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Computer Time Sharing

Cover: A symbolic portrayal of computer time sharing in which orbs of light represent the proliferation of communication between man and machine. Instead of a single user tying up the resources of the computer, time sharing permits persons in many different locations to tap computer power simultaneously and receive almost immediate feedback. A report on this emerging multibillion-dollar industry begins on page 2.

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Computer Time Sharing

New multiaccess EDP systems mean that the resources of the computer are no longer limited to one user at a time.

by Robert Cecil

Computer time sharing is an emerging multibillion-dollar business that is greatly increasing communication between man and machine. It permits people in many different locations to tap computer power simultaneously and receive almost immediate feedback.

An engineer sitting at a video display unit can electronically discuss a stress analysis problem with a computer while a mathematician, miles away at another remote terminal, is retrieving data for a statistical table. At the same time, a marketing executive can check production schedules, and an inventory control manager can feed raw-material data into the same computer. Directions and questions flash over telephone circuits in a single burst, but this makes no difference to any one of the computer users. As far as each is concerned, he has the undivided attention of his electronic partner.

Problem solving is only one aspect of time sharing. The multiple-access computer can handle requests for theater tickets from a local supermarket as well as questions in higher mathematics from a distant university. Both assignments are easily within the capability of the rapidly proliferating breed of time-sharing systems that is making the computer business the fastest growing major industry in the world. When man interacts directly with machine, service is immediate.

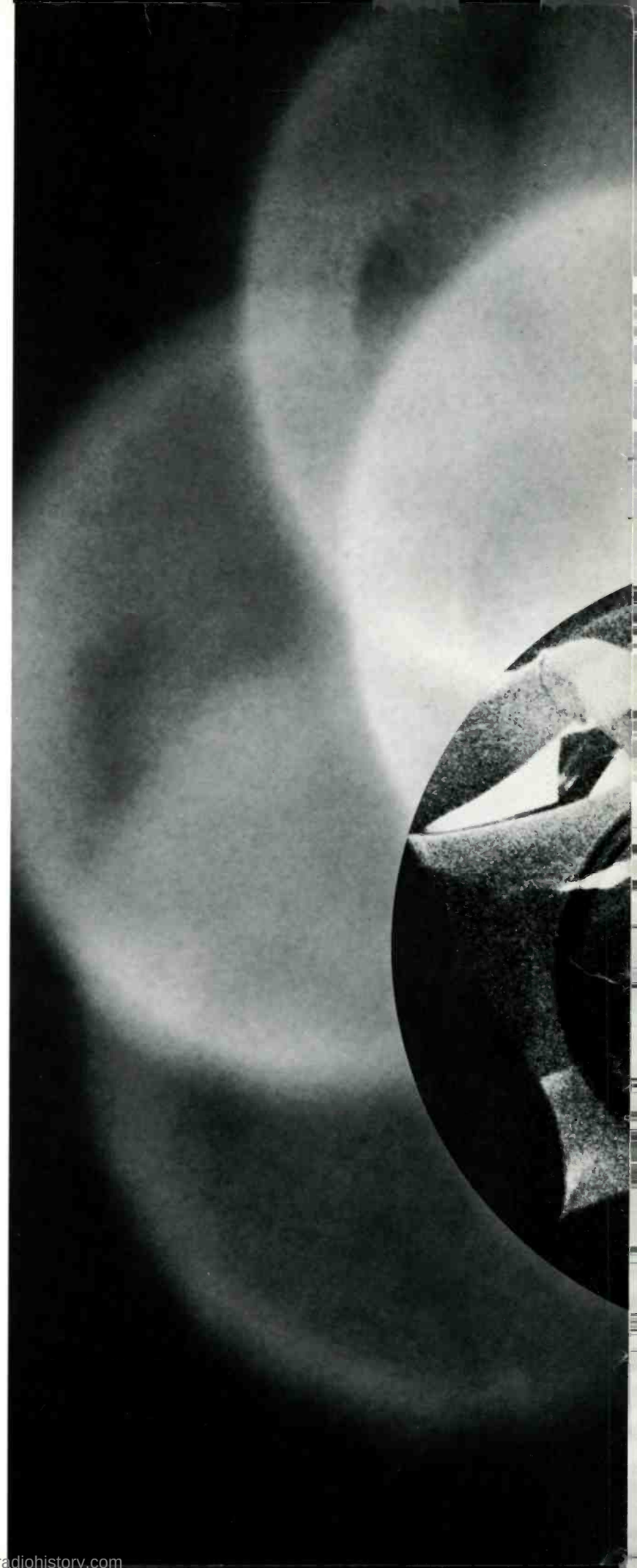
Robert Cecil is on the staff of the RCA Information Systems Division.

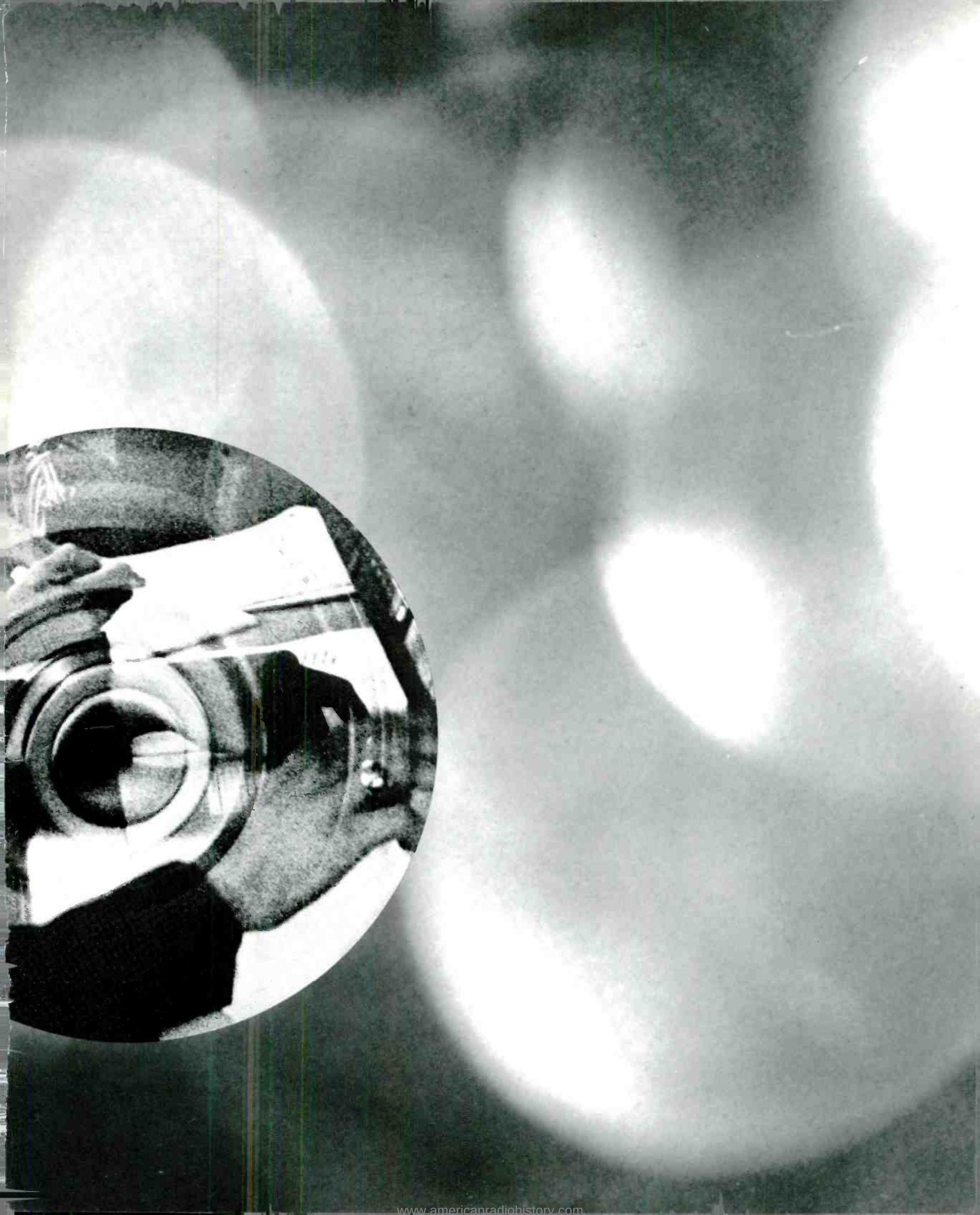
The first commercial time-sharing services were introduced late in 1964, and the following year revenues totaled about $10 million. By 1967, sales had reached the $30-million level. A year later, they rose to around $50 million. One prominent industry source sees the service market reaching $1 billion in sales by 1975.

However, the nature of time-sharing services will change, according to Ian Ebel, a British-born aeronautical engineer who is manager of revenue forecasting for Computer Sciences Corporation, a California-based EDP consulting firm. "In a few years, you'll find fewer local service bureaus, and they'll be the ones that specialize along certain lines — offering tailored packages for various businesses. Personally, I doubt that the independent time-sharing service bureau will ever represent more than 10 per cent of the over-all time-sharing market."

From an equipment standpoint, EDP manufacturers also have a huge stake in time sharing. Shipments of the specialized computers are expected to make up 10 per cent of the market by 1971 and should grow to represent half of all shipments in about five years. This would be approximately $2.5-billion worth of hardware. Both major and minor computer makers are vying for a share of this business and are marketing a variety of systems and peripheral equipment.

