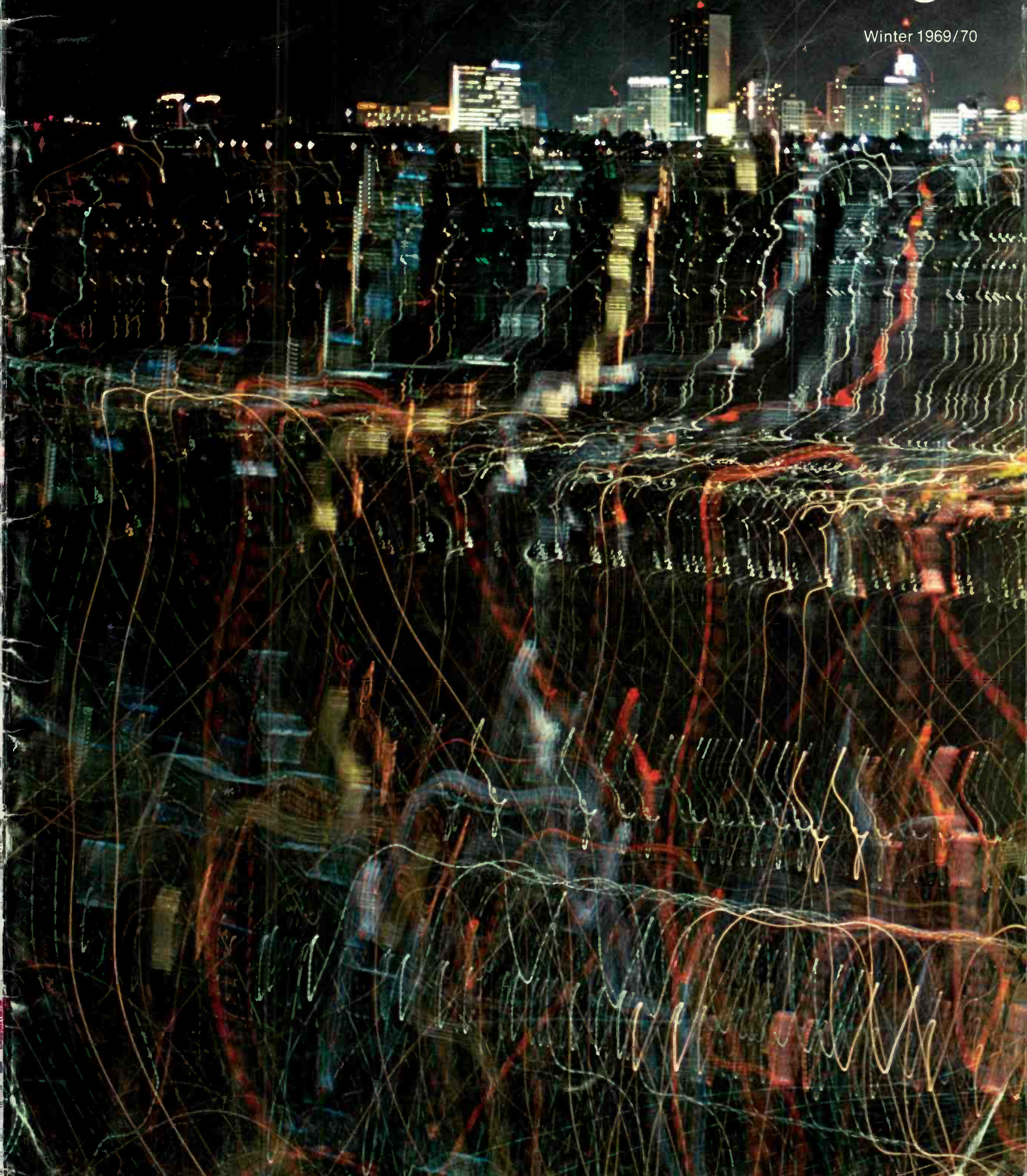
RCA

Electronic Age

Winter 1969/70



Cover: The problems of the city are as intricate as these patterns traced from the lights of the Miami skyline. "Unless we take into consideration the enormous scope of the urban problem and look for answers that encompass all its ramifications, we will be engaging in an exercise in futility," says the author of a commentary on this timely subject, which begins on page 10.

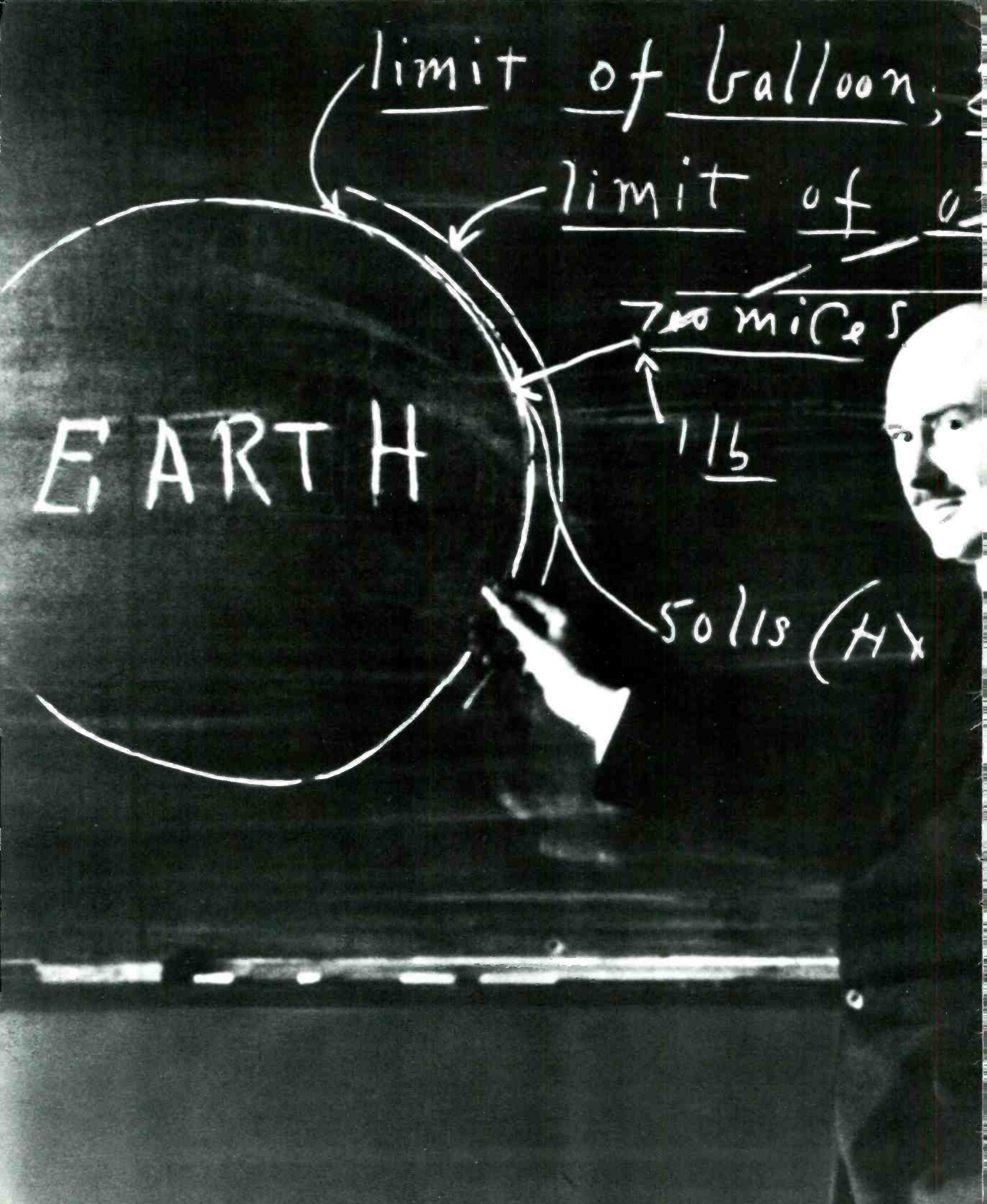
Electronic Age

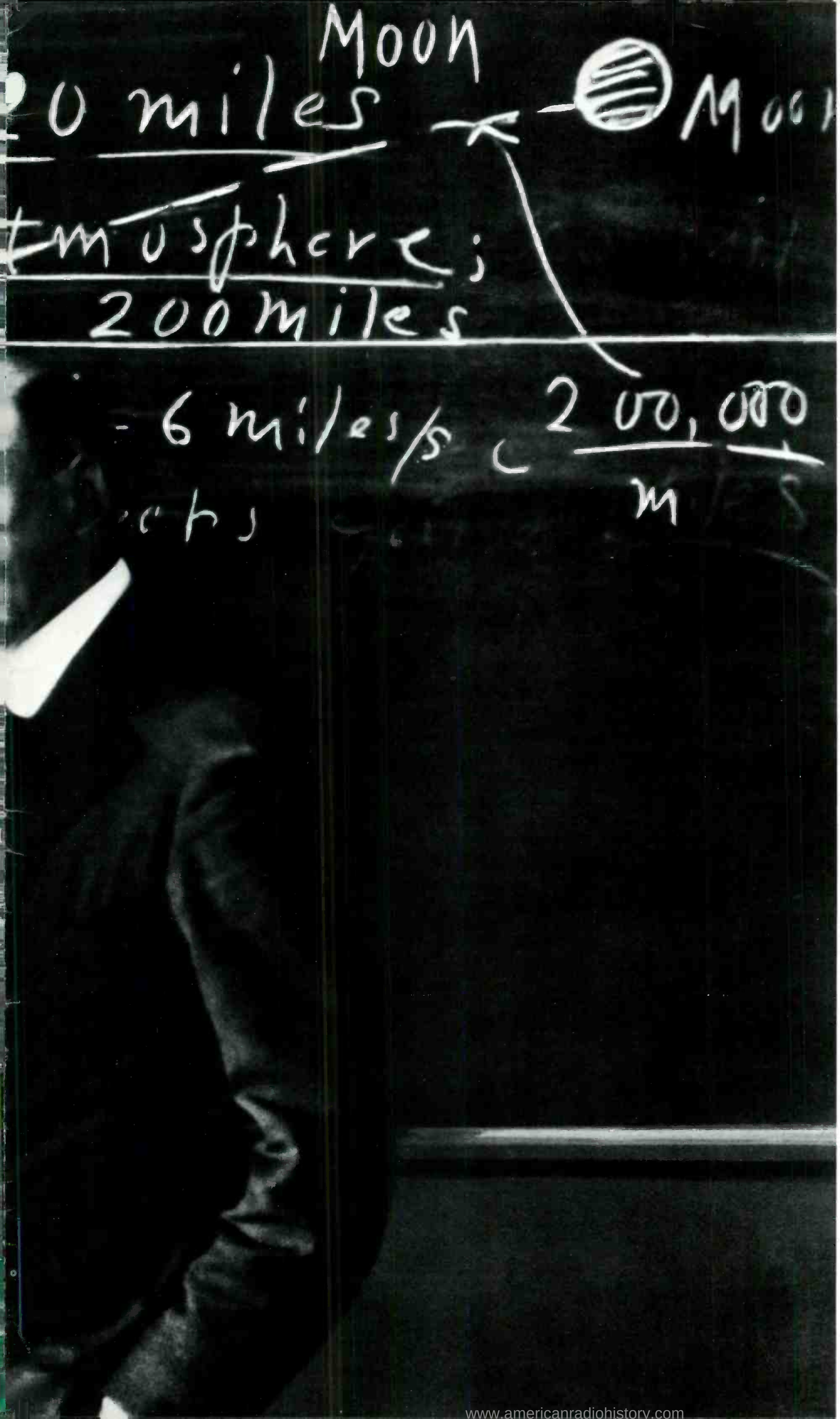
Published
Quarterly by
RCA
30 Rockefeller Plaza
New York, NY 10020

When requesting a change of address, please include the code letters and numbers appearing with stenciled address.

Contents

Winter 1969/70 Vol. 29/No. 1


limit of balloon
limit of
EARTH
1 lb



Prophet of the Space Age

Robert Hutchings Goddard, whose work laid a technical basis for the Apollo flights, predicted intergalactic travel, human migration from earth, and the harnessing of solar energy.

by Arnold C. Bailey

Man will journey to Mars and other planets, using the moon as his jumping-off point. Neptune will become his launching base for explorations to other solar systems, other galaxies. He will allow his body to be reduced by freezing to granular protoplasm and travel in sleep on voyages lasting thousands of years, to be awakened automatically at journey's end.

Then, one day, man will find his own planet no longer able to support life. He will begin his final voyage from earth, a lonely migration in search of a distant home. He will carry with him, in condensed form, the best of all human knowledge so a new civilization can begin where the old one ended.

This glimpse of man's destiny in space could be a fantasy by Jules Verne or a Buck Rogers thriller, exciting to consider but easy to dismiss. It is neither. Instead, these predictions are found in the private papers of Dr. Robert Hutchings Goddard, the pioneer American rocketry scientist whose work laid the technological foundation for many of this nation's prodigious accomplishments in space. The recognition Goddard has received as father of the space age makes his view of the future doubly exciting. And, because the Apollo moon landings have demonstrated the soundness of his historic research and testing, his predictions are uniquely difficult to dismiss.

Aviator Charles A. Lindbergh, one of Goddard's earliest and most consistent supporters, summed up the scientist's visionary legacy in the foreword to *This High Man,* a biography of Goddard by Milton Lehman. His ideas "must be considered as belonging to an open volume, with a preface of fact on one side and

Arnold C. Bailey is Director of the Robert Hutchings Goddard Library Program at Clark University.

At Clark University in 1924, Goddard lectures on how man eventually might reach the moon.

thick chapters of fiction on the other. Year by year, time keeps turning the pages of fiction over into the preface of fact."

As the pages turn, Goddard can be seen as a mixture of the conservative, matter-of-fact scientist and the adventurous, imaginative visionary. During most of his lifetime, Goddard kept a tight rein on his imagination—a reaction to public skepticism and ridicule of his work. It must have been like trying to hold back a Saturn rocket with a kite string. On the night of January 14, 1918, he completed the writing of "The Last Migration," a 12-year compilation of notes concerning interplanetary travel and the work that he himself called his "most extreme speculation." Typically, Goddard sealed the manuscript in a folder deliberately mistitled "Special Formulae for Silvering Mirrors" and had it locked in a friend's safe.

Early in his work, Goddard had been marked publicly, perhaps indelibly, as "the moon rocket man." And, to be sure, reaching the moon was Goddard's persistent dream. But it was just one of his dreams. He clearly envisioned the lunar surface as the stepping-stone to the other planets in our solar system. In "The Ultimate in Jet Propulsion," a summary of his ideas written in 1943, he suggested the possibility of establishing a self-contained moon station where both propellants and constructional materials could be produced for use in expeditions sent out from the surface of the moon. He theorized that hydrogen and oxygen could be made on the lunar surface with the same 500,000-watt solar plant that would have propelled the spacecraft (which was converted into the moon station) during its journey to the moon. The power plant would be capable of electrolyzing one ton of water in slightly more than two-and-one-half hours. The moon station would have a protective covering with movable ports to counter possible dangers from meteorites.

"The station could be made a veritable astronomer's paradise," Goddard wrote. "Since there would be no atmospheric disturbances, telescopes and other moving instruments would be of small weight and would move slowly, and observations could be made in any direction for as long as desired. In addition, extreme ultraviolet light and electrified particles from the sun and even similar rays from the stars could be studied. A station in which sunlight was used to grow vegetation could be, in effect, self-supporting. A start from such a station, using jet propulsion, would require much less initial mass than that required for a start from

1926

This frame supported the rocket during its first launch at Auburn, Mass.

the earth. Moreover, sending mass to a craft in space suggests a means of reducing still more the mass of propellant required."

Always the physicist, Goddard did not neglect opportunities for lunar-based research. "An interesting investigation, made possible by the absence of air, would be a study of impacts of very-high-velocity ions," he wrote.

Travel to other planets was frequently on Goddard's mind, although he became increasingly cautious about mentioning it in public. However, one of his former students at Clark University in Worcester, Mass., where Goddard served on the faculty for 29 years, recalls a moment of boldness when the professor flatly predicted to his class: "Gentlemen, I can assure you that during your lifetime men will be traveling to other planets in our solar system."

Mars and Jupiter seemed especially likely destinations to Goddard. Mars could be reached, he theorized, directly from earth without using the moon as a jump-off station. As early as 1918, he worked out the specifics of such a journey, basing his calculations on the use of solar energy. "A rough calculation," he wrote, "shows that for a journey from earth to Mars the average velocity should

1926

Goddard with his liquid-fueled rocket: the motor is at the base and the fuel tanks are above it.

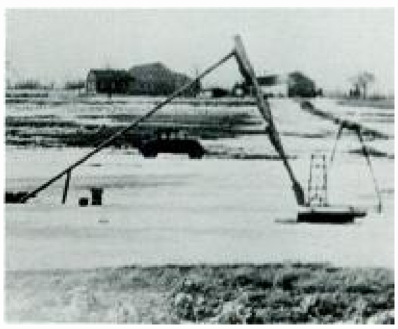
be about three miles per second, the mirror surface per 500 pounds being 680 square feet." The journey's duration, he suggested, would be 14.26 weeks. Two years later, he revised his figures, calculating that an average speed of seven miles a second might be possible. Earth to Mars, he said, was a seven-week trip.

Rocket propulsion, of course, had always been one of Goddard's special interests. His initial work had been conducted with traditional powder rockets, but as early as 1907 he began considering liquid propulsion to increase efficiency. Goddard tested the first liquid-fueled rocket that ever flew on March 16, 1926, at Auburn, Mass. His initial reasoning behind the use of liquid hydrogen and oxygen was that the liquid type of propellant would be more likely to make interplanetary travel possible than any other known fuel. Goddard theorized that, whatever the makeup of planetary bodies, some surely would contain hydrogen and oxygen that could be collected electrolytically. Such reasoning led him to suggest the establishment of the previously described moon station.

However, Goddard looked to other forms of propulsion—nuclear, ion, or solar energy—as the ultimate solution to space travel. In fact, Goddard thought enough of solar and ion motor concepts to take out patents on these two methods. Today, both are in the research and development stage.

His interest in the possible use of atomic energy as a propellant illustrates how far ahead of his time Goddard was. In 1907, Goddard put it this way, "The navigation of interplanetary space depends for its solution on the problem of atomic disintegration"—his concluding statement in a paper written as an undergraduate for a senior physics course at Worcester Polytechnic Institute. Nine years later, he collected his fragmentary ideas on the subject in a paper entitled "Atomic Disintegration." Interestingly, this paper predates by almost three years the first actual disintegration achieved with alpha particles from natural decay by Ernest Rutherford in England, and by 15 years the first disintegration by artificial means by J. D. Cockcroft and E. T. S. Walton.

1926



Test site for the rocket launch at Auburn, Mass.

Goddard wrote: "If it is possible to obtain intra-atomic energy, the matter of transportation in space would be comparatively simple, and a large body could be sent from the solar system, thus affording protection from meteors to the contents. In this case, living beings might be carried, the necessary light and heat being furnished by radioactivity. If atomic disintegration is solved, the way may be open to the creation of what might be called artificial atoms in which energy might be stored by many high-speed particles. This tremendous amount of energy could be liberated when these artificial atoms were broken up or the particles were removed gradually."

As early as 1906, Goddard began considering the possibilities of ion propulsion. In essence, his concept of an ion motor resembled today's electric light bulb. It required a filament or foil and, for ejection, virtually any substance that could be incandesced or broken down electrically. A number of tests were conducted under Goddard's direction by graduate students in the laboratories at Clark University—their work helping Goddard draw conclusions on ways that man might reach the stars.

However, Goddard saw solar energy as perhaps the most efficient and feasible method of propulsion, employed either alone or combined with other systems. His method made use of a solar sail, a lightweight, collapsible, mirror-like apparatus of metal foil, about 600 feet square. Like a parasol, it would be unfurled in the vacuum of space. He theorized that such a sail could be used to push a spaceship outward from the sun or some other star with pressure from the light of these bodies acting much as the wind that drives sailing ships. The sail could be furled or tilted on edge to permit a return to the sun or star through the pull of gravity. The power plant would be a shell or boiler into which the radiant energy could be directed, its outside highly polished and inside blackened. This was one of three possible methods of absorbing solar energy considered by Goddard; the others were based on combining fluid with absorbent materials. In all three methods, a turbo-generator would be used with the boiler, employing electromagnets near individual turbine blades. The generator would be designed for small current and high potential in order to give high velocity to a small amount of matter. The boiler would produce a jet or stream, and the ship would sail effortlessly.

During the 1930s, Goddard developed a prototype of a solar motor in his shop at Roswell, N.M., where he conducted his later research and tests. His autobiographical notes indicate his belief that it was only a matter of time before solar energy could be harnessed. "The main ideas regarding the absorption of solar energy and the directing of the mirrors appear to have been conceived."

1934

Centrifugal pump and turbine that were tested at Clark University.