Time sharing covers a spectrum of customer information needs. The military employs it in specialized command and control work. Business utilizes time sharing for preparing and debugging computer programs and handling large integrated data bases, while schools use it for computer-assisted instruction. Its ap-





"Time sharing is not necessarily a two-way conversation between man and machine. People not only 'talk' with the computer but converse with each other through the system."

plications in industry include drawing up programs that automatically guide machine tools.

Time sharing is not necessarily a two-way conversation between man and machine. People not only "talk" with the computer but converse with each other through the system. MIT faculty members work on scientific problems with students through terminals located at various points in the Boston area — the teacher at his home teletypewriter, the student from a campus-based terminal. Space and time no longer hinder active collaboration among members of a research team.

Time-sharing applications also extend to the airlines, which rely on automated reservations systems to keep plane seats filled. One air carrier handles up to 30,000 inquiries an hour from a network of push-button terminals located in 30 major cities, with lines feeding into a pair of computers at headquarters. Arrival and departure data on all flights are given in seconds.

Many brokerage offices maintain computer information bureaus in metropolitan train depots to assist investment-minded travelers. Such data as the latest quotations and announcements of stock splits are instantly available. The traveler merely types the New York Stock Exchange initials assigned to the company in which he is interested on a keyboard in front of a video screen, then presses a switch. A reply is displayed on the screen before he can lift his finger from the button.

One New York stock brokerage firm retrieves up-to-date information on the 3,500 most widely owned stocks. Account executives at any of the firm's 150 nationwide offices can retrieve computerized business reports at the flick of a switch.

These applications of time sharing fall under the heading of dedicated systems, since only one type of job is involved. Simplicity is paramount, hence programming is generally limited to a single computer language. In these cases, the effort hinges mainly on information storage and retrieval, which Ebel describes as "electronic pigeonholing." Anyone can push the buttons.

According to Ebel, service bureaus could provide this kind of help for businesses that depend on large data bases and fast action to keep customers satisfied. Rates would be determined by amount of data and desired access times. "I believe the growth of on-line, instant-response systems promises a bright future for pigeonhole techniques," Ebel says.

The other side of the coin is the general-purpose system in which users select from several computer languages and have the opportunity of broad control in solving problems.

J. C. R. Licklider, a psychologist and time-sharing specialist who is teaching at MIT, writes that "being logged in with a computer is like sitting at the controls of a jet aircraft after having been merely an airline passenger for years. There is a thrill of a sort, but a reluctance to maneuver boldly." Two other noted time-sharing specialists from MIT, Robert M. Fano

and F. J. Corbató, wrote that "it doesn't take a long stretch of the imagination to envision an entire business organization making and executing all its major decisions with the aid of a time-shared computing system. In such a system, the mass memory at all times would contain an up-to-date description of the state of the business."

An early prototype for such a system was put into service in 1959 at the Onada Cement Company, Ltd., of Japan, using a general-purpose UNIVAC computer with time-sharing features that permitted on-line communications between each of its 72 branch offices and headquarters in Tokyo. A staff of 150 operated the 680-unit configuration. Commenting on the "monster" system, a company spokesman stated that "the computer's value in guiding management toward making more informed decisions has far exceeded its $1.25-million pricetag."

Actually, the concept of time sharing predates the computer. In 1940, the American Mathematical Society witnessed an information system demonstration by Dr. George Stibitz of the Bell Telephone Laboratories. A teletypewriter at Dartmouth College, where the Society had assembled for its fall meeting, printed mathematical output from a relay calculator in New York, with the data carried by long-distance telephone lines. Members seemed impressed by the 20-second response time but were dubious about the future of Stibitz' invention.

The demonstration highlighted two essential time-sharing ingredients: an automated calculator and a means of data transmission. However, it failed to pass muster for true time sharing since only one person at a time could use the system.

It remained for the postwar information explosion and the computer to create time sharing. Here was highly expensive capital hardware, and every moment of its activity was critical to profitable operation. There is no financial justification for a $25,000-a-year scientist tying up a million-dollar machine for extended periods while other jobs wait. The thinking process of a man is just too slow for the machine — the logic circuits of the computer are several million times faster than human nerve cells. At the same time, it hardly seems fair for the scientist to have to queue up and wait while other jobs are processed.

A solution to this dilemma was suggested 10 years ago by an English mathematician in a paper written for UNESCO. The author, Christopher Strachey, was the first to envision computers running several programs simultaneously in a time-sharing mode. He reasoned that, if the machine worked on a task taking no more than a split second, many people could enter jobs at one time and no one would have to wait. A rapid shuttling of programs in the machine — called interleaving — would let each user feel that he commanded exclusive control of the computer's resources.

The academic community seized upon the idea for problem solving. In 1961, MIT put into operation the first model of its Compatible Time-Sharing System. This was followed two years later by a more sophisticated version for the university's Computation Center and for Project MAC (identified variously as Machine-Aided Cognition, Man And Computer and Multiple Access Computer), a federally financed time-sharing effort that subsequently captured national attention.

Today, MIT has some 400 terminals located in laboratories, offices and even professors' homes. Users dial the computer at either the Computation Center or Project MAC headquarters. MAC also is tied into teletype networks, permitting computer access from thousands of terminals throughout the country. A store of approximately 1-million computer words is on file, and some 100 programs direct everything from on-line program debugging to exercises in plasma physics.

In 1964, Dartmouth acquired a multiple-access computer system, and by now the students are confirmed time-sharing buffs. Two out of every three undergraduates dialed the computer last year, and

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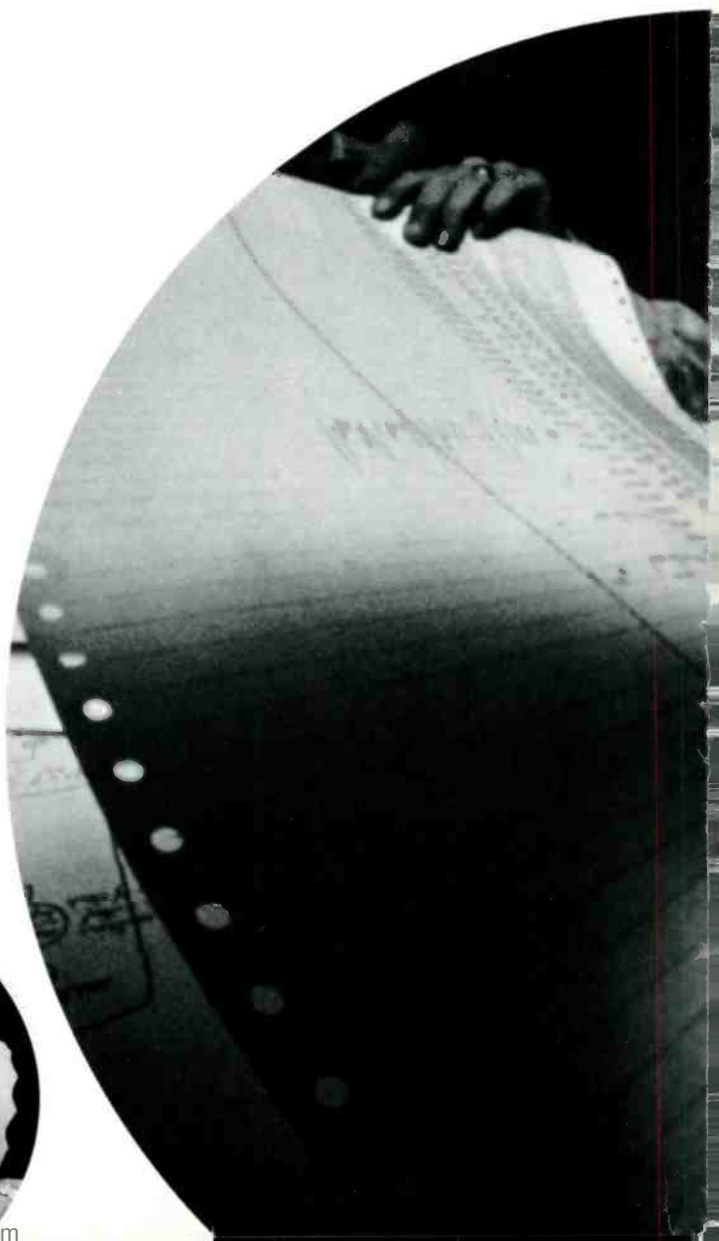


half the faculty regularly uses it for teaching and research. Part of the reason for this success is the development of BASIC, a simplified computer language designed by the college for its time-sharing system.

This fall, Franklin and Marshall College will become the hub of a cooperative computer network centered around an RCA Spectra 70/46 Time-Sharing System. The computer will be leased to a new nonprofit corporation called the Middle Atlantic Educational and Research Center (MERC), whose eight charter members include Franklin and Marshall and five other Pennsylvania schools as well as two medical research institutes. Footing the bill for any one member would be prohibitive, so costs are shared.

Franklin and Marshall President Keith Spalding states that MERC is believed to be the first attempt by a group of small institutions to organize a time-sharing computer cooperative for education and research. He predicts MERC eventually may become "one node of an interrelated complex of centers that joins scattered institutions by means of the computer. There's considerable interest in the mid-Atlantic region for a cooperative project, and MERC could become a model for similar networks in other parts of the country."

MERC will run as a pilot program through June, 1971, with the dual objectives of educating members in the use of the computer and studying how small organizations can best employ time sharing.

By its nature, the computer is eminently suited to handle science and math routines. But Dr. Richard S. Lehman, secretary of MERC, believes that EDP has potential for the humanities as well. "You may find English majors turning to the computer for content analysis such as checking an author's works for recurring themes. Or it may be concordance studies, where authorship of a questioned document is attributed to a particular writer by analyzing his style," he explains.

The Moore School of Electrical Engineering at the University of Pennsylvania, where the computer was born nearly one-quarter of a century ago, and the University of Dayton use RCA time-sharing systems for numerous educational and research projects.

One major innovation that has widened the potential of time sharing is Dataphone service, developed at Bell Telephone Laboratories 11 years ago. This opened the way for the transmission of up to 800 pieces of data a minute over long-distance telephone circuits and set the standards for speed and accuracy. Most important, it encouraged more extensive computer communication. Today, one computer manufacturer employs time sharing to analyze communications networks for customers. Costs of different services — such as point-to-point private lines and Direct Distance Dialing — between remote points and the computer are determined in conjunction with FCC tariffs.

The number of terminal devices is an important barometer for time sharing. As one expert points out, "The real impact of time sharing is not felt in shipments or in dollars spent but in the number and type of people actually using the system."

A study by RCA disclosed that a total of 20,000 keyboard terminals existed in 1965. By 1970, there should be 90,000, and a half-million in 1975. Honeywell Inc. carries this forecast forward and expects keyboard terminals to reach the 3-million mark by 1980, based on a growth rate of 33.3 per cent a year.

If the latter projection proves correct, at least 3-million keyboard users may be buzzing the computer by the end of the seventies. This is nearly 10 times the current number of programmers in the United States. However, many of these future terminal operators will not have to be programmers. "Plenty of nonprofessionals are going to jump into the act," one industry figure comments.

Time sharing also has proved a valuable tool in software development. Program debugging often took months when test runs were batch-fed into the computer. The slightest program error — even a missing or misplaced character — meant a new run that might take days to schedule. Now, turnaround times (getting the work through the machine and back to the user) are almost instantaneous. This is a key benefit for independent software houses where sales last year totaled $270 million and where keen pressure is felt for delivery of contract programs on a specified date.

Time-sharing computers closely resemble other members of the digital family. However, because multiaccess communication is essential to time sharing, special interface devices must be provided. Main memory sizes vary with time-sharing computers, yet almost invariably some kind of auxiliary on-line storage, such as disk units, is necessary to hold huge quantities of data. On-line storage is not always required for batch processors.

More significant than hardware differences is the way time sharing works. Data on one job can be read in for processing while the computer conducts output operations on another assignment. Through a process of complex juggling, all available resources are utilized in a given time period. In contrast, batch processors work serially — tackling one part of a job at a time — so that at any given moment only one machine resource is employed. The others remain idle.

On a single job, time sharing works no faster than batch processing. Both systems can complete the same work using the same amount of computer time. But the unique ability of time sharing to keep every system element active gives many people a chance to pursue their problems concurrently. A joint study by the System Development Corporation and Carnegie-Mellon University reports that "time sharing is more effective throughout all stages of problem solving."

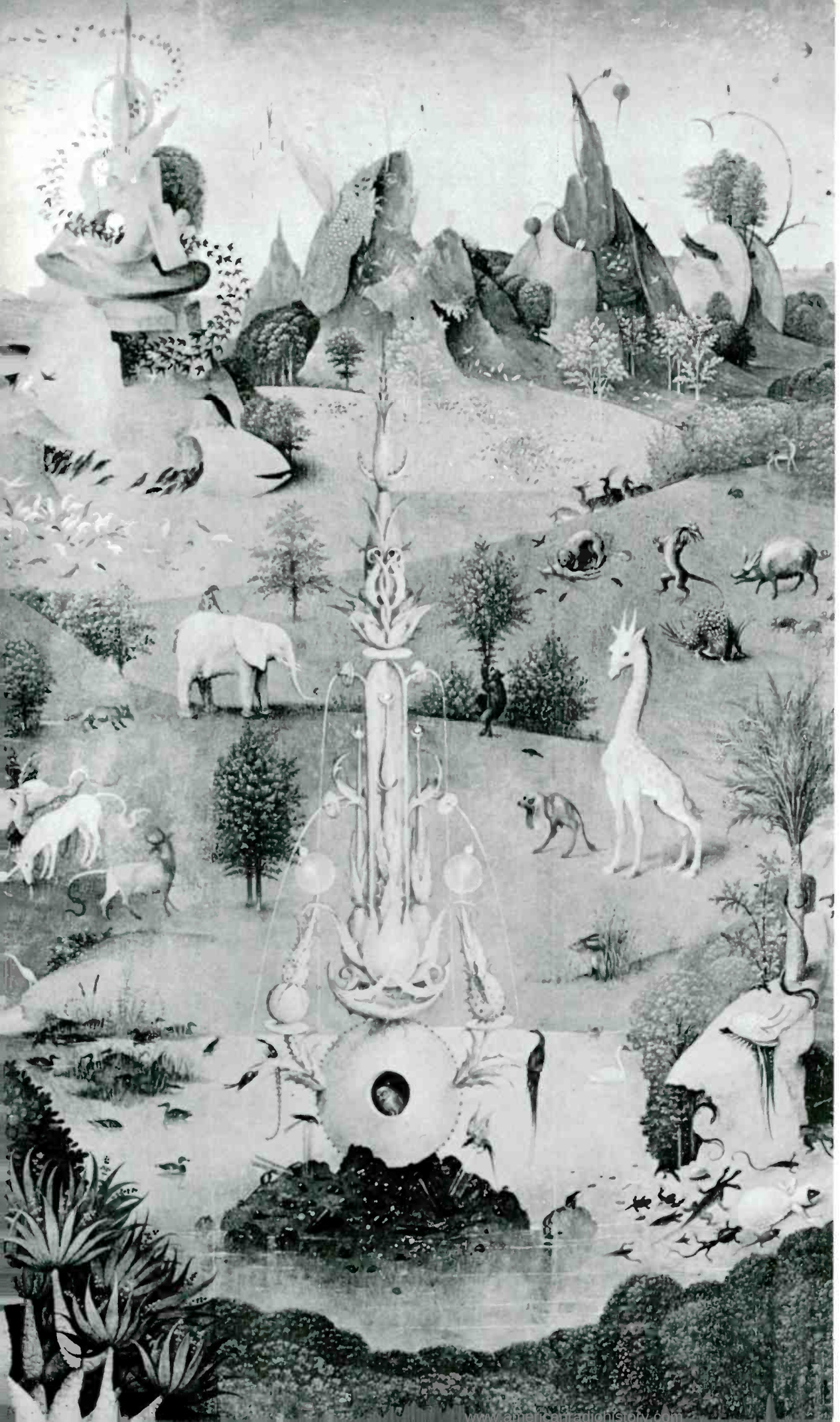
Today, many computer users are turning to systems that combine batch processing and interactive time sharing. Both types can be run at once on a sliding-scale basis — so many batch jobs for so many time-sharing users, and vice versa. As a result, during peak time-sharing hours (generally mid-morning and early afternoon) the greater part of the system works for the individual, while at other times the process is reversed in favor of batch routines. "My guess is it won't be long before most computers will have time-sharing as well as batch capabilities," one expert predicts.

Computer reliability always is a matter of concern, but in time sharing it becomes especially critical since many people can be affected by equipment failure. Data centers are particularly vulnerable to electrical storms. A common question when machines go down is "Were you hit by lightning?" The new RCA large-scale time-sharing system, the Spectra 70/61, has a built-in safeguard for power failure. Either a surge or drop in power causes the computer to order its software (operating system) to shut down user programs within a few thousandths of a second. Then the computer continues to supply power while the operating system records where it stands with each user so the thread can be picked up when operations resume.

Successful time sharing depends as much on precise programming as on precision-engineered hardware. Operating systems, which allocate machine resources, have to function smoothly in transferring user programs from auxiliary storage to main memory and back, keeping track of incoming calls and directing processing as well as output. Yet, user programs must be carefully separated in the memory to avoid contaminating fast-moving data and to keep the contents of personal files secure. It is a delicate mixture of operations that tolerates no mistakes.

Only a few years ago, these programming complexities bred disappointments, and at least several manufacturers stumbled with large-scale time-sharing systems. The idea of "information utilities" based on mammoth time-sharing computers, which had been drawing respectful attention, was talked down. Now, some experts see a reversal, pointing to the fact that company-wide information systems are not only feasible but actually are being implemented.

"Time sharing continues to be very flexible," says Ebel. "There are no tried and proven avenues. The technology moves so fast that I may have to change my mind about a lot of things in just six months." Yet, with all the twists and turns and thrusts of this volatile market, the trend toward time sharing appears irrevocable. ■



Is There Intelligence Out There?

by Isaac Asimov

Until recently, mankind was sure it was not alone in the universe. Other intelligences? Of course! Every culture believed in a variety of all-knowing gods and demons, of spirits and angels, of jinn and fairies and little people, of goblins and gnomes and elves. And every one of these species of intelligence was believed greater than man — stronger and longer lived. Of all the intelligent beings in the universe, we viewed ourselves as the weakest and least knowing.