Goddard pictured man traveling not only in interplanetary space but through what he called "superspace" into other solar systems and other galaxies. Neptune, he believed, would serve ideally as a space base. In 1927, Goddard proposed: "To leave the solar system with a fairly high residual velocity, using hydrogen and oxygen and solar energy, the final start should be made from or near the planet Neptune, such materials as are needed being stored on this satellite, on which solar energy could be employed. . . . Of course, the satellite could be a halfway station, and the final start could be beyond the orbit of Neptune. . . ."

Goddard doggedly believed that man was at his best as a curious, exploring creature who inevitably would benefit from learning the ways of the universe. The vastness of space, he theorized, might someday be man's only hope for survival. He suggested that in the future the sun and its planets might grow cold or lack sufficient oxygen and that mankind might be forced to seek a more hospitable environment.

In the final pages of "The Last Migration," in a section cautiously entitled "A Glimpse into the Future," Goddard paints a striking, almost frightening, picture. "If passage is possible from planet to planet within the solar system, it can be seen that, as the solar system cools down, migration can take place to the planets near the sun and finally to the sun itself. It may, however, be possible to migrate to the planets that are around the fixed stars after the solar system has cooled to such an extent that life within it is difficult or impossible.

"The most desirable destination would be a planet near a large sun or suns . . . preferably hydrogen, or new, stars . . . so situated that the temperature would be like that of earth but on which the cooling process would be slower. The destination should be in a part of the sky where the stars are thickly clustered so that any further migration would be comparatively easy. Because of the danger from meteoric matter, expeditions should be sent to all parts of the Milky Way where new stars are thickly clustered."

It is at this point that Goddard, the outwardly cold-facts scientist, stretched his imagination to limits that even today are breathtaking. Fifty years ago, when Goddard evolved his plans in the privacy of his research laboratory, they were not to be whispered. He realized that, because of the distances involved in explorations of other solar systems, the pioneer travelers might find their greatest personal adversary in time itself. The voyages would entail enormous self-discipline. The space pilgrims might marry, give birth, grow old, and die long before their journey was over. Their sons might follow the same course and so might their grandsons and great-grandsons. Generations might pass before journey's end.

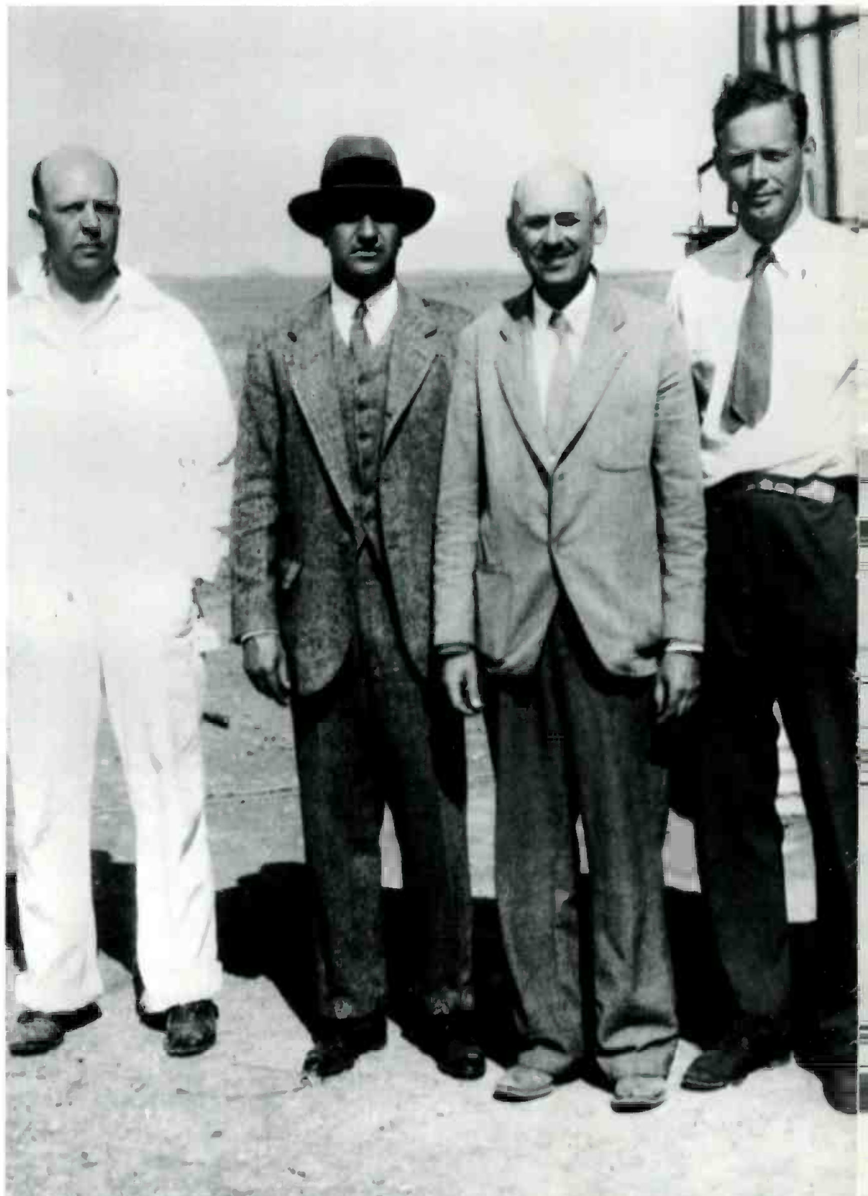
Surely there must be a way to postpone death, Goddard thought. As far back as 1905, he had conceived of a state of granular protoplasm for these space passengers, allowing man to travel for centuries in a dormant state, waking in a new part of the universe. In his early notes, he groped for the answer. "If there was some substance like formaline that would permeate every tissue and kill all bacteria life except the spores, and besides, if the body were placed in a sealed glass containing nitrogen and the temperature remained constant and a little above freezing, there seems no reason why the body might not remain in this passive condition indefinitely since decay is absolutely arrested from the moment the passivity is assumed, although the same amount of moisture is present as when the body is active. . . ."

The pilot would be awakened or animated at intervals to steer the apparatus, if this were necessary. The intervals could be 10,000 years for near stellar systems and 1-million years for very distant systems. "The awakening could be accomplished," he suggested, "by a radium clock, the pressure of the gas evolved, or the change in mass producing the desired result."

In "The Ultimate in Jet Propulsion," Goddard updated his view. "It has long been known that protoplasm can remain inanimate for great periods of time and can also withstand intense cold if in the granular state. In this connection, it may be pointed out that quick freezing of food products as a technique is at least suggestive. Furthermore, Drs. John Field II and Frederick Fuhrman, physiologists,

1934

Demonstration of sun-motor apparatus for rocket.



Goddard (third from left) and his crew were visited at their workshop near Roswell, N.M., by philanthropist Harry Guggenheim (second from left) and aviator Charles A. Lindbergh (third from right).

have recently found that cold does not cause the killing of brain cells. Perhaps, this latter is a hint of a solution. . . ."

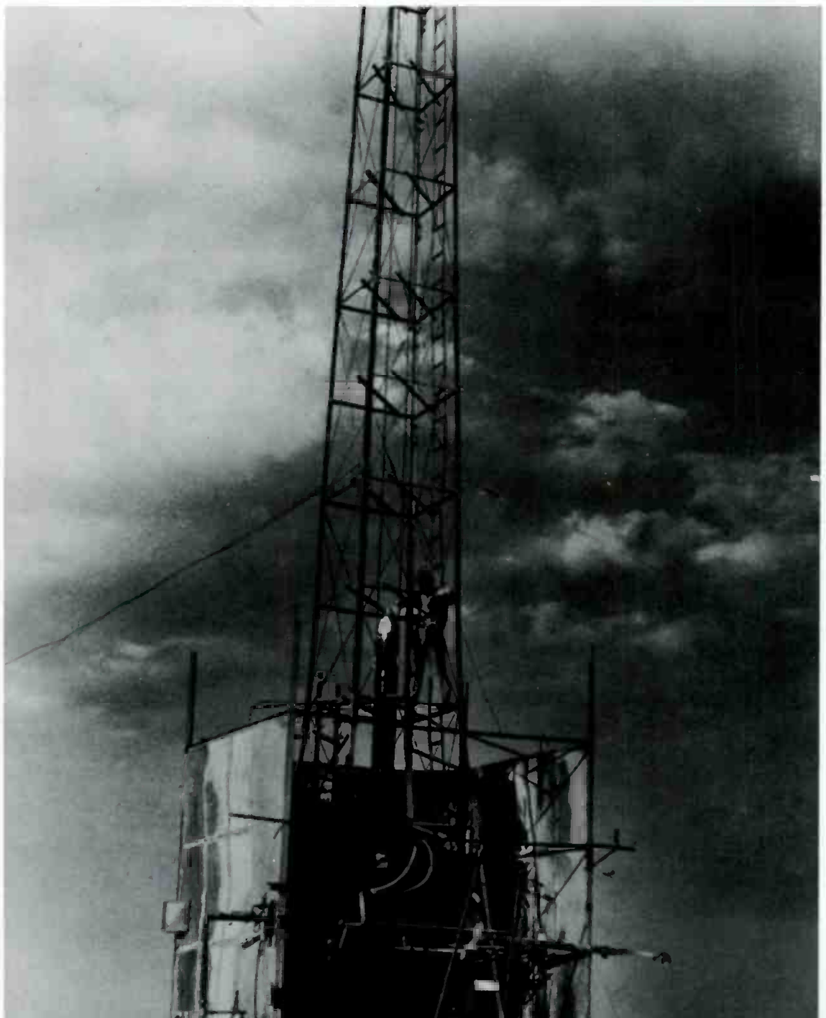
As an alternative, Goddard mentioned the possibility of enclosing granular protoplasm and sending it out of the solar system, there to create intelligent life — the protoplasm being of such a nature as to produce human beings, in time, by evolution.

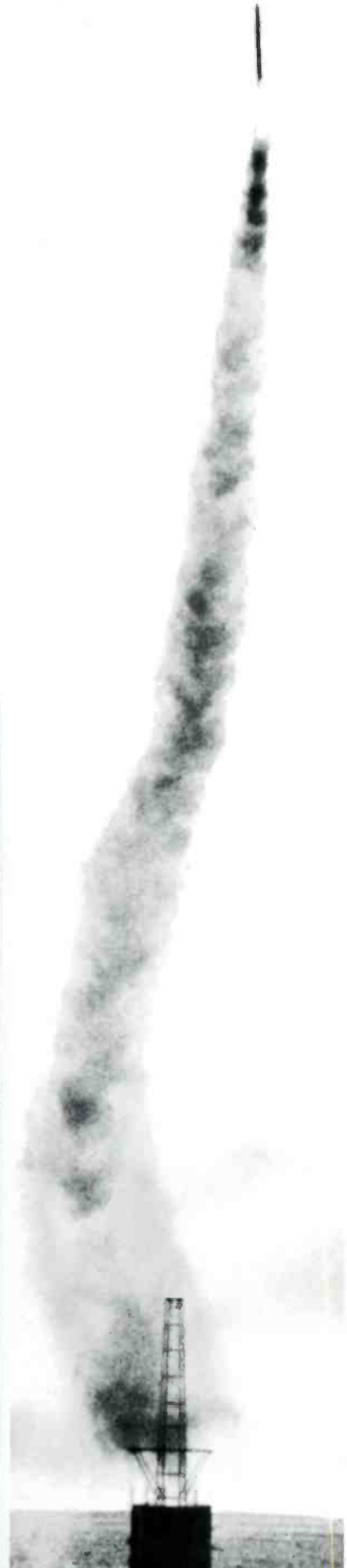
Goddard predicted that, in one state or another, men eventually would set out as did the Pilgrims in the early voyages to New England in search of a new home. They would carry with them as much as they could of all human knowledge in as light, condensed, and indestructible a form as possible so that a new civilization might begin where the old one ended.

This then is Goddard's imagination, unfurled like his solar sail, reflecting everything within its great range — an imagination that could carry mankind through galaxies. If this still seems like Jules Verne or Buck Rogers, there is an important difference — Goddard not only thought and wrote about the most advanced ideas in space science but also explored most of them mathematically, developed detailed theories, and

1935

1936





Rocket launch tower at Roswell, N.M.
Right: A rocket is launched at the site.

then drew detailed designs for them.

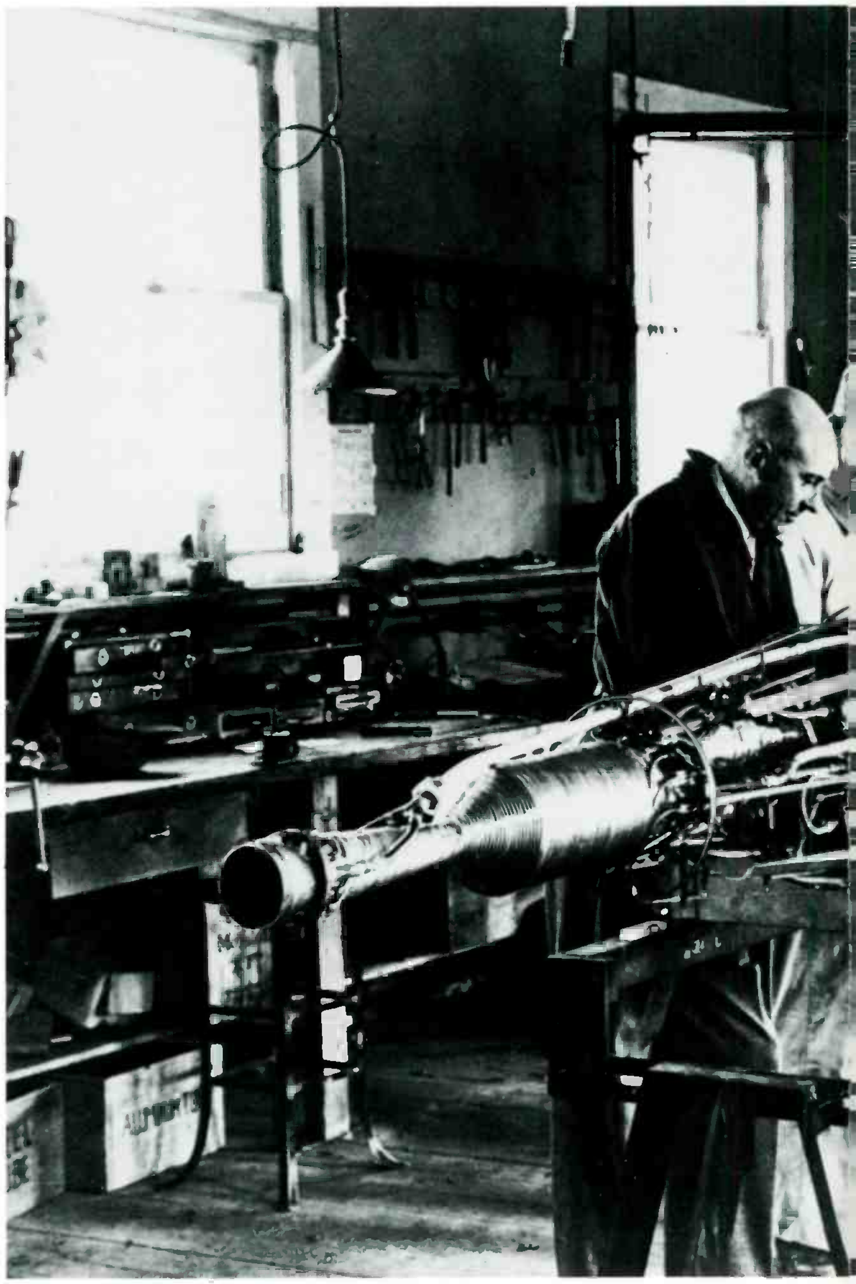
Apollo 11 brought to realization much of Goddard's research and testing. The moon landing itself flipped pages of his ideas from fiction to fact and lent considerable credibility to his ideas for interplanetary travel, intergalactic exploration, and the last migration of the human race.

Certainly, Goddard was one of the earliest and most significant architects of Apollo. Dr. Wernher von Braun, director of NASA's George C. Marshall Space Flight Center and the man most responsible for the development of the Saturn 5 and other space program rockets, is quick to point out Apollo's "debt" to Goddard's work. He stresses the importance of Goddard's 214 patents, stating that "many of these were for components that have become standard today. He introduced, among other things, the gyroscope control, turbopump-fed liquid-propellant engines, regeneratively cooled engines, and the gimballed engine mounting. All these proved essential to the later rockets that boosted man into space, and without them Saturn 5 simply would not have been possible. It can be said that Goddard did most of the basic research that made possible such rockets as Saturn 5."

Von Braun feels that Goddard's greatest single contribution was proving that liquid-propellant rockets could be built and would fly. Goddard's 1926 test, conducted with homemade rocketry hardware and carried out on the basis of theories he pieced together, was a modest beginning for the space age. The liquid-fueled rocket rose only to a height of 41 feet, but it was the first burst sky-

1936

Goddard enjoyed painting during his leisure time. Here, he works in oils near his rocketry workshop at Roswell, N.M.



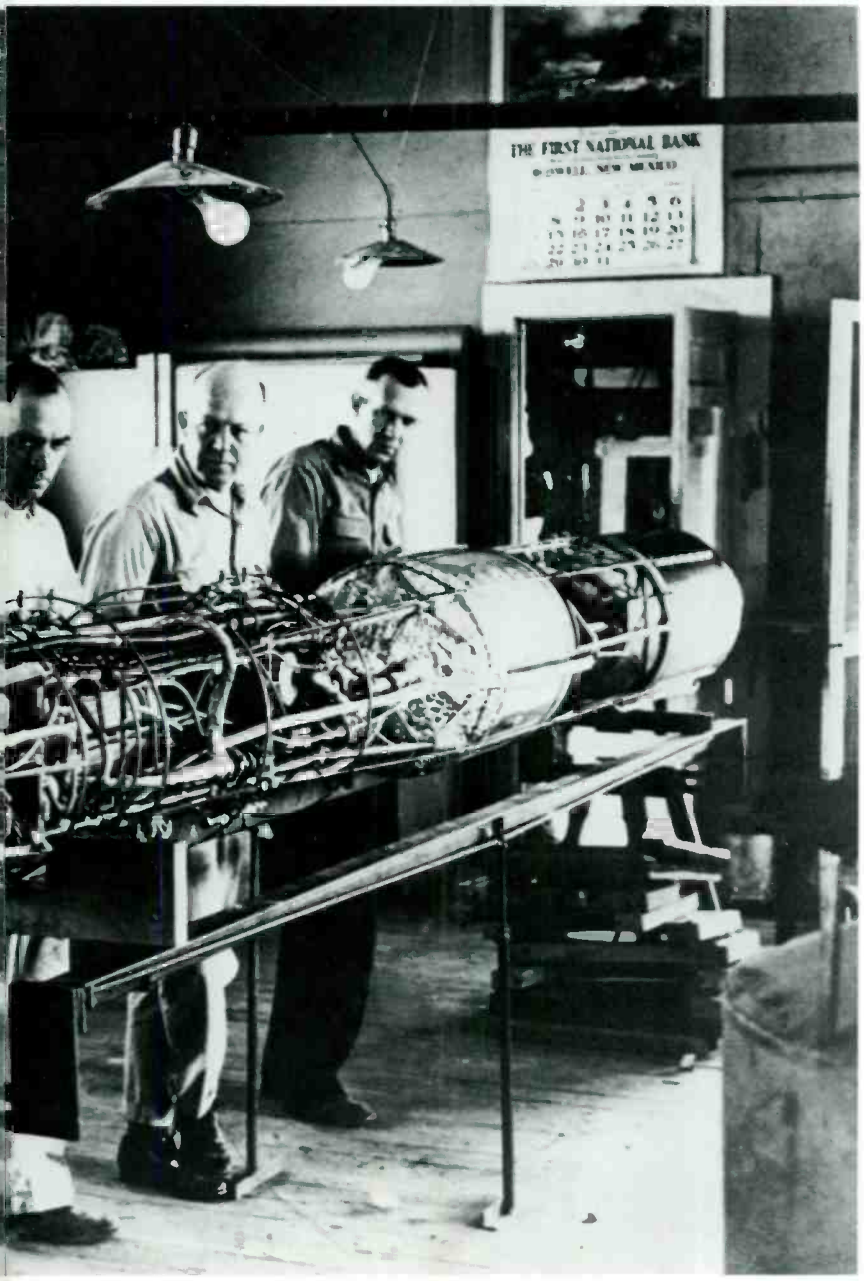
Rocket is checked out by the Goddard team at the workshop.

ward in man's 238,000-mile journey to the moon. For this, Goddard was rewarded with verbal abuse, derision, snickering, and indifference. As a result, he became increasingly secretive and shy in public, devoting himself to the realization of a dream rather than answering his critics. History now reflects on the test in terms as epochal as the Wright brothers' first flight at Kitty Hawk.

His widow Esther explains her husband's plight this way: "Granted he couldn't talk about space travel, even though he knew it was coming; granted he could only hint at the moon, though he knew that was coming; granted, then, he couldn't talk about what was closest to his heart. What outlet, then? First, he could write about it privately, which he did, and he could patent his ideas, which would someday point out to the cognoscenti what he had in his heart — which they did. He was sure they would not come true in his time. But it was precisely these patents that would tell scientists that they had a forerunner who had understood what they could live to accomplish. They were his messages to the future."