But we did consider the earth to be alone in the universe. About the earth might be crystalline spheres that made music, together with hosts of little stars, but earth was the only actual world of its sort anywhere.

Then look what happened!

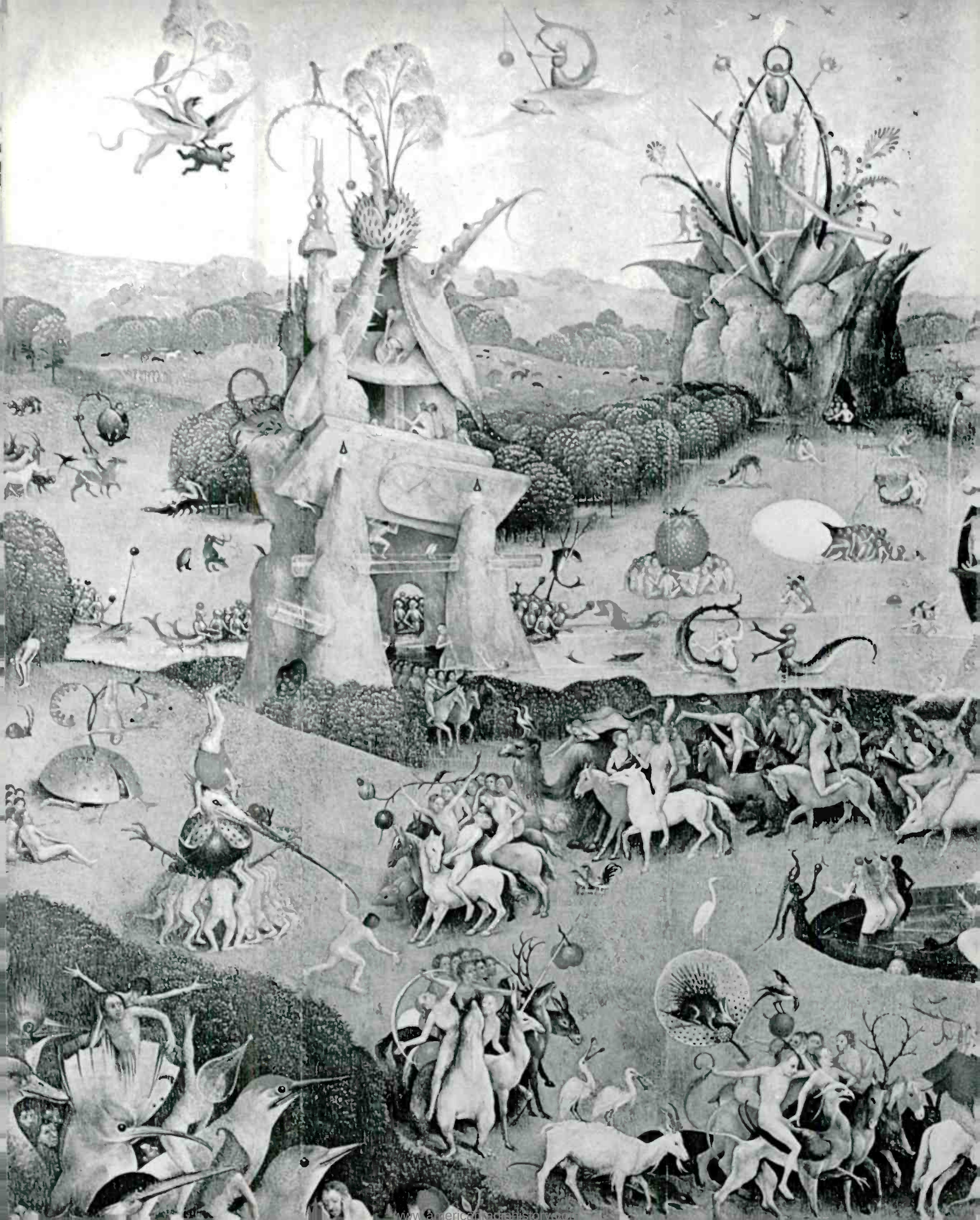
The earth was dethroned from its high place. It came to be viewed as a planet like the other planets circling the sun. The stars, we grew to realize, were really other suns. With every advance in astronomy, we found the universe to be larger than we had previously believed. The planets, it turned out, were millions of miles away; the nearer stars were trillions of miles away; farther stars were quintillions of miles away, sextillions. . . .

The universe seemed incredibly vast and incredibly empty. The stars filled it in the way that three scattered dust specks would fill Madison Square Garden. We were riders on one of those specks lost in nothingness, for, at the same time that the universe expanded beyond all knowledge, most of the spirits vanished from our beliefs. These other intelligences — from demons to leprechauns — now exist only in fantasies and children's books. In the whole universe, as far as we know, we are the only intelligent life.

Or are we? In our own solar system, there is no world fit for us to live on comfortably, except earth. On some of the other planets of this system, perhaps there may be life-forms as complicated as bacteria, but no more complex than that. Conceivably, there might also be life in chemical and physiological forms utterly unfamiliar to us, but we have no evidence

Isaac Asimov is a noted science-fiction writer and a professor of biochemistry at Boston University.

Details from *Garden of Delights* by the fifteenth-century Dutch artist Hieronymus Bosch.



"In our galaxy alone, there are roughly 650-million planets that are capable of developing life under conditions similar to those on earth."

to support that theory, no guidelines as to what the "utterly unfamiliar" might be, no way of talking about it.

On the other hand, in other systems, in other families of planets circling other stars, there conceivably might be worlds as comfortable as earth — habitable worlds. Perhaps on these worlds there may be life-forms as complex as our own. We don't know. Perhaps we may never know. But we can do a bit of speculating.

To begin with, how many stars are there? Our own sun is part of the Milky Way galaxy, a vast conglomeration of some 135-billion stars. There are other galaxies, too, perhaps as many as 100 billion of them. These other galaxies are incredibly distant, and we may as well concentrate on our own. Surely, 135-billion stars are enough to begin with.

Of course, not every star is suitable for the development of life somewhere in its planetary system. It would seem life doesn't develop very quickly, judging from the case of our own earth. A planet must form, settle down, and develop complicated chemicals, simple life-forms and then more complex ones. Finally, an oxygen-containing atmosphere must slowly be created by the action of living things.

It was only about 600-million years ago, at which time the earth was 4-billion years old and creatures as complex as shellfish already had evolved, that our oxygen atmosphere was formed. And it was only about 300-million years ago that life advanced out of the seas to penetrate and conquer the land areas of the earth.

During all the time that life was developing, the sun had to, and apparently did, deliver light and warmth to our planet at a steady rate. Life, after all, is a delicate thing, and what might have been a mere hiccup of irregularity in the lifetime of the sun would have been sufficient to wipe out life on earth.

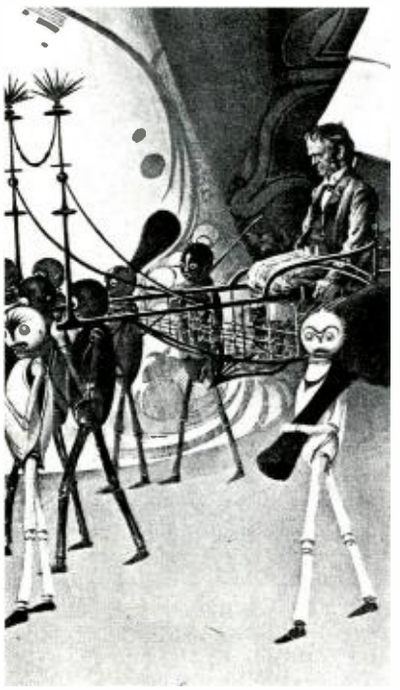
Astronomers know enough now to be able to tell a great deal about a star from the analysis of the light it emits. Some stars are too dim and cold to serve as sources of enough heat and light for life to develop at any point within their planetary systems. Others are too hot. Still others are at a stage in their development that is undergoing rapid alteration or are of kinds that will never settle down for 4-billion years of uninterrupted steadiness of delivery of light and warmth. All this can be deduced from the light sent us by the stars. Less than one star in eight is warm enough and steady enough to possess planets that can develop life, but even so that leaves 17.5-billion suitable stars in our galaxy alone.

Still, just because a star can serve as an energy source that is steady enough for the development of life on one or more of its planets doesn't necessarily mean that it has planets at all. How many stars have planets anyway? Up to 30 years ago, the most common theory of planetary formation involved near collisions of two stars. Gravitational pull was supposed to have yanked material out of each passing star, and from that material the planets formed. But there have been so few near collisions between the widely spaced stars of the Milky Way in all the time the galaxy has existed that only a handful of near misses could have taken place. According to that view, our own sun and the star that nearly collided with it might own the only planetary systems in all the galaxy.

In the 1940s, new information and ideas caused astronomers to change their minds. It began to seem very likely that every forming star leaves behind clouds of gas and dust that gradually condense into planets. If this is true, then just about every star has a planetary system. In fact, planets outside the solar system actually have been detected. Some of the nearer and smaller stars show wobbles in their motions that can be due only to the gravitational pull of large planets. If there are 17.5-billion stars that deliver energy in sufficient quantities and with adequate reliability, then there are 17.5-billion planetary systems where life might possibly be incubated.

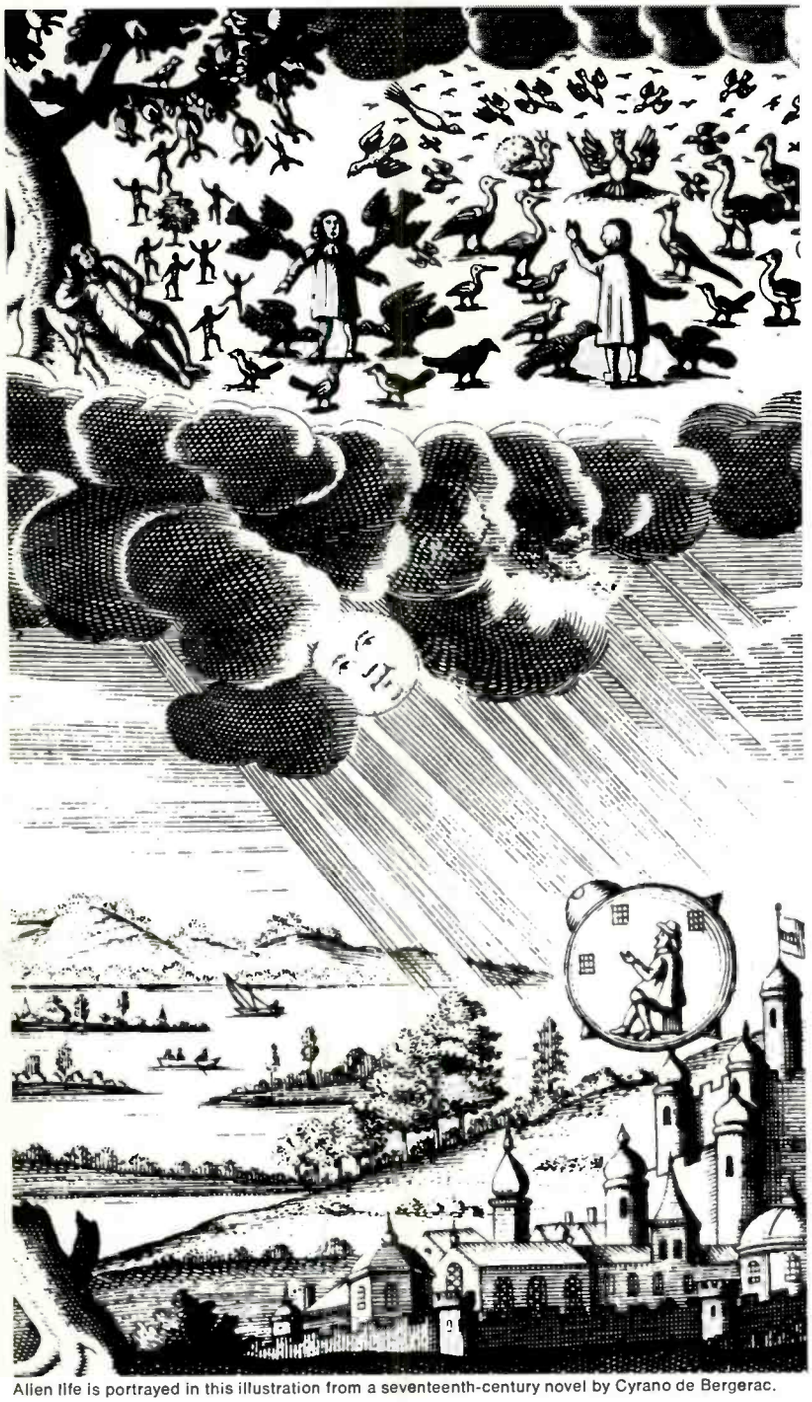
To be sure, not every planet would do. Some would be too close to a sun and too hot, some too far from it and therefore too cold. Some would have orbits

Lunar creatures supposedly discovered by astronomer Sir John Herschel in 1835.



H. G. Wells described moon creatures . . .

. . . and Martians.



Alien life is portrayed in this illustration from a seventeenth-century novel by Cyrano de Bergerac.

that were too elongated, or periods of rotation that were too slow, or tippings of axes that were too extreme. In all these cases, there would be periods where extremes of cold or heat would be too great for life to exist. Judging from the manner in which planets are distributed in our own solar system, it isn't likely that there will be more than one habitable planet for each star and sometimes not any. Making a few rough estimates and a few guesses, Stephen H. Dole of the Rand Corporation has argued that, of the stars suitable for life, only one in 27 would possess a planet on which life of the form familiar to us could take shape. Even so, this still means that in our galaxy alone there are roughly 650-million planets that are capable of developing life under conditions similar to those on earth.

But would life develop on those planets? Or is life just a super-lucky accident that has taken place only on earth? Actually, it is possible to attempt an answer to these questions through experimentation in the laboratory. Data gathered by astronomers concerning the general chemical makeup of stars and of the dust and gas scattered through the space between the stars tell us something about the nature of the material out of which the earth was originally formed. This, combined with our basic knowledge of physics and chemistry, makes it possible to reason out what the earth may have been like chemically when it first settled down into its planetary shape. The consensus is that its atmosphere was composed, originally, of a mixture of ammonia and methane. The action of the ultraviolet light of the sun slowly turned such an atmosphere into nitrogen and carbon dioxide. Finally, the action of life-forms replaced carbon dioxide with oxygen and gave us our present nitrogen/oxygen atmosphere. If this line of reasoning is correct, then life must have formed at a time when our atmosphere was still in its primitive state, perhaps when it was still ammonia/methane.

Beginning in the early 1950s, chemists attempted to trace the course of biochemical evolution experimentally. They started with a sterile mixture of chemicals similar to that believed to have existed in the earth's primordial oceans and atmosphere. That mixture was subjected to a source of energy that was analogous to lightning or to the ultraviolet radiation of the sun. The simple chemicals in the mixture absorbed the energy and combined to form more complicated chemicals of the sort that play parts in certain chemical reactions in living tissue. Mixtures of these more complicated chemicals were used as a starting point, and yet more complicated chemicals were formed, still like those in living tissue.

By the end of the 1960s, the basic building blocks of those all-important chemicals of life — the proteins and nucleic acids — had been formed in this manner. The net result of 20 years of experimentation seems to show that random combinations and recombinations of the common chemicals present in the primordial earth produce substances closer and closer to the makeup of living things. No chemicals are formed that seem to indicate some direction of development away from the basic chemistry of known life-forms.

Life, then, seems to have resulted from movement along the chemical line of least resistance. Given certain chemicals to begin with plus a supply of energy, life must form. No other direction of chemical change could have taken place with anything like equal probability.

If this is so, then we might suspect that on any planet like earth — one with a similar chemical makeup and exposed to the radiation of a sun like our own — life must form and possibly might do so within a billion years. Following this line of reasoning, we can conclude that, in our galaxy alone, there are not only 650-million planets capable of bearing life but 650-million planets that do bear life.

But what kind of life?

Ah, there at last we are totally stuck. We cannot say. It is impossible, so far, to experiment with organic evolution as we have been doing with chemical evolution. Life develops inevitably, but where matters will go from there remains a mystery.

We know, to a certain extent, what has taken place in organic evolution on earth,

but are we typical? May not earth be a most unusual exception? Might not life ordinarily remain at the one-celled stage so that earth is a curious anomaly where, alone in all the galaxy, large multicelled creatures have formed? On the other hand, other planets might have developed elaborate organisms, within 100-million years of the origin of life, with evolution racing on from there to super-intelligence. If this is true, earth may be a lonely primitive exception.

How can we say for sure whether intelligence has developed on other worlds? We can't, but we can still speculate.

Suppose earth is a typical or average life-bearing planet. It took some 4.5-billion years of existence before intelligent life formed, and that might be just about the span of time required on other worlds as well. Those earthlike planets that are older than earth would have developed intelligent life long ago. On younger planets, such life would not yet have evolved. If earth is of an average age for a planet of our galaxy, then we might suppose that intelligence has developed on a little more than half of the life-bearing planets — 325 million of them.

At the rate at which intelligent species advance their technology, any world that is even a few hundred-thousand years ahead of us would be incredibly advanced. We might expect 325-million such "super civilizations" in our galaxy. If so, why haven't they made themselves known to us? Why can't we detect beams of radio signals that they may be sending out? Why don't they visit us?

Let us suppose those 325-million planets are evenly spaced throughout the galaxy. Since about 90 per cent of all the stars of the galaxy are far off in its central nucleus, that is where nine out of 10 of the intelligences would be. The remaining 10 per cent would be out in the spiral arms, where we are.

If this is so, then, on the average, 90 light-years would separate neighboring civilizations in the spiral arms. It takes a beam of light traveling at 186,281 miles a second — the maximum speed possible in this universe — 90 years to traverse a distance of 90 light-years. If a spaceship launched from earth were traveling at a speed of merely 18,000 miles a second, it would take nearly 1,000 years to reach the nearest outside intelligence. To send detectable beams of light or radio waves over that distance would require tremendous amounts of power. And communication would be extremely complicated, since each set of signals would require 180 years for the round trip.

"They *seem* friendly."