On the day the Apollo 11 crew returned from its magnificent mission, Mrs. Goddard was overjoyed. But, like her husband, she looked to the future. "Now that this has been attained, perhaps his further dreams as found in his papers may be met with less elevating of the eyebrows. I am blessed to have seen part of his dream fulfilled today. I can do no less than express the conviction that the rest will follow." ■

1940



GODDARD FIRSTS

First to develop a rocket motor using liquid fuels and to develop and test a liquid-fueled rocket.

First to shoot a liquid-fueled rocket faster than the speed of sound.

First to receive a U.S. patent on the concept of multistage rockets.

First to explore mathematically the practicality of using rocket power to reach high altitudes and to reach the moon.

First to prove, by actual test, that a rocket will work in a vacuum; that it needs no air to push against.

First to publish in detail the mathematical theory of rocket propulsion and flight.

First to develop a gyro-steering apparatus for rockets.

First to use vanes in the blast of the rocket motor for steering rockets.

First to develop self-cooling rocket motors, variable-thrust rocket motors, and practical rocket-landing devices.

First to forecast scientifically jet-powered airplanes, rocket-borne mail, and travel in space.

Is Urban America Out of Control?

Comments on the crisis of the cities.

by Samuel M. Convissor

The American city has been called an unmitigated mess. It is, in most instances, rapidly approaching a desperate condition. Air is often polluted (New York, Los Angeles, and other metropolitan areas already have experienced emergency conditions), streams and lakes are being poisoned, mass transit systems are almost paralyzed, housing is woefully inadequate, school systems are overcrowded and archaic, streets and sidewalks are crime swept rather than swept clean, and urban populations are split by racial tensions. Municipal administration is losing talent faster than it can attract professional managers. Urban beauty is now viewed in terms of the height and cost of columns of aluminum, glass, and steel. Finally, the financial strength of American cities is insufficient to solve their problems, and the situation is getting worse.

Some urbanologists feel that the solutions to many of these problems rest with increased business-government participation plus large amounts of money.

Samuel M. Convissor is a member of the RCA Public Affairs staff.

However, many of the more cynical city hall and state house regulars feel that business has a lot to learn before its marriage with local government will show tangible results. Nevertheless, there is a strong movement under way, which already has had some success in bringing the public and private sectors closer together. Will this movement result in achievements in time to celebrate the nation's bicentennial in 1976? The facts are not encouraging.

In the August, 1969, issue of *City*, the publication of Urban America, a nonprofit organization, editor Donald Canty states that the need for domestic achievement is intense. He urges that "we make 1976 the target date for such achievement, and that we plan and work toward it in a way that encourages not just the spirit but the reality of national unity. The achievement would be, simply put, the design of a workable urban society. We are far from having one now."

Not everyone's city is beset with all the forementioned urban problems, but there is no American city that is not directly menaced by one or more of these conditions. Yet government officials and business leaders are bullish in their prognostications about the future of the city. Maybe the experiences of working together—maybe the results of a few cases—can make one optimistic.

There are some real signs of improvement. The state of West Virginia formed a business task force whose chairman is a vice president of Union Carbide Corporation. The subsequent action on a report to the governor by this committee is helping to streamline the many departments and agencies in the executive branch into 10 major areas of responsibility. However, the report contained 17 proposals requiring constitutional change. Although the business community did a major job in focusing statewide attention on the issues, the decision is now up to the voters. Will they support change?

In Indiana, Governor Edgar D. Whitcomb took the lead in forming a business task force to streamline state govern-

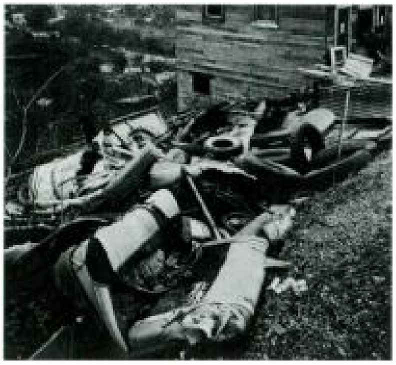
ment. One RCA vice president was a member of the committee, and other executives of the Corporation participated in various studies. But, here again, the distance from study to implementation gets longer each year. New York *Post* columnist Murray Kempton recently put it bluntly: "As America gets worse, its reports get better."

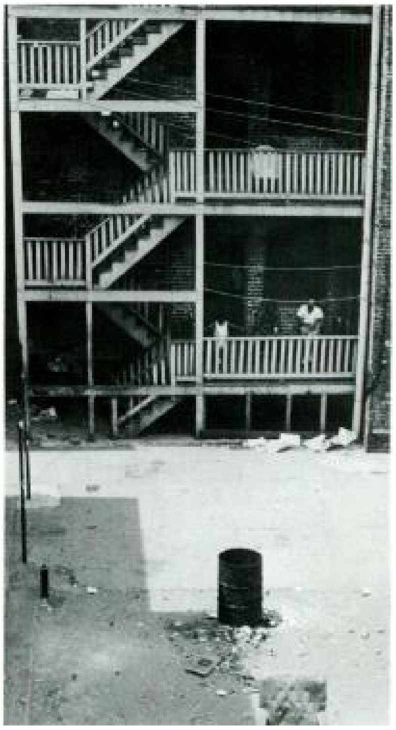
New York City has labored valiantly to improve its municipal administration with the voluntary assistance of business, and hundreds of other cities and states have utilized business know-how to help substitute modern industrial management concepts for bureaucratic thinking. More recently, electronic data processing has been introduced as a possible solution for many of the ills of urban America. But it still appears that the problems are outpacing the solutions.

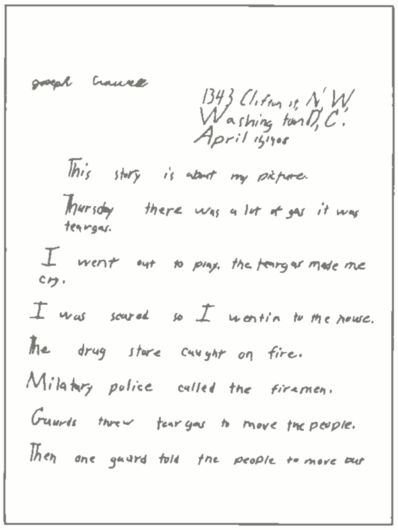
Police departments in cities such as Memphis and Cincinnati are relying on computer technology as an aid to efficiency. However, according to FBI reports, crime is growing at twice the rate of our population, even with new techniques to control it.

The learning process is being improved through computer-assisted instruction as business moves forward with local government to test new electronic programming techniques in our city schools.

As we look at the results of these new advances, it appears that improvement in technique and advancement through technology, while holding much promise for helping to ease the administrative burden of government, have not really






joseph [illegible]
1343 Clifton st, N.W.
Washington D.C.
April 1968

This story is about my picture.

Thursday there was a lot of gas it was teargas.

I went out to play. the teargas made me cry.

I was scared so I wentin to the house.

The drug store caught on fire.

Milatary police called the firemen.

Guards threw tear gas to move the people.

Then one guard told the people to move out

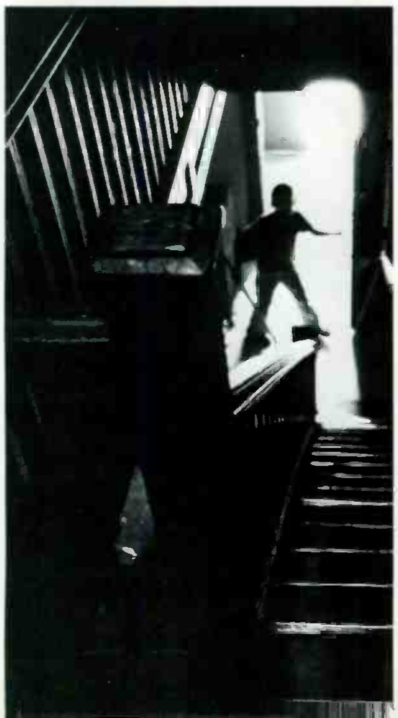
changed the human condition of the city.

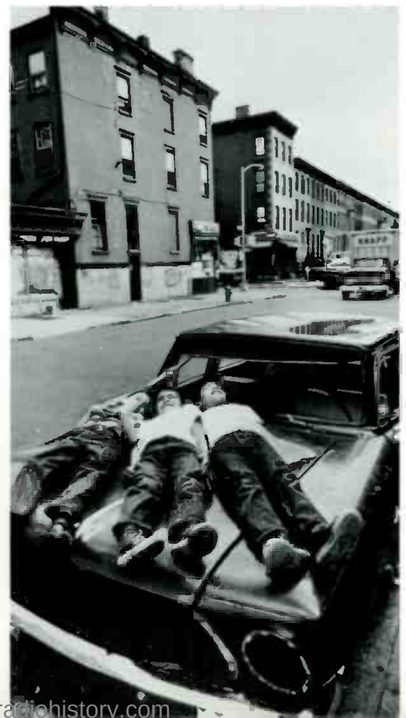
Ten years ago, at a conference of city officials and concerned businessmen, the late Adlai Stevenson stated: "Urban problems have today become metropolitan problems; problems that cross all lines between city and suburb, between incorporated and unincorporated areas; problems that have no city limits.

"The plain fact is that the resources on which our urban life depends — land, water, and breathable air — are getting scarcer. The decisions about their use, like the

decisions about mass transportation, are hard decisions. Any assumption that the city planners or high-level commissions will devise the answers seems to me to go only halfway. For the answers, however wise, won't mean anything unless they are adopted through the political decision-making process by those affected by these decisions."

To achieve the goals that Stevenson proposed will require much greater energies than those so far exhibited by businessmen and others involved in the type





"...change is possible, if the people within the urban environment want change badly enough to forsake some of their own special interests."

of government problem solving now in fashion.

In 1920, the United States was still a rural country. Less than 50 per cent of the population lived in cities. Today, more than 80 per cent of us are urban metropolitan dwellers. This rapid change from rural to urban living more than anything else is the real problem of the city. The cities simply cannot handle the growth.

Unless we take into consideration the enormous scope of the urban problem and look for answers that encompass all its ramifications, we will be engaging in an exercise in futility. Any simple solutions being put forth by the variety of groups and study commissions now involved in urban problem solving will be mere patchwork—insufficient and more damaging than if nothing at all were done.

One example of patchwork is the makeup of the New York metropolitan area. In the 50-mile radius surrounding Times Square, there are 22 different counties in three states, involving more than 1,400 governmental units. The patchwork is evident in the housing, schools, transportation, air pollution control, water conservation, and all the problems mentioned earlier. To solve any of these problems would require give-and-take among these localities, and not one of these myriad separate independent units is about to take the first cooperative step toward sanity.

We live today in an environment of the great city complex. There now exist more than 260 metropolitan areas similar to greater New York. We face this environment bewildered, confused, and whipsawed both by the scientific revolution and the social revolution that are taking place before us. Each day brings a new technical advance or sociological change, and, with each, a new dimension to the urban crisis takes shape. This is not an easy condition to deal with, even for the best government-industry team, and, unless the political realities of metropolitan life are considered, the new studies and recommendations will gather dust on bookshelves across the country.

On the other hand, American industrial and scientific know-how gives us new tools daily to help in the municipal fight. We have sophisticated machines, statistical data, and computer technology. Yet our environment continues to swing out of control—or so it seems. A recent New York *Times* report on one utility asks: "Has urban America become so complex and volatile that it is outstripping the ability of planners to keep up with its movements and thereby to meet its needs?"

In reality, it may not be out of control at all. True, the city is not what it used to be, nor is it like anything that many would like it to be, but it might very well be the way it has to be under present conditions. But change is possible, if the people within the urban environment want change badly enough to forsake some of their own special interests.

There is a children's song sung by Misterogers on his late-afternoon National Educational Television program: "Everything grows together because you're all one piece, your head grows, your feet grow... because you're all one piece." City life is no different.

When someone complains about crowded streets and urges that new superhighways be built into the heart of a city, he is suggesting a change—a new input—in the urban environment. By building the highway, we have to raze homes, lessening the already small supply of inner-city housing units. This, in turn, causes relocation problems and changes shopping habits and retail sales, which then alter the wholesale distribution pattern.

In short, each action that we take to improve urban life affects the total system in ways too many of us do not yet understand. The result is a growth of crash programs (usually designed to be completed prior to elections) and crisis situations that add up to a total lack of commitment to the over-all problem solving that should take place. Thus, we live from crisis to crisis.

Let us take public education, a typical urban problem, and follow it through in order to gain a better picture of this interrelatedness. Most big city school systems are overcrowded. While the city population itself has declined (there are more large cities today and more metropolitan areas than before, which give us a larger urban population), the school population has increased. This is due in great measure to the fact that the poor who move to the city have more children than the middle-income families that they replace. The overcrowded conditions thus force the school boards to consider new school construction. A new school costs money, which the city does not have, and furthermore usually requires removal of tax-producing property from the city's tax rolls. Once built, the school must be staffed, costing still more money. (In this brief example, there are school, tax, housing, social, and probably teacher-contract problems.) If this process is repeated too many times in any given city, the result can be chaos. Yet the biggest demand in the inner city is for better education—smaller classes with more teachers who are more understanding.

This seamless web of urban problems is not limited to education. Paul Ylvisaker, who until recently was Commissioner of Community Affairs for the state of New Jersey and was formerly Director of Public Affairs for the Ford Foundation, has been an advocate of "general government" for a long time. His first maxim is the requirement that "each geographic area shall have a general government covering the whole range of governmental functions, rather than a partial one related only to a particular function." Ylvisaker explains, "If the citizen as a whole person is to be drawn into participation, the government with which he works must be comprehensive—that is, equally whole."

Several years ago, many businessmen rushed ahead on a campaign of equal employment opportunity programs, an extremely important but only limited part of the solution to big-city problems. While integration in American industry did take place—at least at entry-level positions—it opened the eyes of businessmen to the realities of total urban problem solving. It was no longer just a matter of recruiting the black worker. Industry found that the all-black schools had to be improved so that they would turn out qualified job candidates. The urban transportation system had to take into account the fact that the new workers would have to get to the plant or office on time. Housing patterns had to be broken so that minority-group employees could find homes and apartments commensurate with their new economic condition. Industry also discovered that testing procedures had to be changed and personnel counseling approaches altered.

To many business leaders, what seemed a simple solution to an urban problem was turning into an administrative nightmare. They began to realize that it was impossible for industry to attempt to deal with an isolated segment of the urban crisis. The problems of the city are all interrelated.

The result of all this pattern changing is that our definition of "normalcy" for living might have to be changed until such time as the environment itself will be changed. The difficulty is that the very same people who cannot tolerate the "current situation" and are eager for a return to the "good old days" are, in fact, the same people who are fighting the improvements needed for the health of the cities. They are not willing to sacrifice—to give up something they now have—in order to improve the total environment of urban life.

In the struggle for more livable cities, urban residents are in a daily contest with many of their suburban and rural counterparts who want to maintain the status quo. In some cities, neighborhood is pitted against neighborhood. And yet, according to the President's Commission on Intergovernmental Relations, "to implement proposals for change will require public support and confidence." However, a political leader who faces evaluation of his work every four—and in some cases every two—years, finds it difficult if not impossible to gain enough sustained support to change dramatically the conditions that now exist.

According to Ylvisaker, one can look at a list of physical and financial complaints of the city and not come across what probably is the one item that needs changing first—indifference. All the obstacles that face the urban environment can, in fact, be overcome if only there is a firm will to do so. "The only one that may block the way is the obstacle of indifference," Ylvisaker concludes.

Planners design outstanding schemes for the redevelopment of a central business district. Social scientists warn of potential dangers if we do not care for the ill-fed and ill-housed. Experts point out the tremendous burdens that society has assumed as a result of uncared-for problems. And yet, the average citizen is only casually aware of the impact, socially and financially, that these burdens eventually will make upon him.

Many people, urbanites and suburbanites, live in a narrow groove that is getting deeper with each commute between home and work. To shake these people from their complacency and their apparent indifference to the plight of the inner-city will take a severe crisis situation in which life is endangered, livelihood becomes impossible, or freedom of movement is curtailed. If these states of complacency and indifference are in fact true (notwithstanding the current rash of business/government involvement) and more and more people want to give up less and less to solve the condition of the metropolitan environment, then the only answer, really, is to sit back and wait for matters to deteriorate further. This may be followed by more prolonged periods of crisis, causing an outpouring of public indignation, which, it is hoped, will result in support for a meaningful, all-inclusive solution to the urban problem.

A look at a recent dramatic urban riot demonstrates a solution by crisis. One of the major causes of the 1967 riots in Newark, N.J., was the friction that developed in the argument over the amount of land needed for the new campus of the New Jersey College of Medicine and Dentistry. While nearly everyone—residents of the slum area, business leaders, and the State Board of Medicine—wanted the school in Newark to help serve the needs of the city's indigent, the insistence by the College on 150 acres in midtown was too much for many people to accept. It was not until after the riot (crisis) that a compromise figure of 50 acres was arrived at.

There are too many examples of this kind of thinking for one to be anything but cynical about the need for crisis situations to focus attention on urban problems. One is forced to ask himself, "Is a crisis the only thing that works?"

Too often, labor agreements are not settled until the deadline (crisis), traffic lights are put up only after a child is killed (crisis), and school budgets are passed only after the school is threatened with closing because of a lack of funds (crisis). If a crisis is the only thing that works and if public indifference to planning is one of the major reasons that leads to the crisis, then the solution to the urban problem rests with what can be called "the creative role of the crisis."

How can a political leader control the crisis situation sufficiently to gain support for needed changes in the community? Perhaps by fighting fire with fire, crisis with crisis. The leader who has tried to rally his community in a campaign of civic improvement knows full well the difficulties of generating enthusiasm for change if it will cost money. The answer: create a crisis. The problem: control it once it has been created.

For anyone who has worked in the field of urban life for any period of time, the question inevitably boils down to "Does anyone really care?" Shall we tax ourselves sufficiently for cleaner air, better-paid police officers, and cleaner streets? Are we concerned enough about highways and public transportation to work shifts or at least stagger the hours at the start and finish of each workday? Do we care enough about the inadequacies of public housing projects in the city to lead a suburban crusade for low- and middle-income housing in our own neighborhoods? The programs of support by suburban groups, churches, industry, and hundreds of service clubs are worthy and important but meaningless if these same people vote against the very issues that will make a difference: open housing, urban-suburban school programs, and sufficient coverage for the welfare family. If the city system is out of control, it is principally because we have an ambivalent position regarding the central city and its problems. We want change but don't want to pay for it.

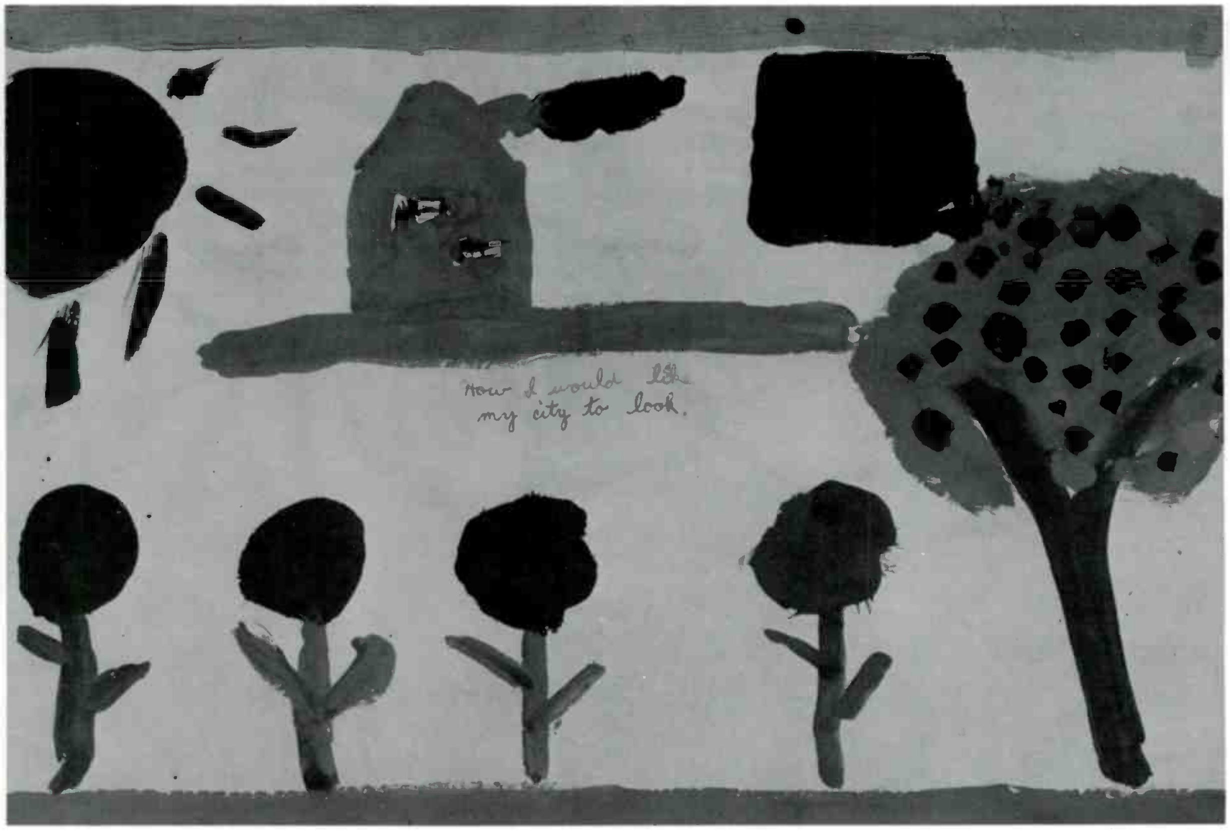
There are no simple answers to the urban crisis. Anything so complex cannot possibly be solved simply. I assume we all want to remain in a democratic country and, as such, before we move ahead on any given program, we must have voter approval. The very fact that voters in too many instances have not supported programs of progress has resulted, for example, in a growing number of apolitical metropolitan and multi-state "authorities"—impersonal and virtually free of having to rely on citizen support at the ballot box.

Nothing short of a nation's concern, commitment, and a continuing deliberate policy to solve the whole problem will build a better environment and bring things once again under control. ■

I would like it to be

A play ground to play in;
No apartments at all;
A swiming pool,
A slide and a swing;
A sandbox to build;
A train to ride;
A store with candy
I hats how it will be.

Barr Wangonde
Meyer School 203



Assault on MAR

Within two decades, man may set foot on the red planet.

by Dr. I. M. Levitt

The manned Mars spacecraft with its complement of 12 astronauts is returning. In a few days, it will be August 14, 1983, and the men who departed from earth some 640 days ago on their dramatic mission to land on Mars will reenter the earth's atmosphere. Except for a few minor mishaps that fortunately did not jeopardize the mission, every element had functioned with a precision that mirrored the Apollo 11 textbook landing on the moon far back in 1969. A tumultuous welcome was being planned for the returning astronauts: their spectacular trip had thrust mankind into a new era. This voyage marked the first time in history that men had set foot on a major planet of the solar system. Now, men could move forward with the audacious plan to explore the entire solar system — our incredibly tiny corner of the universe.

It began in the late 1970s when the United States discovered that the Soviet Union, in a move to regain preeminence in space, was planning to leapfrog the Apollo landings on the moon and move directly on to Mars. To counter this, even under tight budgetary constraints, Congress initiated an unprecedented program for a manned mission to Mars. Nuclear shuttles, reusable boosters, space tugs, and even the lunar ferry were developed.

From these components, two gargantuan spacecraft, each weighing more than 1.5-million pounds and carrying six astronauts, were assembled in earth orbit. Three nuclear shuttles were linked together, side by side like cigars in a box, to provide the energy to start each spacecraft on its journey to Mars. The two outer ones would propel the spacecraft to escape velocity before they "peeled off" to return to earth; the third would propel it the rest of the way. After blasting free of earth orbit, the two spacecraft linked up in space for the 270-day trip to Mars. In case of emergency, one of the spacecraft could be used as the rescue ship, and, although it might prove a tight squeeze, each spacecraft could accommodate the entire crew.

It was November 12, 1981, when the two spacecraft broke the gravitational bonds of the earth. On August 9, 1982, the two spacecraft separated from each other and entered 24-hour elliptical orbits around Mars. Once in orbit, the astronauts dropped lunar-module-like landers that were guided with precision to preselected areas on the surface. Out of each lander hatch emerged a small, mobile, instrumented robot. The robots scooped up some uncontaminated Martian surface material at a considerable distance from the lander touchdown points and returned to their landers, which rocketed off to rendezvous with the orbiting mother ships. There, scientists carefully subjected the samples of Martian soil to critical biological and geological analysis. The most sophisticated tests known to man were conducted, and their results indicated that the Martian surface was safe for terrestrial human beings. Next, the two orbiting spacecraft were reunited, and the Mars Excursion Module (MEM) was readied for descent. Six of the 12 astronauts stepped aboard to be launched to the Martian surface. The MEM contained a vehicle to provide mobility for the astronauts and a 30-day supply of life-support equipment. The spacemen used the MEM as living and laboratory quarters — eating, sleeping, and executing their assigned tasks within its narrow confines. When their mission was completed, they took off for the mother ship and rejoined their colleagues in the orbiters. On October 28, 1982, some 80 days after its arrival on Mars, the dual spacecraft departed for the journey home.

However, the astronauts did not travel directly to earth but headed toward Venus, which they reached on February 28, 1983 — 123 days after leaving Mars. As they approached Venus, two 2,000-pound probes, provided with heat shields to absorb the high reentry heat load, were launched toward the planet. One was projected to the surface, and the other was a "floater" that remained buoyant in the Venusian atmosphere. Both relayed information on the physical characteristics of Venus and its atmosphere to the manned spacecraft.

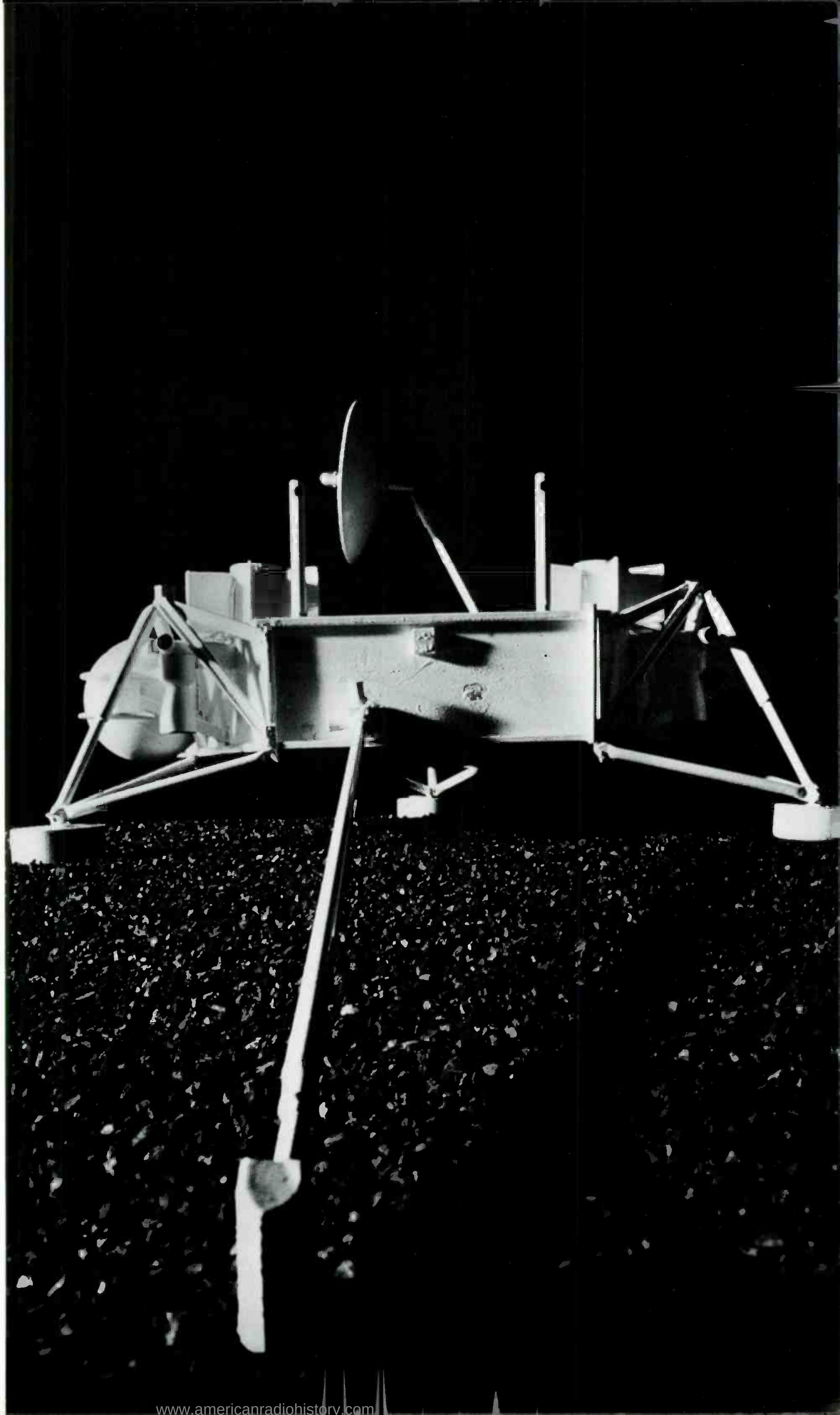
When the spacecraft swung past Venus, it lost some of its circumsolar velocity to help reduce its approach velocity to the earth and then headed out from the sun toward the earth. Finally, on August 14, 1983 — 167 days later — the spacecraft made its approach to the earth, with the engine deboosting the craft to lodge in earth orbit. From here, the reusable shuttle would carry the astronauts down to the surface with their precious cargo. Thus would end the first exploration of a planet by man.

The assault on Mars actually began in 1962 with the launching of the dramatic Mariner 2 flyby to Venus. This was followed three years later by the Mariner 4, which successfully flew by Mars.

Mariner 2 relayed a tremendous volume of information back to earth. As a result, it was discovered that Venus had no magnetic field and no radiation belts, was impacted by the solar wind, and that the density of meteoroids in the vicinity of the planet was 0.1 per cent of that around the earth. The most significant fact obtained from the Mariner 2 flyby was confirmation that the Venusian surface temperature was in excess of 600° F. The

Dr. I. M. Levitt is Director of the Fels Planetarium in Philadelphia.

Model of a Viking lander. In 1975, unmanned landers are scheduled to probe the Martian surface for signs of life.



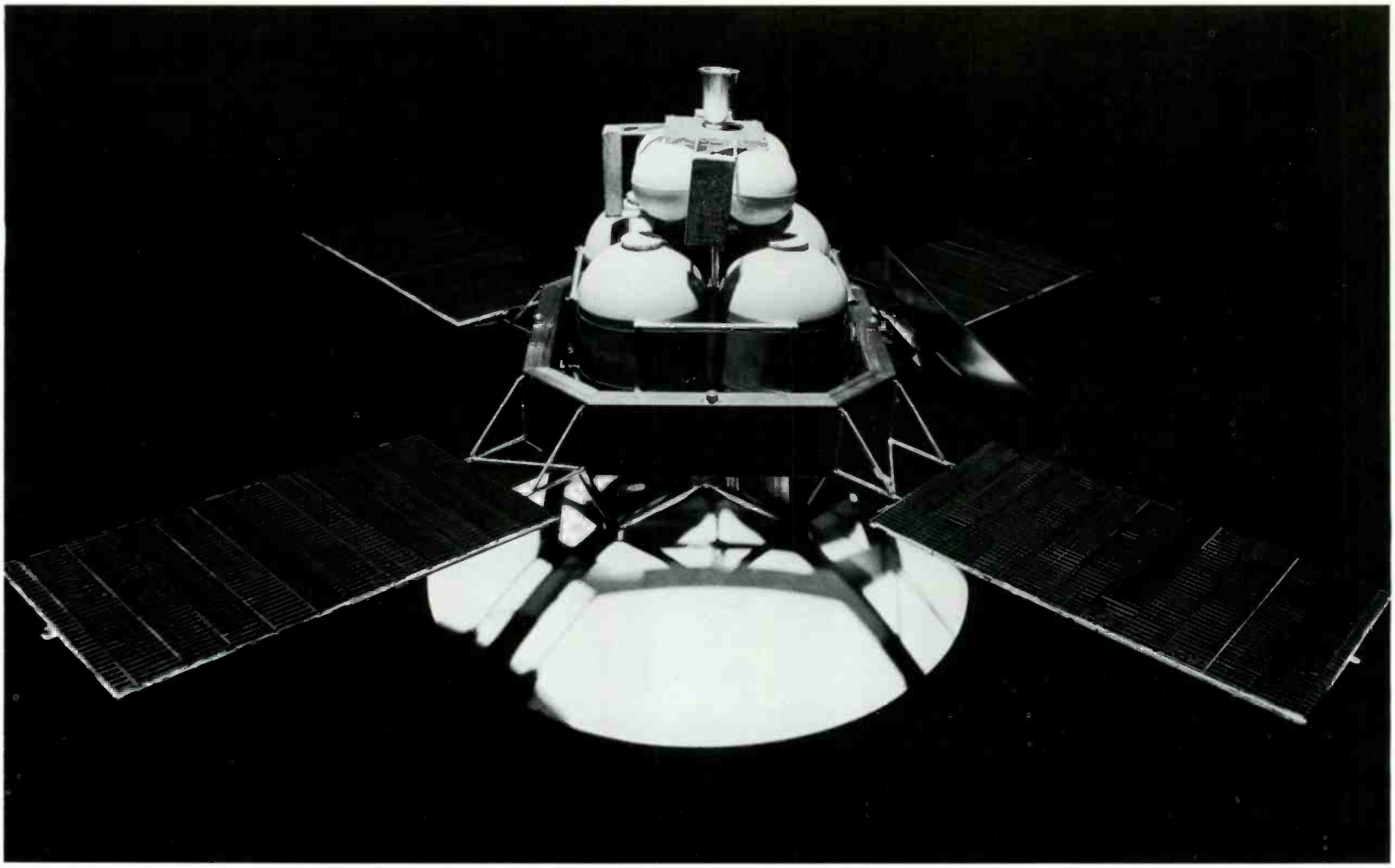
success of this flyby set the pace for the entire Mariner program, and in 1965 Mariner 4 sent back the first relatively close-up look at Mars.

Data from the Mariner 4 flyby were analyzed and studied and, in 1969, Mariners 6 and 7 were launched to fly by Mars on July 31 and August 5, respectively. The spacecraft took television pictures with high and low resolution from 2,100 miles above the Martian surface. In these pictures, the surface features were more carefully documented by the television cameras. When the pictures were relayed to earth, they indicated that the Mariner 4 photos had not been fully representative of the planet, and with Mariners 6 and 7, Mars suddenly assumed a character all its own unlike that of the earth or the moon.

The 1969 probes disclosed that the temperatures were so low at the south pole that the south polar cap was probably composed of carbon dioxide with the possibility that a very small amount of water-snow also was present. On the daytime side, temperatures at the equator rose to 75° F. and plummeted at night to about 100° below zero. These flybys also verified the analysis of the atmosphere made by Mariner 4 — that it is composed primarily of carbon dioxide with perhaps some water vapor, carbon monoxide, and molecular oxygen also present. However, there was no sign of nitrogen.

The observed lack of nitrogen on Mars is significant since the element is a major constituent of every known life form. If nitrogen is absent from the Martian atmosphere, or present only in undetectable quantities, could it be present in surface materials? This is not known. The absence of this element indicates to some astronomers that life, as man un-

S



Viking orbiters, such as the model shown here, will photograph the Martian surface in the mid-1970s to help determine sites for future manned landings.

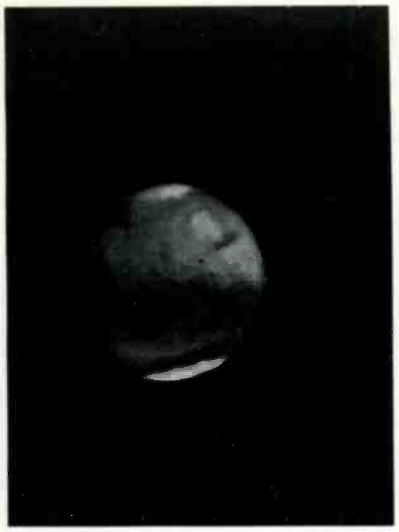
derstands it, cannot be present on Mars. On the other hand, a seasonal change takes place on Mars that is most difficult to explain unless it is assumed to be a form of vegetation. If there is life, why does it not manifest itself in the form of detectable nitrogen in the atmosphere? The 1969 Mariner flybys simply added to this mystery.

The hunt for Martian life goes back almost a century to 1877 when the keen-eyed Italian astronomer Giovanni Schiaparelli turned his telescope to Mars. He recorded some strange, faint, dusty streaks at the critical limits of visibility, which means that at times they were seen and at other times they were invisible. However, they did remain visible long enough to be recorded, and tne illustrations Schiaparelli made were among the first to record the delicate straight-line markings. He named them *canali*, an Italian word meaning channels. Two years later, in 1879, Schiaparelli viewed these lines again in precisely the same positions and was surprised to see one of them as a double line. Later, he found that many of the lines he first thought of as single turned out to be double.

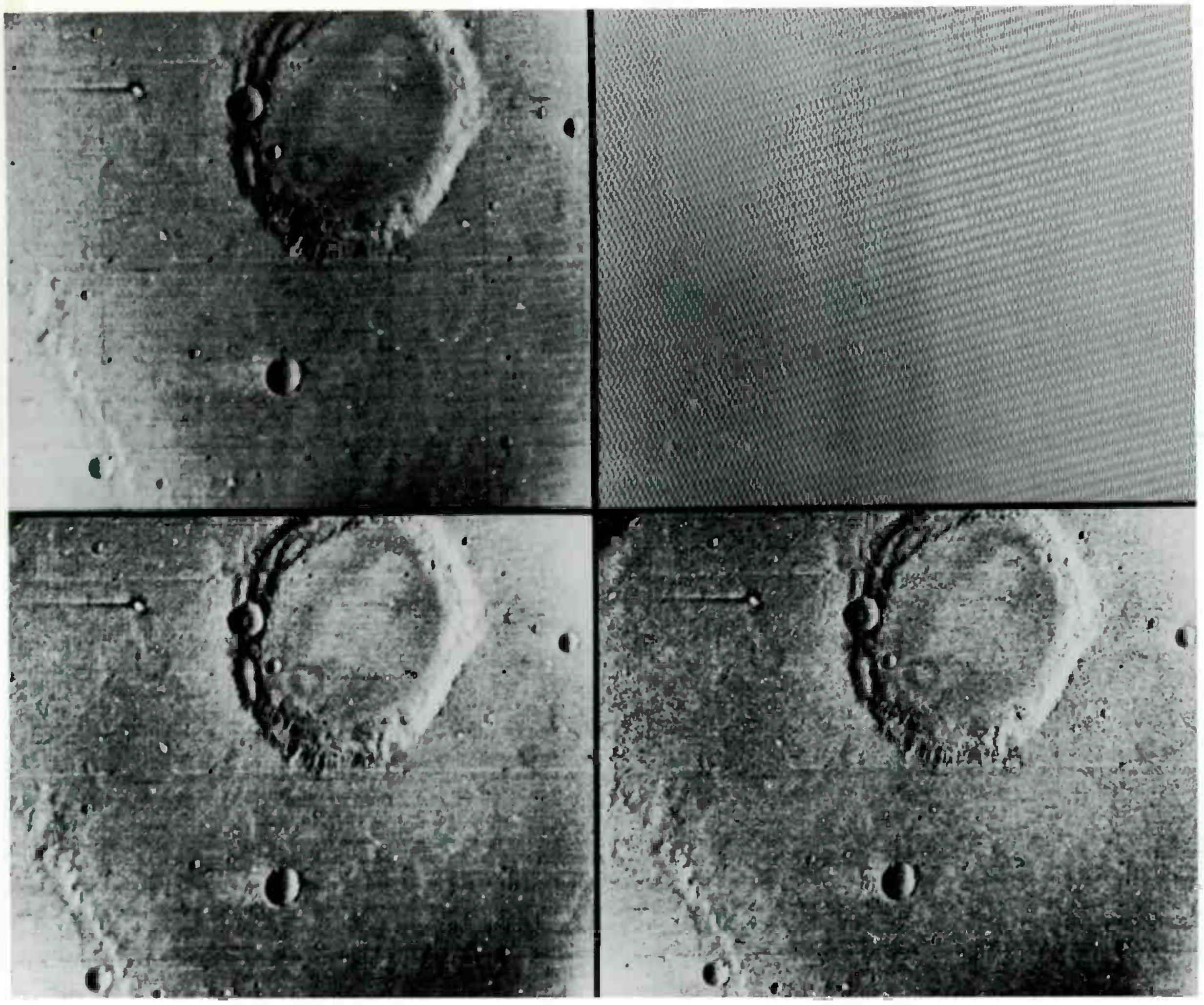
Toward the end of the nineteenth century, other astronomers reported seeing these lines. In 1892, at Flagstaff, Ariz., Percival Lowell observed the lines and became so fascinated and absorbed by them that he devoted the rest of his life to drawing, photographing, and writing about Mars. He drew a complex network of canals that covered the Martian surface. Lowell believed not only that there were canals but that they joined at intersections to create what he termed oases. In 1906, in his book *Mars and Its Canals*, he suggested that the network of canals and oases appeared to be a stupendous engineering project by living beings endowed with a high degree of intelligence. These beings had engineered canals to circulate and distribute the meager supply of water provided by the seasonal melting of the polar caps. Although most astronomers did not interpret the lines as canals, the concept of an intelligent life form on Mars caught the imagination of the public. Many persons were convinced that there were living creatures on this planet, and the Sunday supplements of the late 1920s and 1930s bear testimony to the manner in which this idea was exploited.