This is the chief reason that I remain skeptical about reports that flying saucers may be ships piloted by extraterrestrial intelligences. That those intelligences exist I consider conceivable; that they might wish to visit earth is also conceivable. However, I cannot believe that repeated trips from star to star would be made without any serious attempt to establish contact. Surely, any intelligent organisms capable of making an interstellar flight would be so far beyond us technologically as to have no need for fearing contact. Lack of contact would mean only that we didn't interest them. But then, if we are so retarded in comparison to them that they see no point in making contact, why should so many flying saucers visit us?

To me, it seems that, if any intelligent race were to plan an extraterrestrial voyage, it would choose targets with the greatest care, in view of the investment of time and energy that would be necessary. I suspect that no advanced civilization would consider earth worth even a single trip, though, if a ship were to pass us en route to somewhere else, we might be subject to casual, distant observation.

It is possible that we have never been visited because, although the galaxy is full of life, it is void, or almost void, of intelligence. Suppose the earth has not followed the typical course of organic evolution. Perhaps the development of human-level intelligence here on earth was a sheer accident of the most extraordinary kind. After all, there is no real reason to assume that intelligence is the inevitable consequence of organic evolution, as life is of chemical evolution. Intelligence doesn't even seem to have much survival value.

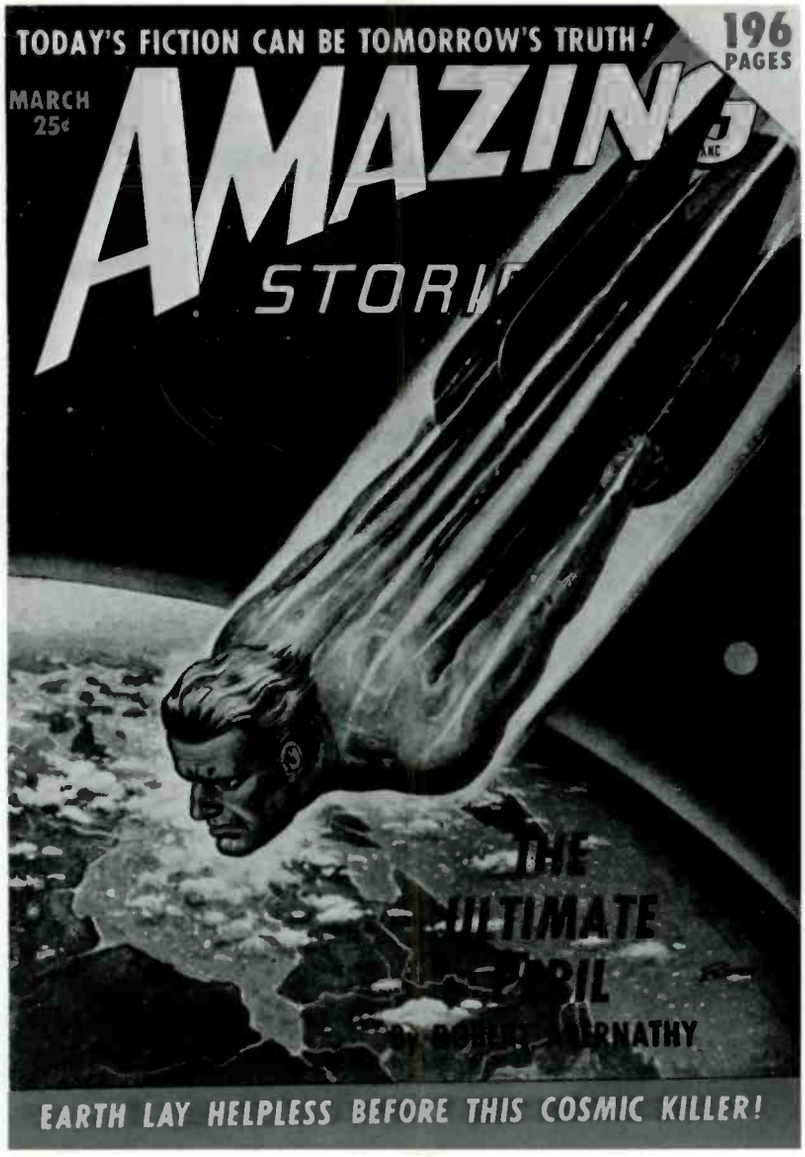
Mammals, with all their intelligence, aren't doing so well as insects, as far as sheer survival is concerned. The highly intelligent elephant, for example, isn't as hardy as the quite unintelligent cockroach. What really counts in survival are sheer fecundity (the ability to have many young) and the ability to eat almost anything. Man's early survival under conditions where the apes did poorly is likely due to the fact that men would eat virtually anything whereas apes required specialized diets.

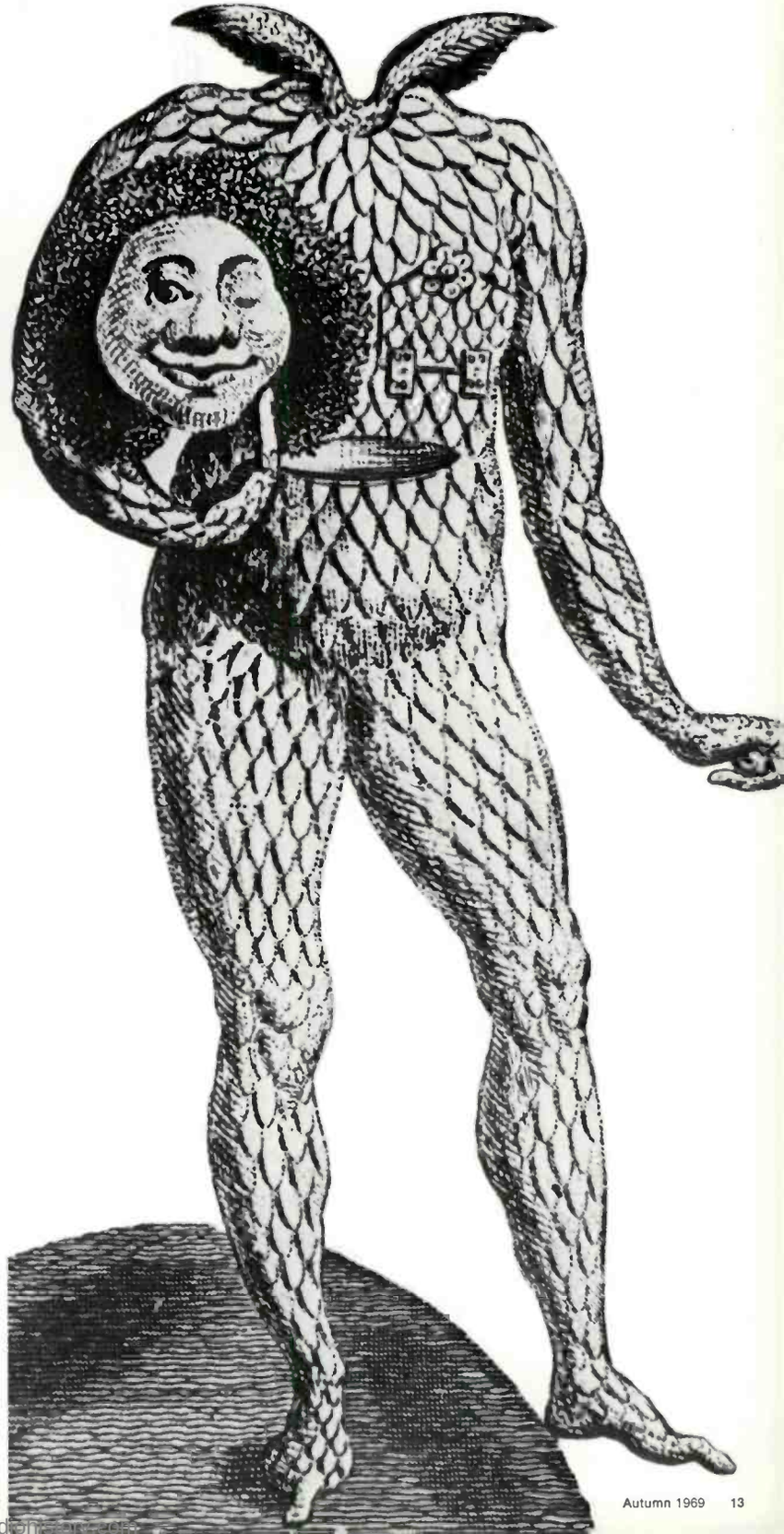
Of course, once an intelligent creature passes a certain point — becomes capable of taming fire, perhaps — he will advance to control his environment and will, therefore, come to dominate his planet. But is it perhaps inevitable that, in so doing, the intelligent creature eventually will discover nuclear power and destroy himself in war? Is it inevitable that the intelligent creature will strip his planet of habitability by consuming part of its resources and polluting the rest? We might argue that man is a freak among intelligences in this respect. Other intelligent creatures on other planets, we might speculate, are not so combative or competitive as man. I certainly hope this is true, but it is also possible to argue that, without a strong streak of combativeness and generally aggressive instincts, no intelligent creature can manage to win the struggle for survival that is necessary before "This is my property" can be stamped on a whole planet.

In either instance, if intelligence does not develop in the course of organic evolution except through the most unusual accident or if intelligences that do develop generally commit suicide within a million years, there may possibly be no other intelligences in the entire galaxy. In that case, if we ever play a game of cosmic "knock-knock," there will be no one to answer "Who's there?"

And if this is so, then surely it is more important than ever that we beat the game; that somehow we must learn before it is too late how not to commit suicide through nuclear war, overpopulation and overpollution. After all, the whole galaxy may be ours — all those millions of rich planets that bear life but not intelligence. Let us live to inherit them. ■

"There is no real reason to assume that intelligence is the inevitable consequence of organic evolution, as life is of chemical evolution."



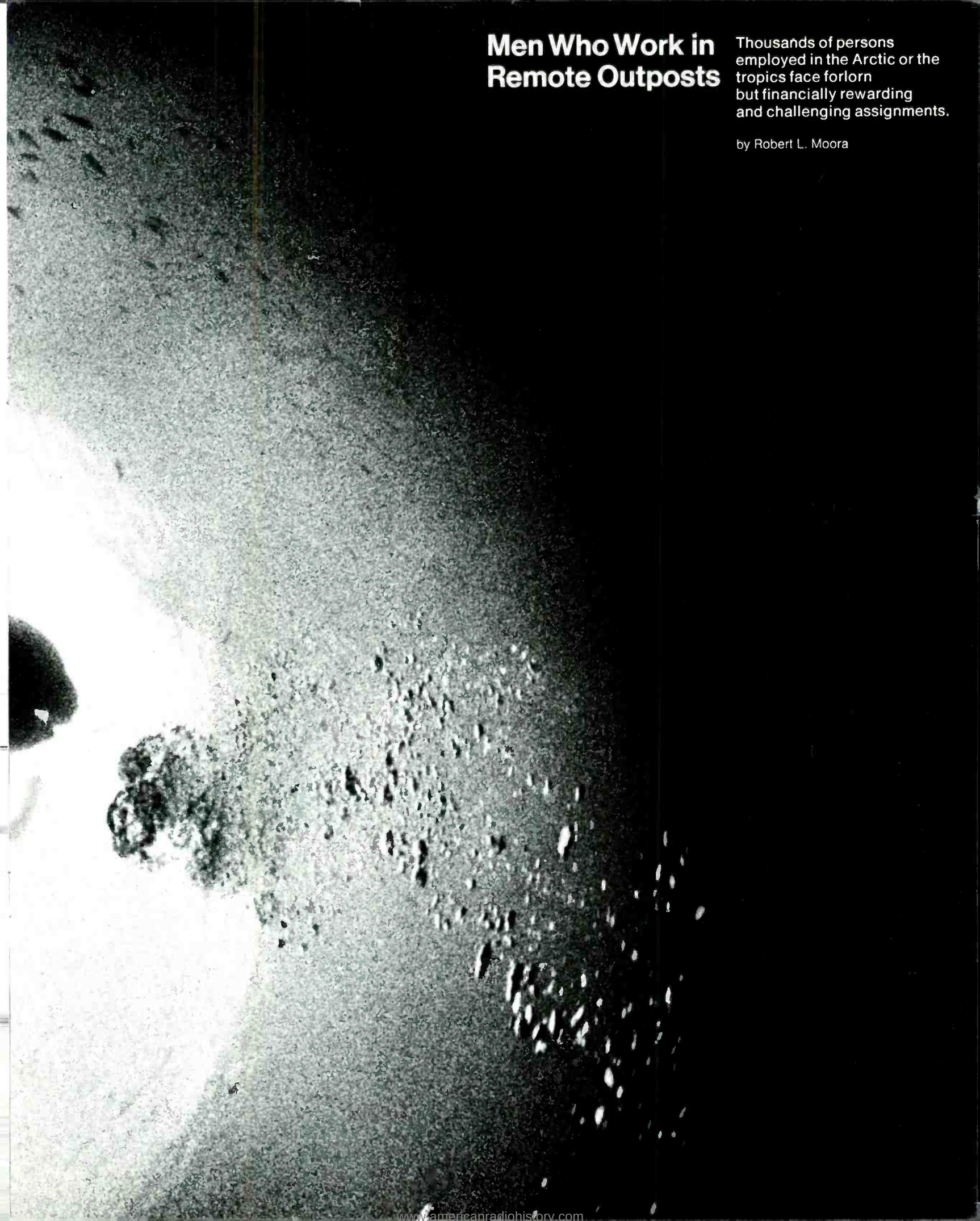


Cheerful moon man of an eighteenth-century Baron von Münchhausen novel had a removable head and eyes.

Men Who Work in Remote Outposts

Thousands of persons employed in the Arctic or the tropics face forlorn but financially rewarding and challenging assignments.

by Robert L. Moora



Close to the coast of Andros island, just north of Cuba, a motorboat plies slowly through the blue waters of the Caribbean, towing a scuba diver some 10 feet below the surface. The diver is careful to make no sudden motion, for he fears it might prompt an attack by the three blue sharks that are escorting him.

Thousands of miles away, deep in the Alaskan Arctic, in a little shack huddled beside a towering radio antenna, a man is seated at a desk studying a technical manual. There is a sudden shattering of glass and wood, and with one quick glance toward the noise the man reaches for his shotgun to fend off the polar bear that has crashed through the window.

On a small atoll in the Marshall Islands, far out in the Pacific, a bus pulls to a halt at its regular stop. A large, shaggy dog steps aboard and takes a seat in the second row opposite an engineer in work clothes; neither the driver nor the passenger raises an eyebrow.

These men are not adventurers or tourists, but electronics specialists who man the world's newest frontiers — the far-flung outposts made necessary by the space age and the sophisticated advanced electronics technology of the industrial and military systems it has created. Thousands of men like these are stationed today around the world from the tropics to the Arctic. They may be electronics technicians or mechanical engineers, or they may be construction workers, clerks, storekeepers, janitors, truck drivers or other personnel needed to support these electronic outposts. In some fortunate cases, they may enjoy the company of their families and many of the comforts of civilized living as they perform their conventional jobs in unconventional surroundings. But for the most part, theirs is a forlorn though financially rewarding life.

The man at Andros island was trying to find a hydrophone that had come loose in an undersea detection range (the sharks never attacked him). The man in Alaska was a technician at a remote communications relay station (he killed the bear). And the canine caper occurred on Roi Namur, an atoll near Kwajalein island, where a whole herd of shaggy mongrel dogs, left behind by natives and fleeing Japanese troops 25 years ago, has adopted the strangers from America who have come to operate a radar base for study of missile reentry through the atmosphere.

These outposts can be termed remote in two different contexts, one geographical, the other human. Some are fairly close to cities — Fairbanks or Juneau, Alaska, for example — but nevertheless are so cut off by the terrain and the elements that they can be supplied only by plane or helicopter. Some, on the other hand, are much farther removed geographically (Thule, Greenland, 600 miles north of the Arctic Circle, or Kwajalein island, halfway between Hawaii and Australia) but despite their remoteness are like small cities in the size and scope of their facilities. The life and work of the men who operate them vary widely.

Some of the bleakest outposts are in the Arctic. "The northern lights have seen queer sights," as Canadian poet Robert W. Service wrote, but seldom have they seen stranger ones than man's activities in bringing modern science into the frozen wilderness to build and operate the military warning systems and communications networks that serve and protect North America. These include the Ballistic Missile Early Warning System (BMEWS), operated for the last 10 years by RCA to maintain a radar vigil against ICBM attack over the top of the world, the Distant Early Warning System (DEW Line) operated by Federal Electric Company to keep similar watch for high-flying bom-

Robert L. Moora is on the RCA Public Affairs staff.

bers, and the Alaskan White Alice Project, operated at different times by both RCA and Federal Electric to provide communications for the military, commercial interests, and the public as well as link the forty-ninth state with the rest of the world.

There are other outposts, too. On the western shore of Hudson Bay, in Canada's subarctic bush country, Pan American World Airways operates a miniature Cape Kennedy for the dominion's National Research Council. There, in an almost year-round frigid environment, 200 men are conducting scientific experiments that include rocket launches to study the aurora borealis — its interference with radio communication and its significance in meteorology. (Occasionally, a Pan Am helicopter crew will take time out to ferry a wandering polar bear back to its natural habitat.)

The northernmost station in the warning systems — but by no means the bleakest — is the BMEWS base at Thule, Greenland. It is about 800 miles south of the North Pole and actually farther north than the magnetic pole. Planes serving the area always carry full loads of fuel, since they frequently are forced to turn back by the sudden storms with winds up to 125 miles an hour that sweep off the Greenland icecap. But despite its remoteness, Thule is virtually a municipality. Built adjacent to the Air Force base, the BMEWS dormitories house more than 2,000 men who operate or support the big radar site on a hilltop 13 miles north. (Except for a few nurses at the air base hospital, there are no women at Thule. Every newcomer bound for the Greenland post is told: "Don't worry about women; there's one lurking behind every tree." There isn't a tree within 500 miles.)

Thule is not the most comfortable place to work. Hurricane-force winds blow stinging ice crystals off the icecap, and winter temperatures fall to minus 30°F. or lower. But Thule has all the facilities of a modern city — a movie theater, gymnasium, bowling alleys, arts and crafts workshops, social clubs, radio and TV. (The Air Force-operated television station is KOLD-TV.) In addition, entertainment is flown up from the States, and there is a base exchange supermarket with far lower prices than those at any American discount store.

Furthermore, U.S. civilian employees who go up for the normal 18-month period can come home with a sizable bundle of cash. Those who sign up for additional 18-month hitches — there are some RCA employees who have worked there almost continuously since the start of the facility's construction in 1958 — could return with a comfortable nest egg.