In the Mariner pictures, Lowell's oases seem to be identified with large, single, dark-floored craters such as the Juventae Fons. Some of the canals seen by ground-based astronomers appear in the pictures to consist of several dark-floored craters in quasi-linear alignment with each other, and others appear to be composed of irregular dark patches.

An answer to the riddle of the canals was provided even before the advent of the space age. In the early 1950s, the French astronomer A. Dollfus indicated that, on nights of excellent "seeing," he could observe the straight-line features just as drawn by Lowell. However, on nights of superb "seeing," the straight-line features were resolved into a string of heterogeneous markings, which Lowell



Mariner 7 photograph of Mars taken from a distance of about 500-million miles.



Right: Computer enhancement is illustrated in this Mariner 6 photograph. A portion of the frame as originally recorded is shown at upper left. In it can be seen a faint basketweave pattern caused by electronic pickup in the camera system and a general softness because of limits in resolution. Computer analysis revealed the pickup pattern shown at upper right. When the appropriate numerical value determined from the pickup pattern was subtracted from each of the 658,240 elements of the picture, the result was as shown at lower left. Two further computer programs, used to compensate for the softness, result in the picture shown at lower right.

apparently had seen integrated as canals. Data from the 1969 Mariners have indicated that the canals may possibly be identified with a variety of surface features, and thus the space probes resolved one problem that was the subject of acrimonious debate among some of the most competent telescopic observers who ever lived.

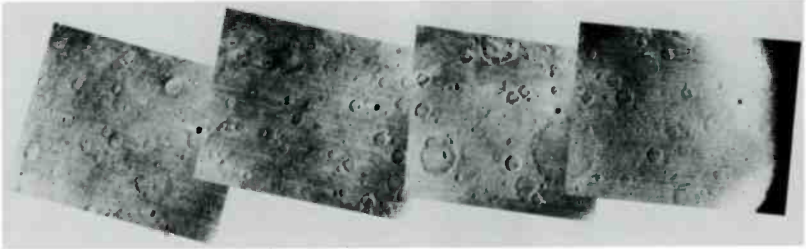
What is little known outside of scientific circles is that Mariners 6 and 7 also resolved the mystery of the "hollow Mars." Astronomers had, for some time, been puzzled by what seemed to be a flattening of the polar regions of the planet. This oblateness should have produced a distortion of the planet's gravitational field, which, in turn, would affect the orbital behavior of the two Martian moons, Phobos and Deimos, in a way that could be measured precisely. But these measurements did not check out. There was a 20-mile difference between the predicted and actual measurement of the Martian polar diameter. One method of explaining this was to postulate a hollow Mars. This was an artificial and unlikely explanation, but it represented the best of some rather unlikely solutions. However, the Mariner pictures disclosed a "dark hood" over the south polar cap that had led to a smaller observed optical diameter. When the polar diameter of Mars is increased to allow for the dark hood, the discrepancy in diameters disappears, and today Mars does not have to be hollow to account for the motions of its satellites.

The pictures relayed back by Mariners 6 and 7 permitted scientists to differentiate among three different types of terrain on the planet.

The first is cratered terrain, which provoked such a stir in the scientific community when the Mariner 4 pictures were examined. It was discovered that Mars is indeed pockmarked by craters of all sizes, not unlike the lunar surface. However, there is one major difference: the wall height of the craters on Mars in comparison to their diameter is a good bit less than that of craters on the moon. Mars has a very thin atmosphere, and there is minimal erosion on the planet, particularly in areas of cratered terrain. Scientists believe that some of the craters may have been formed in the earliest days of the solar system, going back perhaps 3- or 4-billion years. This has helped to set limits on the approximate age of the planet.

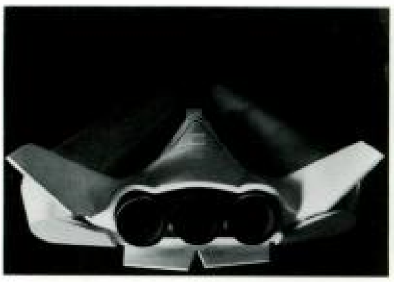
The existence of craters indicates that they should be present all over the planet. In reality, only the southern hemisphere of Mars has been explored, and knowledge of the surface in the northern hemisphere is quite limited. To date, there is little evidence that volcanic activity played a significant role in forming the Martian craters, while volcanic craters are much in evidence on the moon.

The second type is termed chaotic terrain. In such areas, the relatively smooth cratered terrain gives way to irregularly shaped areas of jumbled ridges that would look like scattered, terrestrial mountain ranges to orbiting astronauts. Curiously, the ridges have a higher albedo, or reflectance, than adjacent cratered areas and appear mostly craterless. Chaotic terrain is one feature that makes

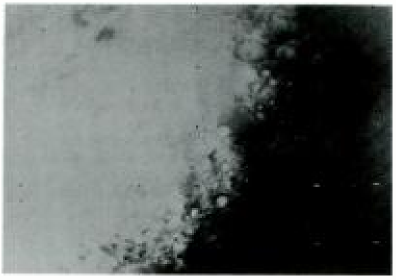


These composite, high-resolution pictures taken by Mariner 6 show cratered terrain.

"Mars . . . will provide the key to the exploration of the entire solar system."



Mock-ups of nuclear space shuttles that could be used to propel a manned spacecraft to Mars.



Mariner 7 photo of craters on edge of south polar cap. The deposit is believed to be either a layer of frozen carbon dioxide ice a few feet deep or a layer of water ice less than an inch deep.

Mars unlike the earth or the moon and gives the red planet a flavor, a character, all its own.

The third type is termed featureless terrain and consists of the desert regions that astronomers see as reddish in their telescopes. These areas appear to be craterless down to about 1,000 feet.

The most spectacular photos relayed back by Mariners 6 and 7 were of the south polar cap. On carefully prepared pictures of this region, the edge of the cap is seen as ragged, and the carbon dioxide "snow" enhances crater visibility along the rim. Since the snow lies preferentially on the slopes of craters facing the pole, these craters are better detailed and more easily seen because of the high contrast.

Since the successive Mariner probes revealed new kinds of terrains and other unexpected phenomena, scientists expect more important surprises when future spacecraft are launched to Mars. The two 1971 Mariner spacecraft to Mars will adapt their flights to study these new features and will circle the planet for at least 90 days.

These spacecraft will be launched to Mars at a cost of $120 million. Their success is considered likely because the same subsystems that worked so effectively on Mariners 6 and 7 will be used for the 1971 Mariner flights. The principal objectives of the 1971 flights will be to make a detailed exploratory examination of the surface features and to map the planet.

The spacecraft will approach the southern hemisphere of Mars during early summer. One of the orbiters will swing into a 12-hour-long elliptical orbit inclined 60 degrees to the Martian equator, coming within 1,000 miles of the surface at its closest approach and 10,000 miles at the other extreme. The second orbiter will go into an almost polar orbit that takes about 33 hours. With this spacecraft, NASA hopes to obtain closeup photos of the Martian satellites. Scientists had hoped to have the closest approach within 1,000 miles of the surface, but, if the altitude were less, the motion of the orbiter would blur the vital television pictures.

Because the two orbiters will spend at least three months circling the planet, they will be able to monitor changes in the surface features and perhaps provide an answer to the nature of seasonal changes on Mars. Instruments will record the wave of darkening as the surface features change from bright to dark with the seasons and will attempt to make a definitive measurement of water vapor in the atmosphere as well as detect changes in its composition over certain areas as surface changes appear. The planet also will be monitored for dust storms and weather patterns. It is hoped that the sublimation of the south polar cap (evaporation of the carbon dioxide directly from its frozen state) can be studied to detect evidence of variations in the thickness of the deposit and of the possible existence of a permanent deposit. The polar orbiter also will have a chance to study the north polar cap.

The portrait of Mars painted by Mariners 6 and 7 is of a planet with an environment that is incredibly harsh, dry, and so saturated with deadly ultraviolet radiations that the possibility of the existence of life forms is extremely remote. However, Mars still must be explored to make certain that this opinion is an indisputable fact.

Everything learned from the Mariner program will be vital to the planning now under way for the Viking project, presently scheduled for 1975. That mission will consist of launching two unmanned spacecraft that will orbit Mars and release landers to soft-land probes on the Martian surface. Instruments aboard the Viking orbiters may aid in preselecting the landing sites and guiding the two landers to their target areas, which will be in an equatorial strip bounded by 10 degrees South to 25 degrees North. While the landers descend, atmospheric measurements can be made and relayed back through the orbiters to earth in real time. Simultaneously, this information also can be stored in the landers, which will then relay it to the orbiters for retransmission to earth. The most significant aspect of this process is that the scientific exploration will be enhanced by the correlation of remote measurements from orbit with direct measurements made by the landers in the atmosphere and on the surface.

The ground rules for the scientific experiments on this mission have been delineated. NASA insists that each lander be sterile. On their way to the Martian surface, the landers should determine the atmospheric composition, with emphasis on water vapor and trace constituents. Once on the ground, each lander will provide visual information about the landing site and data on daily and seasonal variations that occur on the surface. They will search for organic compounds and, more important, for evidence of life forms and also will radio back information on the amount and nature of water in surface materials. Finally, the landers should attempt to determine the daily variations in temperature, pressure, wind, and dust over the Martian surface.

While the landers are on the surface, the Viking orbiters will move into highly elliptical, Martian-day-long orbits with a close approach of about 600 miles and a maximum distance of about 20,000 miles. Each orbiter will take pictures of the Martian landscape and attempt to map surface temperatures and water abundance. They also will make a reconnaissance of the planet to help determine landing areas for future manned missions to Mars.

There is considerable pressure being exerted at this time to soft-land a probe on the Martian surface. The Soviet Union has publicly declared its intention to do so, and some astute observers believe it may attempt this in 1971. Certainly, with the launching of a permanent space station, which the Russians may consummate within a year, they will be in a much better position than the United States is to attempt this feat.

However, the assault on Mars will continue beyond 1975, for this planet will provide the key to the exploration of the entire solar system. The various spacecraft used in the Mars flights will have applications for all manned missions in the foreseeable future. There are opportunities to launch spacecraft to Mars approximately every 26 months. Thus, the first post-Viking flight possibility will be in 1977, and preliminary work on the mission is under way. What about 1979? Currently, lack of information about the planet precludes programming missions so far in advance. Until the data of the Viking mission are analyzed, no one can provide guidance for economical yet meaningful and definitive investigations of the planet.

Aside from technical considerations, the physiological and psychological wellbeing of the crew is a problem of the first magnitude to NASA planners. This is why the 640-day, first manned flight to Mars looms so important. In terms of time and a suitable environment, Mars is the nearest planet on which we can land. To plan any other trips means that, first, we must discover how astronauts will accept the rigors, hazards, and almost intolerable isolation of this flight. Once these factors are known, future flights to more distant targets can be contemplated.

At present, it appears that the 1981-1983 manned flight to Mars is a barest possibility, for Congress is in no mood to allocate the $25 billion or more needed to support an early mission. Vice President Agnew proposed that the target date for a manned flight to Mars be moved to 1986. In all probability, if there is a manned flight to the red planet, it will come in that year. However, it must be realized that any delay that projects the flight into 1986 may mean that the Soviet Union will reach the planet first. The Russian multiple launchings in October, 1969, may evolve as the first step in the manned exploration of Mars.

One thing is certain. Man's centuries-old dream of setting foot on the planet Mars is rapidly coming into the realm of technical feasibility. And the coming development of propulsion systems based on nuclear energy may bring the entire solar system within his grasp. ■

For the Records...

Mozart
Peter Serkin, pianist LSC-7062

Peter Serkin's first solo Mozart album, a two-record Red Seal set, presents a wide variety of the composer's best music for the piano. Serkin has included the Fantasias in C Minor and D Minor, the Sonatas in C Minor and F Major (the latter rarely heard), and the Rondos in A Minor and D Major (two of Mozart's most famous shorter pieces for the piano). The earliest work in this Serkin survey, the Präludium and Fugue in C, dates back to Mozart's more traditional period in Vienna.

Schubert: Sonata in B-Flat, D. 960
Artur Rubinstein, pianist LSC-3122

Artur Rubinstein has played this sonata for his own pleasure since his youth, but his first formal performance took place in 1963 in RCA Italiana's Studio A in Rome, the day after he completed his rerecording of the Chopin waltzes. These sessions inspired Rubinstein to make the sonata the major work in many of his recitals the following season. After years of refinement in his conception of the work, Rubinstein recorded this performance in Rome in June, 1969. Of the performance, Rubinstein has commented: "I have come as close as I am able in expressing my feelings about a work whose ultimate beauty, I feel, is beyond any single performer's ability to completely realize."

Masselos Plays Satie
William Masselos, pianist LSC-3127

The music of Eric Alfred Leslie Satie, a satirist who was one of the famous French Six of the 1920s, has found new interest of late among a large circle of classicists. One of the prime movers in the revival is pianist William Masselos, who has assembled this representative collection of Satie's most interesting pieces. These include Sports et divertissements, which Masselos has incorporated into his regular repertoire; the humorous Le Piege de Meduse; Gymnopedies; and the tongue-in-cheek Embryons desseches.

Volunteers
Jefferson Airplane LSP-4238

This album represents a unique venture for Jefferson Airplane, the most lauded of San Francisco's rock groups. Their most recent RCA album release presents the six artists, along with several noted musician friends, in a controversial look at the contemporary scene. The Airplane sings of youth communities in "We Should Be Together" and of political action in the album's title song and takes its first excursion into the area of country rock with "The Farm" and "A Song for All Seasons."

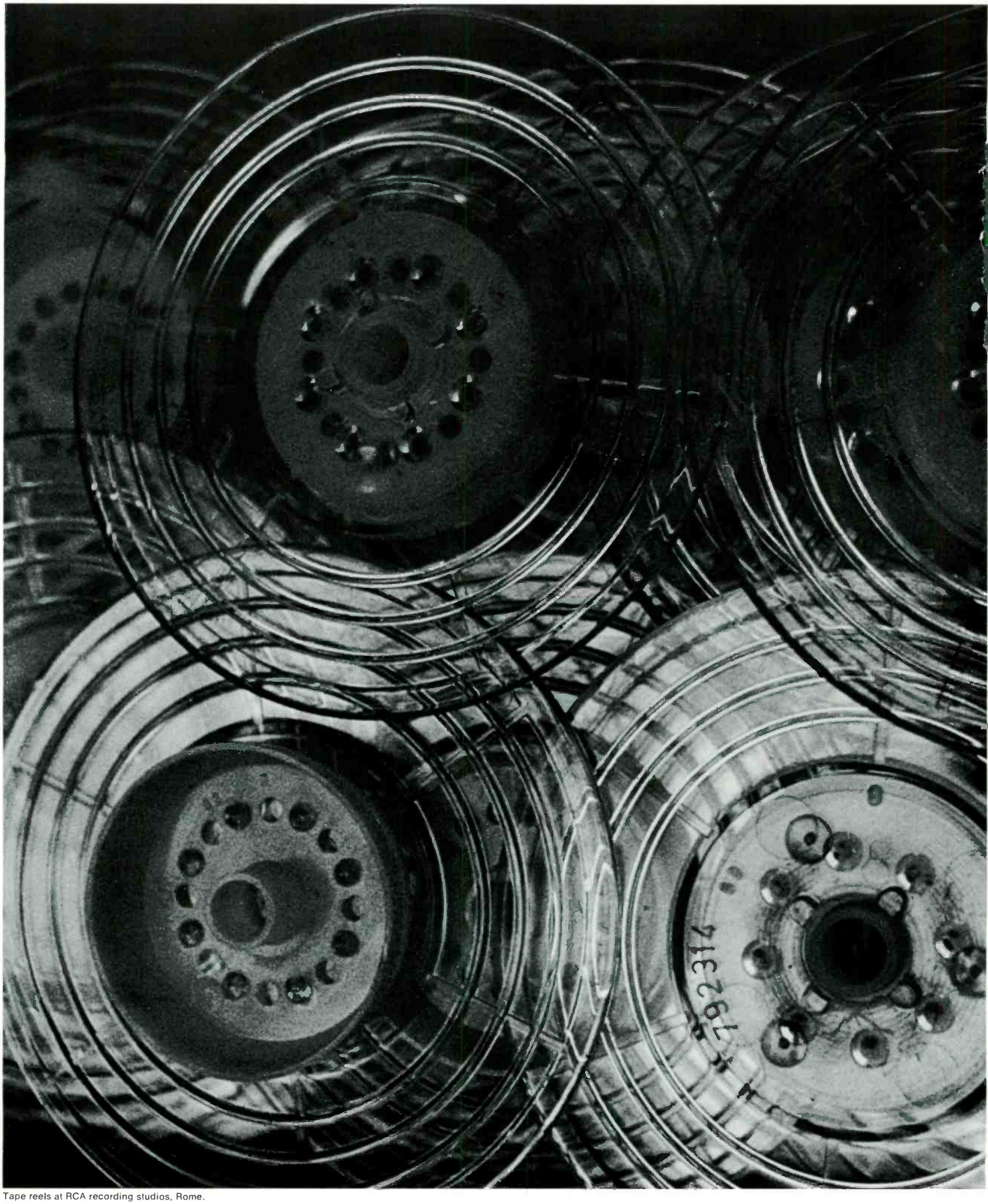
From Memphis to Vegas/
From Vegas to Memphis
Elvis Presley LSP-6020

Elvis Presley's most recent RCA release is a two-record set that presents the artist in two completely different spheres of music. The first record is an "in-person" taping from Presley's smash engagement at the International Hotel in Las Vegas last summer, which had marked his first appearance in nine years before a live audience. The second record features Elvis in a studio session in Memphis. It contains nine songs, composed by contemporary popular writers, that have not been recorded before by Presley.

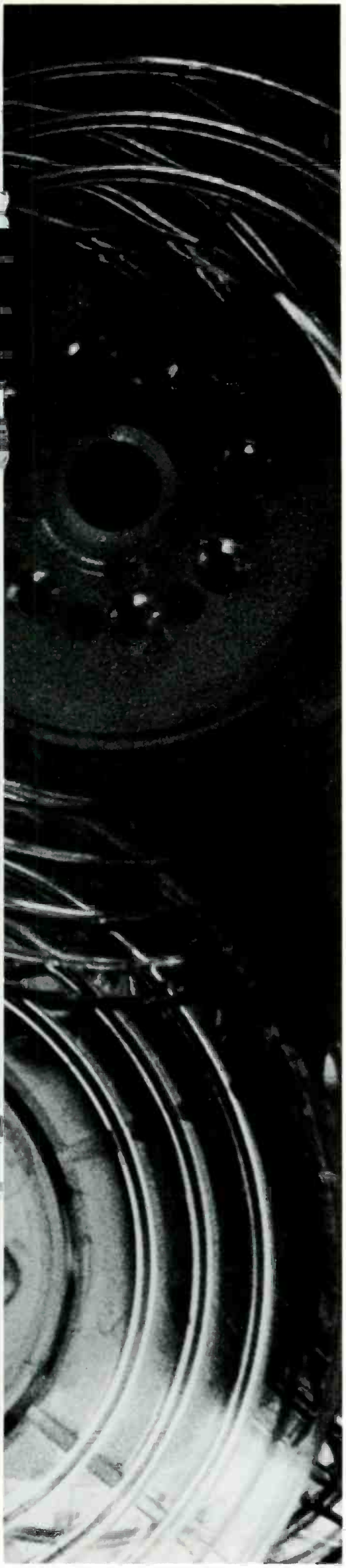
alive alive-o!
Jose Feliciano LSP-6021

Jose Feliciano's first live-performance recording, a two-album RCA set, recaptures the excitement that he created at a packed London Palladium concert early in October, 1969. Backed by a trio—as well as performing solo—Feliciano displays his unique style in a selection of American standards and contemporary favorites, traditional Latin material, and Feliciano originals. He also shows his versatility as an impressionist, doing interpretations of a number of well-known performers, and demonstrates his remarkable instrumental ability across a range of guitar techniques in an original number entitled "La Entrada de Bilboa."

Other Current RCA Releases



Tape reels at RCA recording studios, Rome.



Evolution of the Recording Studio Recording Studio Recording Studio Recording Studio Recording Studio

Modern electronics and age-old acoustical principles play leading roles in the design of today's recording studio.

by Robert Angus

When Thomas Alva Edison shouted "Mary had a little lamb" into the mouthpiece of his newborn phonograph one morning in November, 1877, the Wizard of Menlo Park was not very much concerned about the acoustics of the room. It was enough that the tinfoil cylinder, on which a stylus had impressed the sound patterns, was capable of reproducing intelligible speech at all—and something of a bonus that the voice repeating the nursery rhyme was identifiable as his.

Today, the acoustical environment in which a recording is made is of prime concern. The recording studio plays a major role in determining the qualities of the music and may even help to create distinctive new sounds. In fact, two of the new RCA recording studios in New York were constructed so that their reverberation time can be changed to suit a particular work, and other sound characteristics can be altered as desired. Although the advent of the custom recording studio had to wait for the technology of the late 1960s, the fledgling recording industry quickly recognized the importance of acoustics.

By the turn of the century, when the phonograph had begun to be accepted as a medium for culture and entertainment in the home, Edison was paying a good deal of attention to the room in which his company was making recordings. Because there was no practical way of duplicating the Edison cylinder, it was necessary to use from three to 22 machines operating simultaneously to make copies for sale. A singer would bellow at the battery of metal horns over and over again, until he had produced enough cylinders to satisfy orders, or until his voice gave out.

Take that otherwise forgotten day in 1902 when baritone George W. Johnson stepped up to such an array in the Edison Laboratories. He stood in the middle of the large, bare room, which served as Edison's recording studio, in front of a 10-piece orchestra. Facing him was a battery of horns arranged in a semicircle so that theoretically each horn would pick up the singer's voice and the music from the orchestra with equal clarity. In practice, it was impossible to determine optimum placement distances precisely, and the result was an overpowering of the singer by the tuba, or vice versa.

Edison's technical staff, which consisted of a recording engineer and an assistant, removed every stick of furniture and drapery from the room so that all the sound the musicians produced could find its way into the horns. Before each performance, the assistant fitted a new cylinder on each machine, and the recording engineer stepped up to each instrument in turn, started the motor, and announced, "'The Laughing Song,' sung by George W. Johnson, Edison Records." After he had recorded the title and the musicians were ready, the engineer restarted all the machines simultaneously, and the recording process went on until everyone was exhausted.

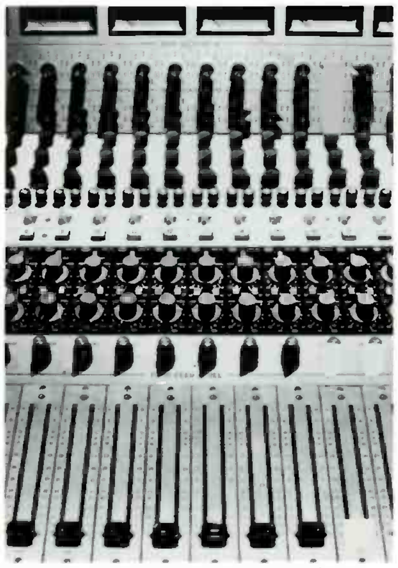
That same year, recording engineer Fred Gaisberg and Alfred Michaelis, who arranged the session, made one of the first and most important on-location recordings. They converted a room on the third floor of the Grand Hotel Statz in Milan, Italy, into a recording studio. To shut out street noises, the two men hung blankets across the windows and stuffed bedding around the door. Then, pianist Salvatore Cotton sat down at the keyboard, Gaisberg started his equipment, and a young tenor named Enrico Caruso spent the next two hours singing 10 of his best-known Italian songs and arias.

In those early days of the recording industry, it was considered enough to prevent outside noises, like the traffic din in the streets of Milan, from intruding on a recording by Caruso and to seal in and reflect into the horns every last note sung by Johnson.

But the acoustical environment was not an impartial observer of the musical recording scene. It favored the powerful voices of singers like Caruso and Chaliapin, while making other voices sound screechy or dull. The sounds of a tuba reproduced wonderfully well, as did those of triangles. But piano and violin sounds were another matter; they tended to fade. Recording engineers discovered that, although they could not overcome the acoustical prejudices of the recording system, they could moderate the effects by moving musicians around—putting some closer to the horn, providing a miniature bandshell to bolster and project the sound of flagging strings, and isolating the noisy brasses from the rest of the orchestra.

Arthur Fiedler recalls that, when the Boston Symphony Orchestra made its first record back in 1917, recording engineers built two igloo-like plywood structures in an attempt to create an acoustical likeness of an actual performance in Symphony Hall. The first igloo housed the trumpets, horns, and trombones and isolated them from the recording system; the second housed the strings and coupled them directly with the system. But the acoustical peculiarities of recording sometimes made it necessary to tamper with the composer's instrumentation.

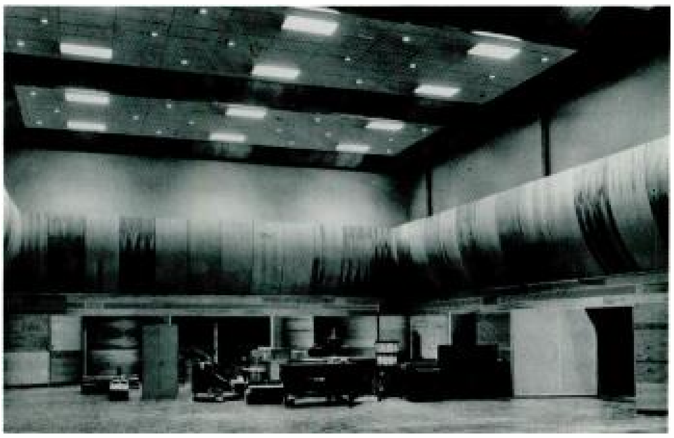
Until well into the 1960s, the aim of any recording session (and of most high-



Mammoth control console at the new RCA recording studios in New York can accommodate 30 microphone inputs.

Robert Angus is editor of *Tape Recording* magazine.

This large RCA studio in New York is for recording operas, symphonies, and show music.



fidelity sound reproduction equipment) was to produce a re-creation of an actual concert. Engineers might argue over whether the ideal spot in the hall was fifth row center, the conductor's podium, or the first row in the balcony, but generally they agreed that realism was what they were after.

And until comparatively recently, a recording studio might be just about anything: a sound-dampened hotel room in which the late Eli Oberstein recorded the first country music back in the 1920s; an abandoned church, movie house, or concert hall; a suite of offices converted into one room large enough to set up recording gear; a radio broadcasting studio; or even the living room of a converted brownstone. At first, the requirements were simply that the room be isolated from outside sounds; that it be large enough to house the musicians, recording technicians, and necessary equipment; and that it have no special acoustical peculiarities. During the big band era of the 1930s and '40s and the progressive jazz period in the early '50s, the idea was to let the musicians "do their own thing" and to put it down on records (and, later, tape) with a minimum of inconvenience and outside distraction.

But several things were conspiring to make this kind of recording studio obsolete. These included the introduction of stereo in 1958, the rock revolution and its reliance on electronic instruments, the improvement in recording tools, and the growing professionalism of the recording engineer. Edison's engineer was not required to know much more than how to set up his recording machines and change cylinders at regular intervals. When electrical recording came into use with the introduction of the microphone in 1925, the recording engineer had to learn something about microphone placement, electrical theory, and at least elementary fading and mixing techniques. However, all these skills could be learned on the job without formal training. Within five years, Leopold Stokowski was experimenting with a multitude of microphones — in fact, just about one for every member of the Philadelphia Orchestra.

Hinged panels that can be positioned to absorb or reflect sound give two of the new RCA studios in New York a variable reverberation time.

The job of the recording engineer became more complex, and his responsibilities grew. As microphones improved and more varieties became available, an engineer could select among them, the way a photographer can interchange lenses, to find just the right microphone to do a particular job. By twisting a knob, he could permit the piccolo to dominate the orchestra or banish the piano soloist to oblivion. Still, it was experience that one picked up on the job, and no formal training was required.

Then came stereo and with it new problems and possibilities. Now each orchestral section, and even single instruments in small groups, could be recorded separately, as Stokowski had done. The new control panels provided first two, then four, eight, and 16 separate channels, and the recording engineer could assign one channel to each instrument or group during the recording. Later, in consultation with the artist, the conductor, and the A&R director (who supervises the musical aspects of the recording), the recording engineer could enhance the violins, subdue the percussion, or shift the sound of instruments from left to right at will. This was precisely what Stokowski had been aiming for in the 1930s. The difference was that once the recording engineer of the '30s had adjusted his dials and lowered the cutter onto the wax master, it was no longer possible to make changes. Stereo and multitrack tape recording made it possible to remix or remaster at any time, even after the musicians had gone home.

Serious musicians were slow to see the possibilities, but pop artists, and especially rock groups, realized that a recording no longer needed to duplicate a live performance. With stereo and other electronic techniques such as echo and distortion of electric guitars, organs, and other instruments, an entirely new sound could be created in the studio that was impossible to reproduce in a nightclub or TV studio. The rock groups began making demands that the physical facilities of some converted offices, homes, or churches could not meet.

Recently, musicians such as conductor/composer Morton Gould have been using some of the new techniques. His "Venice (Audiograph for Double Orchestra and Brass Choirs)" is scored for two separate orchestras. Gould describes how it was recorded. "We decided to take advantage of the technological possibilities of multichannel recording. Milton Katims, conducting the Seattle Symphony, first recorded the Orchestra I part on four tracks of an eight-track tape. By listening over headphones to that part, he then synchronized the performance of the Orchestra II part on the remaining four tracks of the same tape. This was a highly complex and difficult undertaking because, obviously, both orchestras had to dovetail and coordinate with each other. For the finished record, the eight tracks were reduced to produce two stereo channels, with Orchestra I predominant on the listener's left and Orchestra II on the right."

In his "Vivaldi Gallery," Gould worked with Vivald themes, using one orchestra divided into separate units, much as Vivaldi had used multiple instrumental and vocal choirs that were "physically separated from each other but component parts of a whole aural fabric — live stereo, so to say." For this recording, "the strings were separated into String Orchestra I on one side of the stage, String Orchestra II on the other, and in the center was a third group consisting of a string quartet. The woodwinds, brass, horns, and harp were also divided into various groups. . . . These wind and brass choirs supported and enhanced the two string orchestras and the string quartet."

The popularity of stereo and the rock phenomenon launched a boom in studio building. In 1962, RCA Italiana's multimillion-dollar studios were opened in Rome. Other major companies also have built

"We can pretune each studio... then feed the information into a computer so that someday in the future a recording engineer will know in advance the best settings for the rock group he is going to record."

studios in such places as London, Hollywood, and Nashville.

The first problems faced by designers were size and shape. Obviously, an auditorium suitable for recording *Aida* would not necessarily be appropriate for recording a rock performance by The Lighthouse. An opera requires space in which to move around as well as space for equipment and for that elusive quality created by the resonance of a studio that can lend the atmosphere of a La Scala opera house to a recording. On the other hand, most rock groups want an intimate atmosphere in which every sound they make goes directly into the microphone.

To meet the requirements of all types of music, RCA built six studios in New York in 1969. The first measures 30 x 60 x 100 feet and is suitable for recording a symphony orchestra, a Broadway show, or possibly an opera. The second, designed for semiclassics and big band sessions, is 27 x 50 x 75 feet. The third is 24 x 50 x 75 feet and is used for pop groups and larger rock sessions. In addition, there are a smaller studio for rock music, 15 x 27 x 40 feet, and two studios for overdubbing, or adding a vocalist to a previously recorded orchestra.

Although the studios vary in size, the proportions remain similar—a ratio of about 1:2:3. Al Stevens, Manager, Facilities and Operations Engineering at RCA Records, notes that there is nothing new about these proportions. They were developed by the Greek philosopher and mathematician Pythagoras in the fifth century B.C. and applied to the design of auditoriums by Boethius, a Roman philosopher and translator in the sixth century A.D. The formula that Boethius developed from Pythagoras' theories on mathematics and music holds that the ideal room in which to listen to music has dimensions in a ratio of 1:2:3. In practice, engineers today find this ratio nearly correct—but not quite. "It creates minor acoustic problems like dead spots and minor echoes," says Stevens. "So we vary the dimensions slightly from the basic formula, curve the wall panels, and break up the surface to dispel any standing waves."

Another important consideration in designing a studio is reverberation time, or what musicians call tonal decay. "Reverb time," or how long it takes a musical tone to disappear in a room, is what gives a distinctive character to an opera house, a cathedral, or a nightclub. In an echo-free chamber, for example, a tone disappears into the sound-absorbing walls instantly, with a reverb time of virtually zero. In a concert hall or opera house, a tone may reverberate from two to two-and-one-half seconds, while in a cathedral it may echo and reecho for five seconds or longer. For most classical music, engineers feel that a reverb time of about two seconds is ideal. On the other hand, rock groups prefer a reverb time of a half-second or even less.

In the early 1900s, acoustics were largely a matter of capturing sound. Soprano Lina Cavalieri and tenor Lucien Muratore made some of the earliest operatic recordings.

Until recently, the average recording studio was equipped with fixed panels that reflected sound upward or downward, and therefore the room had a fixed reverb time. These panels were constructed of materials that absorbed unwanted sound and reflected the desired tones. But two of the new RCA studios in New York have a variable reverb time. Normally, the reverb time of the larger studio is an exact two seconds, but it can be changed in two ways—by lowering or raising the ceiling and by lowering or reversing the hinged, movable panels mounted on the walls. The ceiling can be dropped as much as 10 feet, cutting the reverb time in half. By lowering the ceiling only part of the way, the reverb time can be reduced proportionately. In addition, the movable, curved wood panels are used to diffuse the sound and to "tune" the studios. These panels can be lowered to expose a sound-absorbing wall behind them, reducing the reverb time to as little as 0.7 seconds.

Indeed, the movable panels are a hallmark of the new studios. They are coated with a sound-reflecting material on their convex side and with a sound-absorbing material on their flat side. Thus, when the panels are reflecting sound, the studio has a "live" sound suitable for a string quartet. When the panels are reversed, the same studio has a comparatively "dead" sound suitable for recording a loud rock session. Also, the largest of the new studios has a pull-out platform, and the hinged, movable panels can be arranged at its top and sides to form a bandshell that reflects sound outward.

In order to subdue certain sounds, such as a rock drummer or some part of an orchestra, recording engineers frequently use an isolation booth. In most studios, isolation booths have been built by using free-moving panels that look like blackboards on wheels. In the new studios, the recording engineer can create an isolation booth simply by pulling out the appropriate hinged panels.

"In fact," Stevens says, "we can pretune each studio, determining what results we get when we alter each panel. Then we can feed the information into a computer so that someday in the future a recording engineer will know in advance the best settings for the rock group he is going to record."

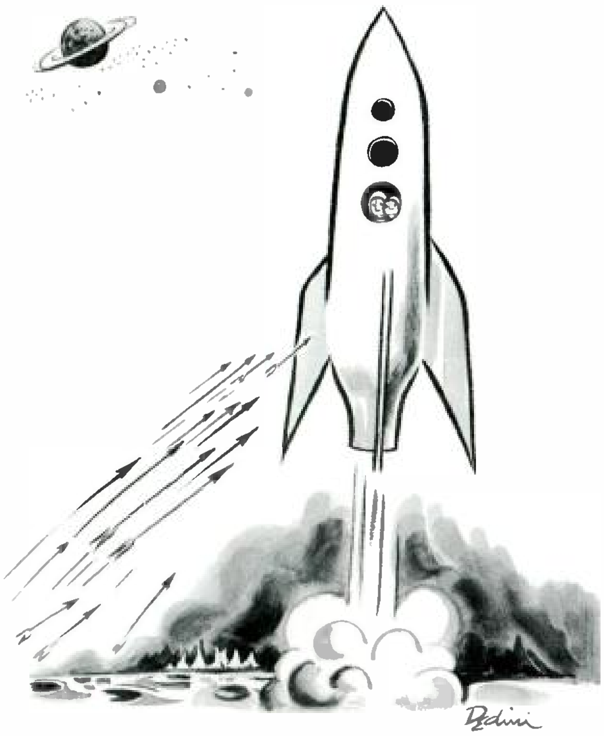
The control rooms, separated from each studio by a large double-plate-glass window, vary slightly in size, although most measure approximately 10 x 20 x 30 feet. Here the A&R director and the recording engineer work, together with a battery of equipment, assistants, technicians—and an occasional interloper. The mammoth console can accommodate as many as 30 microphone inputs and can inscribe up to 16 separate sound tracks on a reel of two-inch-wide magnetic tape.

By using directional microphones very sensitive to sounds immediately in front of them, the engineer can break up the orchestra or rock group into component parts and tape each one separately. Later, working with the A&R man and the performers, he can balance the parts against one another to produce exactly the right sound on a record. In addition, most engineers use two nondirectional microphones to pick up the broad view, getting the ambience of the studio. These so-called ambient tracks can be mixed later with the music tracks to produce a natural-sounding recording.

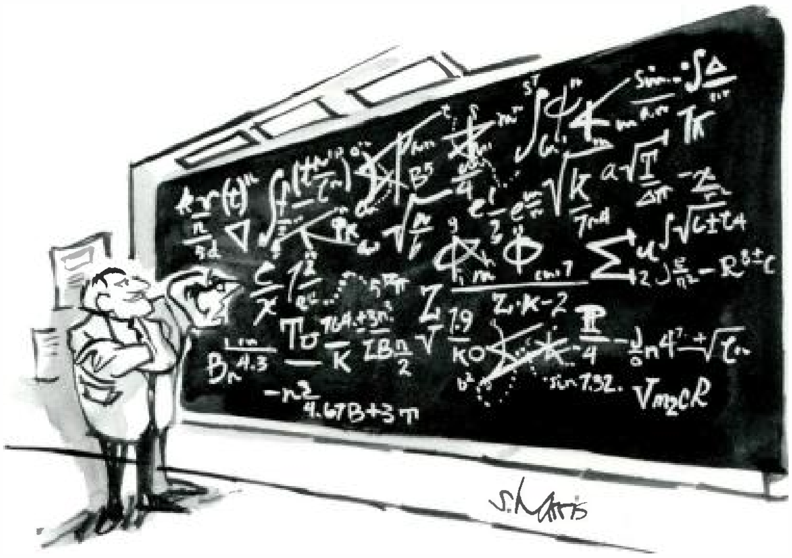
Remixing takes place in the tape mastering room. There, in an acoustical environment identical to that of the control room, the record producer and mastering technician can decide whether a recording needs additional reverberation or echo or if the strings are loud enough in relation to the brass. Stevens and his associate, John E. Volkman, of the RCA Laboratories in Princeton, N.J., feel that this duplication of the studio and control room characteristics is essential to precision mastering. "Traditionally, mastering is done in a separate room to free the studio and control room for another recording session," Stevens explains. "All too often, it's been done in just any room, with equipment entirely different from that used to make the original recording."

Already, pop groups are studying the potential of the variable studio to see how it can help give them a distinctive new sound. If history is any guide, the classical musicians can't be far behind. ■

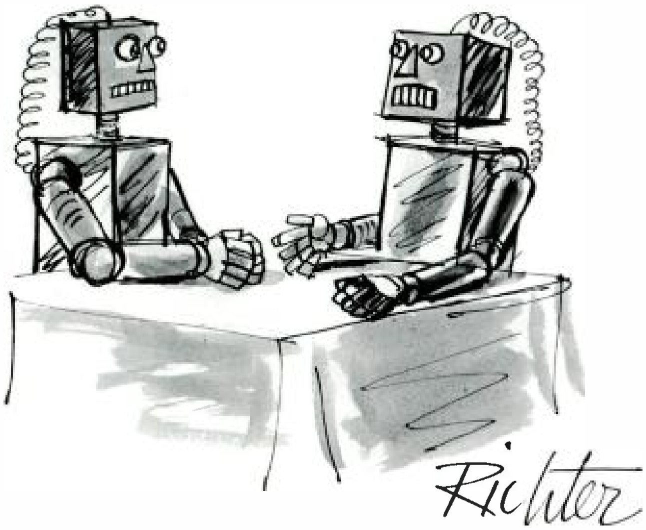
This Electronic Age...



"It always winds up by saying, 'But, you're the boss.' I like that in a machine."



"Amazing! All with ONE piece of chalk?"



"You know what I'd like? An emotional problem."

"Let me refresh your memory, Herr Doctor Claudle. Laser beams can turn corners."

SURVEYS FROM SPACE

Orbiting satellites soon will be used to provide data on the critical natural resources of the earth.

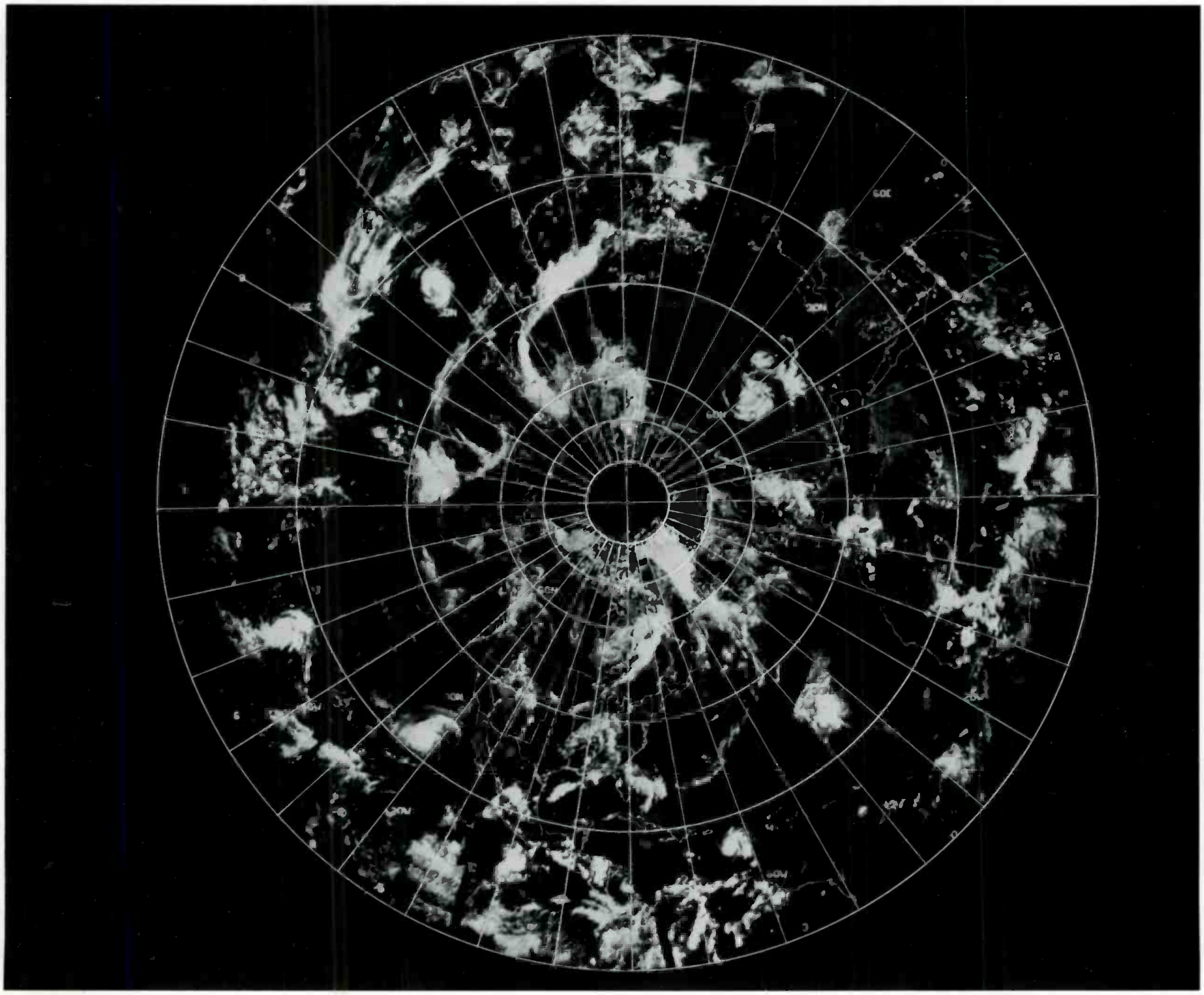
by Tom Elliott

One of the most promising concepts to emerge from aerospace technology is the use of orbiting satellites to survey the natural resources of earth, leading to a better understanding and control of the environment. The Earth Resources Technology Satellite (ERTS), now under development, will herald a new era in the exploration, measurement, and management of the critical resources on which life depends. Vital activities such as agriculture, mineral exploration, map making, and commercial fishing are expected to benefit from satellite-acquired data.

Recently, scientists and engineers from NASA, other government agencies, the academic community, and private industry met at Princeton University for a conference on "Aerospace Methods for Revealing Earth's Resources." They discussed the different applications of ERTS, and some of the benefits that the satellites may bring are reviewed here.

The ERTS spacecraft research and development program initially will involve the launching of two experimental satel-

Tom Elliott is a member of the RCA Public Affairs staff.



More than one-dozen storm areas are depicted in this digital mosaic photograph of cloud pictures taken by the ESSA 5 weather satellite.

"Satellite information could be used to monitor the quantity of crop acreage . . . help find promising sources of oil . . . benefit commercial fishing . . . and make possible better weather forecasts, better land-use mapping, and improved geological maps."

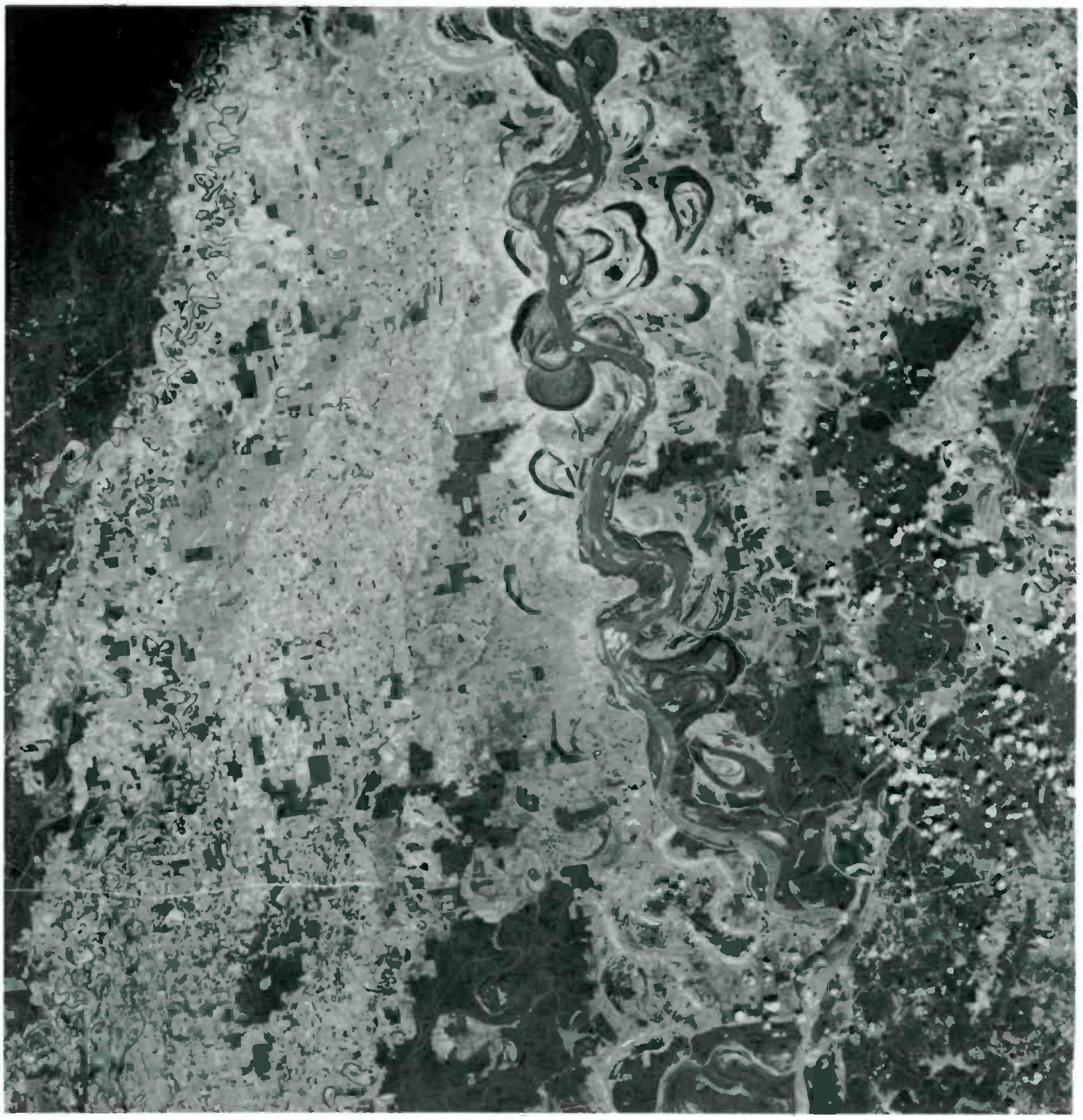
lites, ERTS A and B, as an outgrowth of a NASA study. Follow-up studies are now under way within private industry under sponsorship of the space agency. The first satellite, ERTS A, probably will be launched early in 1972. According to Theodore A. George of NASA, the ERTS satellites will fly near-polar orbits synchronized with the sun's movement so that they will view any given portion of the earth under the same lighting conditions every 17 to 18 days. This course is designed to provide optimum coverage of the United States and its near-shore ocean areas. Ground stations at Greenbelt, Md., Corpus Christi, Tex., and Fairbanks, Alaska, will ensure that at least one receiving site is within range of a satellite at any time that it is over the United States and adjacent ocean areas. Tape recorders aboard the ERTS will store data on distant ocean areas for later transmission to U.S. ground stations. Besides transmitting data from their own sensors, the ERTS satellites will serve as communications relay stations, receiving data from such earth-based instruments as stream flow gauges and then retransmitting the data to ground control centers.

Mission: Space Views of Earth

ERTS A will be designed to function for one year to provide space views of earth throughout the seasons. When ERTS A begins to experience technical problems, ERTS B will be launched to provide another year of experimental satellite coverage. The first operational earth resources satellite could follow sometime later.

However, even the early advent of an operational earth resources satellite will not likely spell the end of research into advanced space systems to study the earth's resources. "In designing ERTS A and B, we have tried to optimize to satisfy as many potential users as possible. This results in certain disciplines not being covered sufficiently. So, a follow-up ERTS program to cover these other disciplines in greater depth could be looked forward to," George concluded.

The principal products of ERTS A and B will be color pictures of the United States and its adjacent shore areas. These will be high-resolution images ac-



The value of satellite data for monitoring earth resources is shown in this Apollo 9 photograph.

quired by advanced instruments described at the conference by George Barna of RCA Astro-Electronics Division and Mrs. Virginia Norwood of the Hughes Aircraft Company.

The key sensors on each ERTS will be three RCA return-beam vidicon TV cameras and a multispectral scanner developed by Hughes. The cameras will be able to produce pictures almost 10 times sharper than those seen on home TV sets. Although the three cameras will look at the same 100-square-mile ground or ocean area simultaneously, each will be configured to image the scene in a different portion of the light spectrum — one in green, one in red, and the third in the near-infrared.

The Hughes multispectral scanner will view the same scene in spectral bands similar to those covered by the TV system. In addition, it will have a fourth channel that goes farther into the near-infrared than the TV system. Slicing the light spectrum in this way will enable the TV and scanner systems to acquire and transmit to earth a series of one-color images of the same areas. These then can be combined into special color renditions in which key ground features are more pronounced.

The individual spectral separations will be valuable in themselves since certain earth resources information is revealed most markedly in specific spectral bands. For example, surface water is best seen in the near-infrared band, while the green band makes it possible to see through water and thereby offers an important capability for remote exploration of near-shore ocean areas.

Information Fallout From Apollo Manned space flights already have provided valuable knowledge for the study of earth resources and have the potential to make even more substantial contributions in the future, Dr. John E. Dornbach of the NASA Manned Spacecraft Center, Houston, said at the conference. "Although the major purposes of the Gemini and Apollo programs had nothing to do with camera systems development, we feel a modest amount of progress was made."

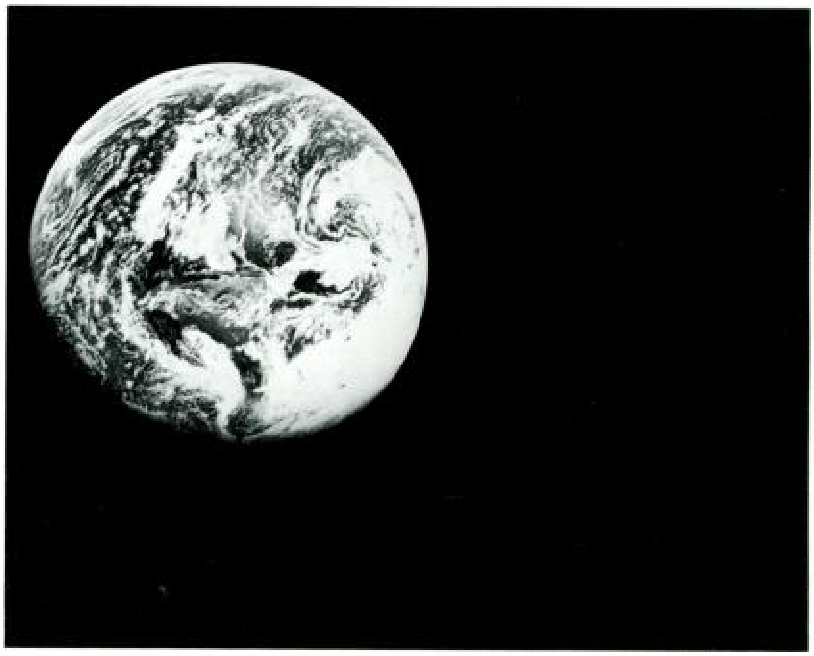
Indeed, the Gemini and Apollo flights, and even the earlier Mercury missions, stimulated scientific excitement by offering a glimpse of the potential of spaceborne platforms. Photographs taken during the Gemini and Apollo flight series have been used to create maps more detailed than any previously available, to chart vegetation patterns, and to reveal such dynamic events as streams in flood.

During the Apollo 9 mission, the astronauts mounted a special four-camera system in their window of the Command Module and photographed portions of the United States in the same spectral bands that will be used in the TV cameras of ERTS A and B. These pictures provided a large volume of data now being analyzed for research into earth surveys from space. In one case, they revealed marked

Land Use
Apollo 9 Imagery
Legend

1 Wetlands
2 Agriculture
3 Forest
4 Water Storage
5 Open Water
6 Urban
7 Grassland
8 Unused (not wetlands)
9 Transmission or pipe line
10 Agriculture (fallow)

Mineral exploration could benefit from data obtained by aircraft and satellites.



The earth as seen by Apollo 10 astronauts from a distance of 250,000 miles.

differences in the vegetation patterns of two adjacent states known to pursue very different policies on the use of water for irrigation. The vegetation of one state was clearly more dense and vigorous. "For years, geologists and cartographers have told you that political boundaries are the invention of man — fictitious and imaginary lines drawn on maps. Well, this shows that political boundaries are not just lines," Dornbach pointed out.

Space Timetable Future manned space programs—in particular, the Apollo Applications Program (AAP) workshop, the Earth Orbiting Space Station, and the Space Shuttle—will provide even greater opportunities to build upon the experiences of Gemini and Apollo, added Dornbach. In 1972, the AAP workshop — the third stage of a Saturn 5 rocket that will be converted to a space laboratory—will be placed into earth orbit. Later, three astronauts will be launched in an Apollo Command Module to rendezvous and dock with the workshop and to occupy it for 28 days. After the first crew returns to earth, the workshop will again be occupied during two more missions. Each later mission will last 56 days and will utilize a different three-man team. The AAP mission will include a multispectral photographic experiment that will be more sophisticated than anything attempted before. Also under consideration for this mission is an even more advanced package that involves a multispectral scanner, an active/passive microwave sensor, and an infrared spectrometer.

By the mid-1970s, American scientists could launch an Earth Orbiting Space Station, or EOSS. The Station initially would be able to accommodate a crew of 12. In the late 1970s or early 1980s, perhaps as many as 100 scientists, along with cargo, could be transferred between earth and space by a reusable shuttle spaceship.

"I think the significant thing here is that the space station is resupplied by a space shuttle. That gives us the capability to take enormous payloads up to the space base," Dornbach said.

One of the principal roles of the crew in the space station would be to operate sensors at optimum times. Dornbach cited the fact that the Apollo astronauts were able to determine when haze or cloud cover hindered photography of earth features. Other space station capabilities important in observing earth resources and developing advanced sensors include on-board data processing, which makes possible real-time analysis and reduces reliance on ground control; electrical power in quantities heretofore unavailable in space; and the ability of the crew to leave the space station and assemble such things as large antennas.

Map Making Cartography is expected to be the first area to benefit from ERTS, noted William A. Fischer of the U.S. Geological Survey, Earth Resources Observation Satellite coordinator for the Department of the Interior. "A satellite is so far away that it looks directly down on the earth. A subject thus maintains its proper spatial relationship and characteristics within the image. For this reason, space-acquired information is an instant map. If you want map-like data, you have to go above an altitude of about 70 miles. This rules out the use of aircraft for some cartographic applications in favor of spacecraft that can operate efficiently at higher altitudes."

Pointing out that the angle of the sun on an area makes a tremendous difference in how the area looks, Fischer displayed a mosaic of photographs taken from an aircraft over a three-hour period. Because of the changing angle of sunlight over the three hours, over-all shading was not uniform. As a result, many ground features, which in fact were virtually identical, appeared different.

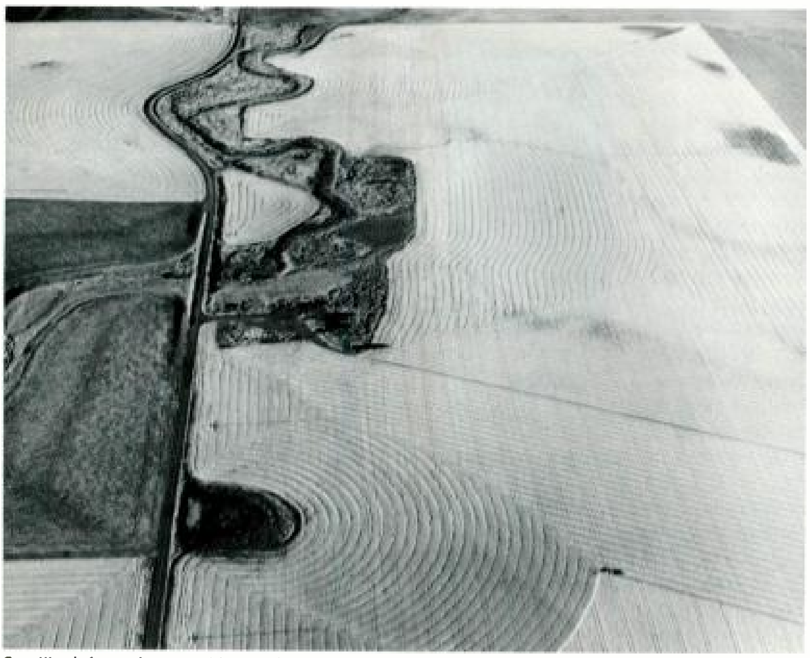
"However, if you were to view this from space, you would see all this area and more from a single point in a single instant of time. Features that are alike would look alike, and features that are different would look different."

Fischer also displayed an Apollo 9 photograph of the state of Mississippi showing what appeared to be small lakes. However, the bodies of water were actually streams in flood.

Apollo 9 photographs also have been used to chart urban patterns in the Fort Worth-Dallas area, and geographers have shown that it is possible to correlate these patterns with population. This indicates that interim census figures can be derived from space photographs and that such estimates would be more timely and as accurate as those now made through conventional means. Fischer pointed out, however, that space photographs are not the answer for all cartographic requirements. The satellite pictures, because they are taken from such heights, do not reveal the contours of the land, and aircraft must be used to obtain this information.

Summing up the key advantages of maps created from space photographs, Fischer observed: "A conventional map, especially at small scale, is limited in content by the ability of a man to draw a fine line. The information content of a map made from satellite photographs is limited only by the resolution of the camera. So the information content is higher.

"Second, and again especially in small-scale maps, there are a host of people engaged in making decisions on what to include on a map. It's a subjective synthesis from larger scales. In space photography, the synthesis is objective — you are seeing everything that is pertinent at that scale. So there is an important difference. In many ways, the space map is superior. Is it economical? Ignoring the cost of collecting the data, which was incidental to other missions,



Satellite information could be used to help forecast and control crop acreage.

Cloud formations over Galveston Bay were photographed by the Apollo 9 astronauts.

we have compiled maps of over 1-million square miles of the earth's surface this past year at a budget of $25,000."

Agriculture Agriculture long has been regarded as a key activity that could be aided greatly by observations from space. The detection of differences in spectral signatures (the individual characteristics of vegetation and other ground features in reflecting, absorbing, emitting, or scattering light, depending on the wavelength of the light and on their molecular structure) will permit agriculturists to distinguish species of vegetation and trees as well as differences between healthy and blighted vegetation and trees.

Dr. Arch Park, formerly of the Department of Agriculture and now with NASA in Washington, described what can be expected from ERTS A and B when the satellite data will be analyzed by computer. "With three spectral bands, we can automatically map the distribution of green vegetation, bare soil, and water. We are not concerned with picking out fence rows by any means, but certainly the gross distribution of these three classes of land use is important. A fourth band appears to be possible, but remember that this is strictly a research effort. We think we can use it to get the distribution of trees. This would be very important in a simplified land-use classification scheme."

The possibilities of performing even more sophisticated sensing of agricultural resources from both spacecraft and aircraft emerged as Park pointed to typical areas of Department of Agriculture research that could be aided by satellite data:

- Forecast and control of crop acreage. Satellite information could be used to monitor quantity of acreage, identify crops by species, and reveal crop vigor.
- Soil mapping. Using conventional methods, it will be 1998 before soil mapping of the entire United States is completed.
- Surveying timberlands to detect where trees exist and to identify them by species.
- Land-use inventories to determine how acreage is being used on a national basis, including the relationship of agricultural lands to the megalopolitan urban areas. "It is true that when urban centers spread and when roads are built, the very best agricultural land that can be found is used," Park said.
- Detection and control of biological pests. "These will be done inferentially, since you cannot expect to see pests from a satellite but rather damage resulting from these pests."

Park indicated that much of the more advanced sensing of agricultural resources – differentiation among crop species, for example – will rely not only on the subtle differences in reflected light but also on thermal infrared images. These are created by the heat that is emitted by vegetation. Studies already conducted have indicated the potential of this approach: Imaging of certain areas showed that differences in soil color correlated very closely with the organic properties of the soil. This information is of key importance to farmers.

Using space photography, the Forest Service developed a multistage sampling technique for timber volume studies. Displaying a photograph of a Louisiana forest, Park explained that "You cannot recognize trees as individuals, but the tone information—and I really can't stress too much that our work is based on tone signatures, not shape—permitted the Forest Service to determine areas of deciduous and coniferous trees and certainly where trees were and where they weren't."

Agribusinesses When considering the value of an earth resources satellite to agriculture, most people think only of farming. There are, however, many businesses related to agriculture—the so-called "agribusinesses"—that will be aided by an ERTS. Harold Lorsh of the General Electric Company said surveys indicate that the fertilizer industry could benefit considerably from better crop information. "Fertilizer must be made in the state in which it will be used, near the time it will be used, because shipping and storage charges are monumental. We talked with two fertilizer companies, and they said that a system that would give them information two weeks faster would save them between $1 and $2 million a year in freight charges. Food processors, storage elevator operators, brokers, and other agribusiness enterprises could enjoy similar benefits from earth resources satellite information."

Grazing Land Management An earth resources satellite could be worth $14-$18 million over a decade to the management of grazing lands in the United States, estimated Dr. Charles R. Frank, Jr., of Princeton University.

Reporting on a study done for RCA by the University, Frank said that the management of grazing lands, which account for nearly one-half of the total U.S. land area and whose forage is worth an estimated $2 billion, could benefit from an ERTS in three primary areas.

First, the satellite images could substitute for, or supplement, aerial photographs for base maps. Second, deterioration of range conditions and of newly seeded areas could be observed to detect the extent and cause of damage. Third, the satellite could monitor soil moisture and vegetation vigor. "Estimating forage production early in the grazing season is very important because it can help the rancher determine the rate at which the stock should go in, the right method of grazing, how many cattle to purchase, how much feed to buy, and

The Blue-Collar Computer

Electronic data processing is being put to work on the production line.

by Thomas I. Bradshaw

The computer, which was invented only two decades ago, already is deeply rooted in almost all phases of modern society. Without the electronic data processor, the space program would still be in the realm of science fiction and the administration of government and most large businesses would be completely flooded by a sea of paper. But the proliferation of EDP is not limited to the world of the administrator or scientist. More and more, the computer is being put to work successfully in the blue-collar or production areas of the economy.

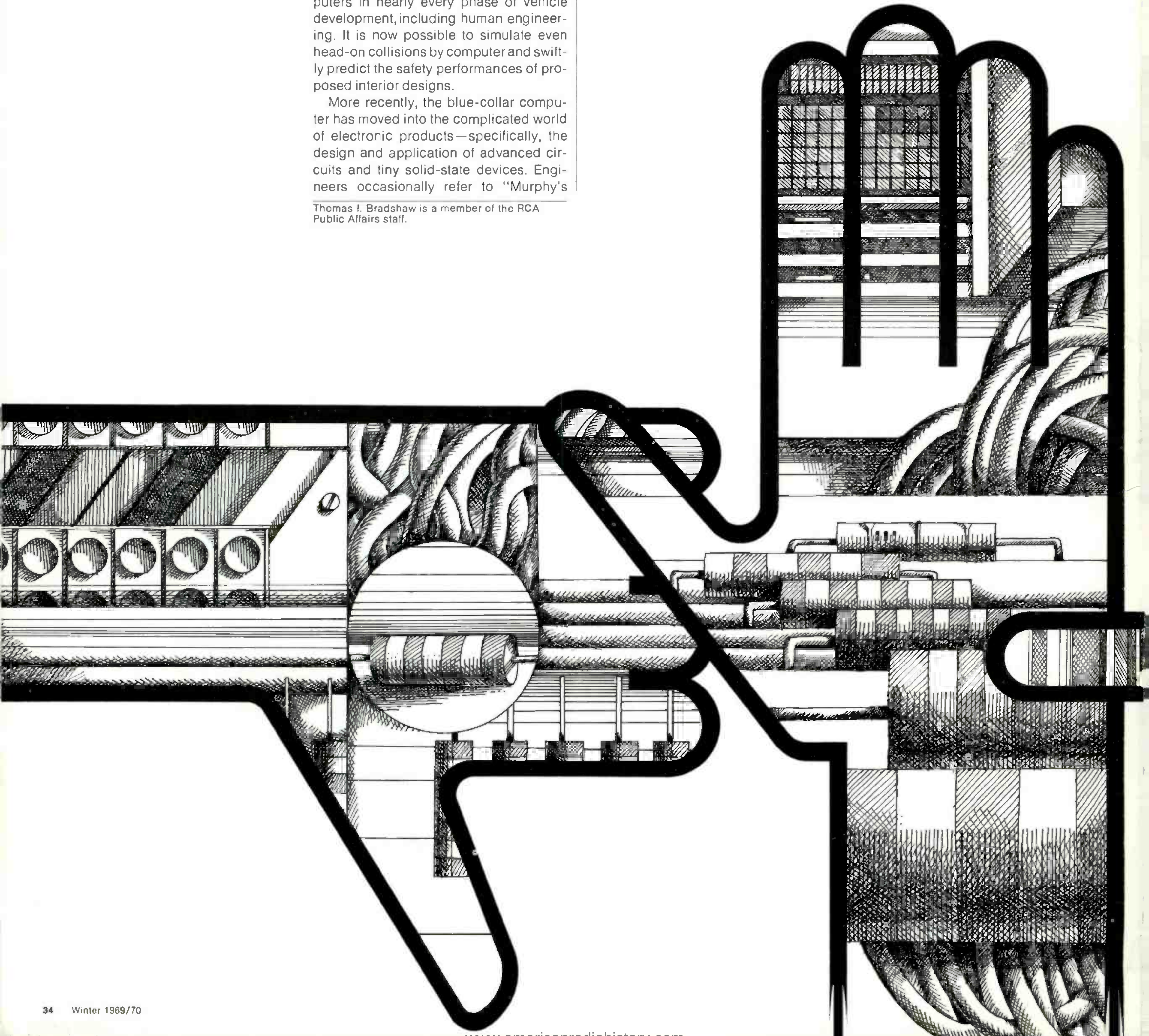
The automobile industry has led the trend to integrate computers into the manufacturing process, quality control, materials supply, safety projection, and car warranty record keeping. For example, the Chrysler Corporation uses computers in nearly every phase of vehicle development, including human engineering. It is now possible to simulate even head-on collisions by computer and swiftly predict the safety performances of proposed interior designs.

More recently, the blue-collar computer has moved into the complicated world of electronic products—specifically, the design and application of advanced circuits and tiny solid-state devices. Engineers occasionally refer to "Murphy's law," which states: "Anything that can go wrong will go wrong." In the electronics industry, that law has been a precept to reckon with for decades because of the great diversity of components. When so many unlike parts must be designed, assembled, handled, and tested, a few substandard items invariably slip through despite the best quality-control efforts.

At RCA, to ensure that each part meets design standards, a computer-oriented production system has been developed. Robert Flood, Manager, Technical Operations at the Consumer Electronics Division, describes it as a dramatic advance in precision and quality control. "Ultimately, it is expected to revolutionize the production and distribution of consumer products by telescoping the time required from delivery of raw materials to final delivery of finished goods."

The Computer-Controlled Operating System (C/COS) is being used at present to direct the design, material control, assembly, and testing of advanced tuners for stereo phonographs. Through the use of the computer, these components are being made in a fraction of the time previously required and with improved quality. The success of this system has led to plans to adapt it to the production of other electronic products for the consumer market, including even the complex color television chassis.

Thomas I. Bradshaw is a member of the RCA Public Affairs staff.



One of the first steps taken in implementing the C/COS program was to develop a feasible method of reducing the huge number and variety of components in a stereo tuner. With the aid of computer simulation, a new type of integrated circuitry—ceramic circuit modules—was designed for the tuner. Inside each tiny, pillow-shaped module is a complex system that comprises miniature resistors, capacitors, and diodes. In a typical computer-crafted tuner, 16 such modules, all of which can be held in one hand, perform functions that formerly required more than 100 separate parts. Pre-C/COS tuners had as many as 294 separate components, while the average computer-produced tuner has only 70.

Again employing the computer, RCA engineers developed master designs for a family of stereo tuners. Performance potentials for a number of suggested designs were run through the electronic "wind tunnel" to determine the best possible circuitry combination before any units actually were fabricated.

After the new species of components had been developed and incorporated in the computer-evaluated tuner designs, an electronic data processing system at the RCA Consumer Electronics plant near Indianapolis, Ind., was linked to a network of 10 test stations. These stations are located along the assembly line and at the point of entry for incoming components. Data obtained in the original design tests both for components and complete tuners were fed into the computer memory to serve as precise guidelines for in-production testing.

The computer, located in an air-conditioned room nearby, scrutinizes test results from samples of incoming materials and pulls out substandard parts before they reach the assembly line. And as the tuner chassis moves down the line, the operator queries the computer for approval of the subassembly or tuner up to that specific point.

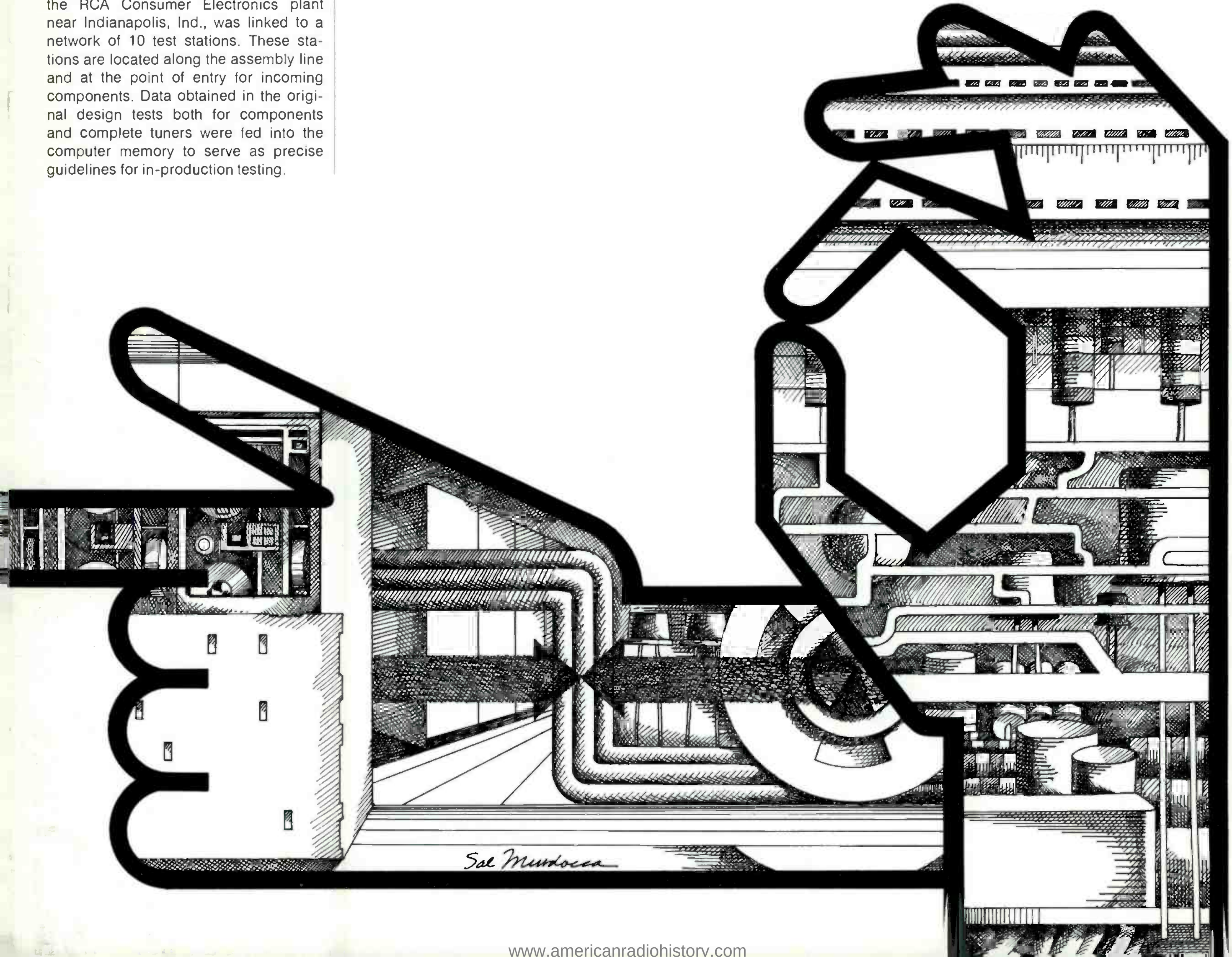
Each of the test stations has a row of control buttons, including one that lights up to indicate "reject." When the computer rejects a part, it prints out a report for the operator telling why the unit was rejected and what steps must be taken to correct the flaw.

Why go to all that bother?

Flood explains, "Design standards are one thing; actual performance of the finished product is another. With the computer, we can find out in a matter of seconds if a tuner assembly is as good as it's supposed to be. What's more, if it doesn't measure up, the computer will tell us where we went wrong."

During the assembly of circuit boards for RCA stereo phonograph tuners, 40 checks are made on each board under computer guidance. Thirty checks are conducted during assembly of the tuner itself, and final acceptance checks are carried out at the end of the assembly process. Computer-checked stereo tuners receive seven times the number of assembly line tests that can be made under conventional manufacturing methods. Moreover, checks that previously took minutes now are performed in seconds.

But Flood rejects the suggestion that a robot factory is in the making. "We still use the same number of production workers on the assembly line. The computer system doesn't replace people—it assists them." The human beings who operate the computer, bringing all the aspects of the system into play, are still an even more vital part of the operation than the computer itself. ■



Electronically Speaking...

News in Brief of Current Developments in Electronics

Space Age "Icicle"

A space age "icicle" that will keep satellite equipment cool during long periods in orbit is under study. The ICICLE (Integrated Cryogenic Isotope Cooling Equipment) is being examined for applications in cooling sensitive infrared detectors and earth horizon sensors that operate at cryogenic temperatures. The ultimate goal of the ICICLE study, which RCA is conducting for NASA's Goddard Space Flight Center, is to develop highly reliable cooling equipment that will have a life of two to five years and would match the expected life of a satellite.

The key components for ICICLE are a Vuilleumier-cycle (VM) refrigerating engine coupled with a nuclear energy source. RCA recently has completed laboratory experiments that demonstrate the potential of the engine for long life and high reliability in space and also have shown that lower pressure on the bearings and the absence of sliding seals give the VM engine longer life potential than standard refrigerating equipment has. The system does not require thermal-to-mechanical energy conversion, as do conventional refrigerating systems, but will operate on thermal energy, leading to a higher operating efficiency.

The study will make an analysis of the ICICLE system and consider the feasibility of integrating it into such spacecraft as the Nimbus and Earth Resources Technology satellites. It also will determine cooling requirements for advanced sensor equipment, the feasibility of achieving a two-to-five-year life, and the thermal requirements for the isotope heat source and the heat pipes.

Ceramic Element for Remote Control

A newly developed solid-state device may lead to TV-type remote controls for home appliances, heating systems, lamps, office equipment, and industrial tools. The device is a tiny ceramic element whose electric properties can be adjusted electronically to turn on or off or smoothly vary the current in a circuit. Because it is completely electronic, it has a longer life and higher reliability than have the motor-driven mechanical units presently used in remote controls. Moreover, it will "remember" its last setting indefinitely, even if power to the circuit is shut off.

If the unit were made a part of the standard electric circuits in the home, many appliances could be controlled remotely. For example, a unit placed on a night table could control a light in the hall or bathroom, turning it up to the desired level of brightness. The temperature of a room could be adjusted from a distance, or, using a more sophisticated version, the temperature in an empty house could be turned up by telephone. A housewife could use the new RCA device to vary speeds by degrees in equipment such as blenders, mixers, or fans. Similarly, a man could use the device to operate power tools with a smooth speed control.

The switch would be operated by two pushbuttons, one to gradually turn on an appliance, the other to gradually turn it off. If it were close to the object it controlled, the two could be connected by wiring. If the distance were large or if considerable mobility were required, the pushbutton output could be transmitted through radio or ultrasonic signals as in present remote controls for TV sets.

Rugged Computer Can Serve as Airborne Command Post

The first computer designed to serve as an advanced airborne command post and to direct missiles and aircraft if ground controls are destroyed is being built. This new computer for military command-and-control use is no larger than an office desk, yet it can handle 400,000 operations a second, the equivalent of commercial systems five to seven times its size. It makes extensive use of medium-scale integrated circuits containing up to 300 transistors on a single chip as large as the head of a match.

The RCA computer is able to withstand the partial vacuum and extreme cold that exist at an altitude of 50,000 feet and has a special fail-safe feature that would enable it to continue operation in the event of a major system malfunction. It is designed to operate in temperatures ranging from 71°C. to minus 55°C. (Commercial systems cannot function below 0°C. or above 50°C. without special protection.) The ability of the system to meet the most stringent military specifications for electronic equipment makes it suitable for a wide variety of uses on land and sea, such as processing intelligence information under battle conditions.

The new computer is a multiprocessor with two central processing units that operate simultaneously. Each unit has independent shielding, power, and cooling facilities. A central processor, input-output unit, memory unit, or any combination of the three can be removed without interrupting its operation, making the system fail safe. The computer automatically reallocates its resources to priority tasks and continues operating. At the same time, it performs a self-diagnosis to locate the malfunction, identify it, and tell the operator what to replace.

Computer Handles Remote Computing and Batch Runs

A new computer will prepare advanced programs for remote computing as well as handle batch processing for the Prudential Insurance Company of America at its Newark, N.J., headquarters. The RCA Spectra 70/46 system will replace one computer and reduce the number of jobs handled by two others. In addition, the new system will absorb work that is presently contracted to several time-sharing bureaus and will extend computer services to Prudential staff activities that previous batch-processing systems could not service conveniently.

Computer programmers and other users within the Company will communicate directly with the system through typewriter terminals and remote video terminals also made by RCA. The latter resemble a television set with an attached typewriter keyboard and are versatile in handling computer input and output.

Oriental Language Typesetting Machine Acquires Holograph Memory

A unique electronic typesetting machine used by the Army to compose Oriental ideographic language text for printing is being equipped with an advanced memory system based on laser holography. The holograms will be able to store 10,000 ideographic characters in Chinese, Korean, or Japanese.

The new RCA memory unit will make it possible to store on a single three-inch-square glass plate characters that formerly had been held on three 12-inch-square plates, thus reducing the size of the memory unit 50 times. The weight of the memory unit and its retrieval system will be reduced from 350 pounds to less than 35 pounds.

The Ideographic Composing Machine was developed several years ago by RCA for the Army's Natick Laboratories in Massachusetts. The Machine combines computer, television, and optical technologies so that a keyboard can be used to set the characters. Previously, Oriental language text was set by hand — a laborious process, since each language contains more than 10,000 characters, compared to the 26 letters of the English alphabet.

Ground-Based Computer System Tracks and Directs Military Aircraft

A ground-based computer system is being developed to direct and control military aircraft. It will combine the advanced technologies of precision radar tracking, data processing, and command and control into an integrated control system, which also will provide voice communication between the control center and Marine Corps, Air Force, and Navy aircraft.

The heart of the system is a high-precision tracking radar that will pinpoint the position of an aircraft continuously. The computer will compare radar information on position with data on the aircraft's destination and provide guidance fixes that will be beamed to the navigation instruments of the aircraft.

The development contract was awarded to RCA by the Naval Electronic Systems Command.

Book Note

The New Electronics, a book by Bruce Shore of RCA, was published in January, 1970, by the McGraw-Hill Book Co. Many of the chapters in the book first appeared as articles in *Electronic Age*.

Photo and illustration credits: cover, pages 10-11, 12 (top center and lower right), 13 (top, middle far right, and lower right), and inside back cover, Tom McCarthy; pages 2-9, courtesy of Mrs. Robert H. Goddard and the Robert Hutchings Goddard Library, Clark University; pages 12 (top left and top right) and 13 (first three in middle row and first two in lower row), Maude Dorr; page 12 (center), Declan Haun; pages 17, 18, and 20 (left and center), Bruce Frisch; pages 22 and 23, Erich Hartmann for RCA; page 24, RCA Records; page 25, Brown Brothers; pages 19, 20 (right), 27, 28, 30 (right), and 31 (right), NASA; pages 30 (left) and 31 (left), National Film Board of Canada; pages 34-35, Sal Murdocca.

Graffiti-covered tenement walls are the billboards of America's urban landscape. For a view of our cities in crisis, see page 10.


Sandy
Frankie
Millie
Papo

RCA

Electronic Age

Winter 1969/70