There are several reasons for the lucrativeness of these assignments. Many American civilian employees work seven days a week, 365 days a year, even Christmas Day. They don't mind, since there is nowhere else to go although there is plenty of entertainment to occupy them in off-hours. They draw overtime pay for Saturdays, Sundays and holidays, receive a 30 per cent bonus for remote service, and their food and lodging are free. If they choose to eat at one of the clubs (officers', noncoms' or airmen's, depending on grade of employment), they can feast on prime steaks at $3 a portion and buy any drink for a quarter. Finally, they pay no income tax, provided they

don't spend more than 30 days back in the States during the 18-month period. Greenland is Danish territory.

However, along with economic benefits, there is a jolting reminder of their daily routine. Along the 13-mile road that the men traverse by bus every day from their living quarters to the hilltop radar overlooking the icecap, there are nine emergency shelters in the event that a sudden storm blows off the icecap. Each has a stove kept constantly burning, bunk beds, food, water, first-aid supplies, ropes, shovels and other emergency tools as well as a hot-line telephone that is answered immediately by the communications center at the radar site when it is lifted from the hook. There can hardly be a better indication of the environment in which they live and work.

Rigorous though life may be at Thule, it would seem like a stateside metropolis to many of the 1,000 or more Federal Electric employees who man the DEW Line. They operate six main stations and more than two dozen smaller ones spread across the top of the Northern Hemisphere from Cape Lisburne, on the Alaskan coast of the Arctic Ocean, across Canada and Greenland all the way to Iceland.

Some of the DEW Line stations are situated in areas so remote they can be supplied only by parachute drop a good part of the year. When construction of the Line was started by the Western Electric Company in the early 1950s, the first workmen were flown in by small skiplanes. Supplies and equipment, including 14-ton plows and heavy trucks, were dropped by means of multiple parachutes so the men could plow out landing strips for the Air Force's huge, double-decked C-124 Globemaster cargo planes. These aircraft flew in more material and food, 24-ton tractors and even prefabricated houses specially designed to withstand 150-mile-an-hour winds. Later, snow trains drawn by Caterpillar tractors came in, at times traversing the frozen Arctic Ocean, to deliver housing modules that were hitched together like freight cars to provide living and working quarters for the men.

It is in these structures that Federal Electric technicians live and work, in crews ranging in size from 10 or 14 men to several score, as they maintain a round-the-clock vigil against possible attack. Most of these men are out of personal contact with the outside world for a good part of the year, except when weather permits aircraft to bring in supplies and periodic medical and dental service. But they are only seconds away from their headquarters in Paramus, N.J., via teleprinter. In the communications room at Paramus, the teleprinter keeps in constant contact with the remote Arctic stations on such matters as erecting new radomes, rehabilitating living quarters, repairing weather station instruments, servicing vehicles, building roads and airstrips, maintaining pipelines, reinforcing antennas, replacing worn-out parts of radio transmitters and receivers, and planning airlifts of fresh food and supplies. From the teleprinter, the larger bases may receive welcome notification of the annual sealift of tons of heavy equipment and supplies in midsummer — the only time that icebreakers, cargo ships, tankers, barges and tugs can get through.

The smaller DEW Line stations, stretched across the Arctic, probably are the loneliest outposts in the world. Yet, morale is high because of a well-rounded recreational program developed by Federal Electric, with much the same facilities as the Air Force and RCA provide at BMEWS bases in Greenland and Alaska. Many

Radar antenna at a BMEWS station in Greenland.

DEW Line stations have fully equipped gymnasiums, including basketball courts and steam baths, and maintain libraries of 300 to 500 books and scores of magazines. In addition, each site provides high-fidelity phonographs and at least three full-length movies a week. As is the case at BMEWS, many DEW Liners are amateur photographers and ham radio operators, and all sites are equipped with darkrooms and electronic accessories. Fishing is an almost universal sport. A much-desired catch is the arctic char, a tasty three-foot-long fish weighing from 15 to 25 pounds. Although hunting is a popular DEW Line pastime in Alaska, it is forbidden in Canada because of the Eskimo's dependence upon game for survival.

There are several formidable hazards facing all workers in the Arctic: the unrelenting cold, the ever-present danger of fire and, curiously enough, sunburn. At minus 30°F., exposed flesh will freeze solid in a matter of minutes, and when a 30-knot wind is blowing at the same time the freezing time is a matter of seconds. On the DEW Line, all men are informed at the start of each work shift, and frequently throughout the day or night, of the temperature, wind velocity and chill factor. In the Arctic, gasoline is handled with particular care, since, if spilled, its high evaporation rate cools the skin below freezing almost instantly.

Every precaution is taken against fire, because a tiny flame, fanned by polar blasts of 50 to 125 miles an hour, can devour a structure in almost no time. Huge signs shout the reminder: "Burning time on this building — two minutes."

Whenever the ground is snow-covered — whether the sun is shining or the sky is overcast — sunglasses must be worn outdoors to avoid snowblindness, a painful sunburn of the eye. Overcast can cause still another hazard when it blends with the snow. Unless there are dark objects on the ground to provide contrast, the result is a whiteout more blinding than a London fog. Men caught in a whiteout have been known to walk in circles for hours before spotting a building or some other object to give them direction. A construction worker once told of wandering around in a whiteout and turning to discover a small black dot following him. When he retraced his steps to investigate, it disappeared. It had been the nose of a white fox.

In another case, an RCA technician on the White Alice Project, driving from Fairbanks to his microwave station 50 miles to the north, suddenly could see nothing and had to halt. Fortunately, he had a citizen's band radio with him and alerted Fairbanks to his predicament. Rescue efforts failed because of the blinding whiteness, and 16 hours passed before conditions permitted the man to proceed. Meanwhile, at the microwave station, a weary operator awaiting his relief was kept awake by deliberate radio chatter from Fairbanks. Ironically, personnel at an Air Force post just 100 yards away, who could have relieved the operator, were unable to reach him because of the whiteout.

Many White Alice stations are in remote locations, from Cape Lisburne to Alaska's southern panhandle, where fog from the Pacific provides still another hazard. One of the most remote, from a human standpoint, is only about 75 miles

A torpedo recovery team off Andros island in the Bahamas.

north of Nome, but it is on a mountain and reachable only by airplane. There, about 20 technicians man a relay station, feed a pet wolf from their door and, despite their being less than 80 miles from the Arctic Circle, bathe regularly outdoors — in a hot spring that bubbles up only 100 yards away.

On the other hand, the BMEWS station at Clear, Alaska, some 60 miles west of Fairbanks, is a veritable township built up in the wilderness. More than 600 workers, both civilian and Air Force, operate the missile-warning base. About 250 of them live with their families, some in small houses but most in trailers in a colony near the base.

Life at Clear is not unpleasant, especially in the summer. Temperatures rise into the eighties and nineties, and an adventuresome electronics technician can go out with a gun in quest of black and brown bear, grizzlies, moose, caribou, wolves and the white Dall sheep with golden horns that are native to the area. But one must be careful. Not long ago, the BMEWS site manager and his wife went hunting in the forest. She shot a female grizzly, and while she was skinning it her husband set out in search of the male. Instead, the male found him, knocked him down as he ran around a tree, and then fortunately turned from the prone man and disappeared in the forest.

In winter, however, life at Clear chills as temperatures plummet way below zero, twice in recent years to minus 70°F. Yet a number of events buoy the winter existence, such as the annual Anchorage-to-Fairbanks ski-mobile race (250 miles in temperatures ranging down to 30°F. below zero), a fur rendezvous for hunters and the yearly "icebreak pool," in which some $150,000 is wagered on the exact day and hour that the eight-to-10-foot-thick ice on the Nenana River breaks up with a thunderous roar. This could happen anytime between March and May.

In sharp contrast to the arctic outposts are the electronic sentinels and study projects that dot the tropical world from the Caribbean to the South Pacific. Ten years ago, the little radar tracking stations on the islands stretching down range from what was then Cape Canaveral all the way to Ascension island, 5,000 miles away, might have been considered remote. Today, served regularly by ship and plane, they have been turned into reasonably comfortable living and working sites, with the cool waters of the Caribbean and the South Atlantic for swimming, boating and fishing in leisure time. But watch out for sharks.

Just off Andros island, where RCA is conducting research in detection of underwater targets — submarines, torpedoes and other objects — a hydrophone (an electronic listening device) came loose. A scuba-diving technician dove under water to find it and refasten it to the chain of hydrophones that stretches below the surface. As the motorboat above towed him along the range, he noticed a large blue shark trailing him. He remained quiet, fearful that any sudden movement might precipitate an attack. Then he noticed a second shark swimming on his right, and then a third. They seemed to be merely curious, not angry or hungry, and he proceeded with his work until the end of the afternoon when he was hoisted to the surface without having found the missing hydrophone. The next day, he went down again, and his three escorts were waiting for him. And so it was on the third day. But this time, he found the hydrophone, returned it to its proper location and lashed it down, at all times under the watchful eyes of his fortunately docile escorts.

On Andros, there are two contrasting types of bases. One, the project headquarters, is close to a native community where there is a semblance of commercial trade and even a bit of night life. The others are more isolated.

Polar bears are sometime companions to DEW Line workers.

Halfway around the world on Kwajalein and Roi Namur — in the Marshall Islands between Hawaii and the Philippines — is another set of remote sites that to a man on duty in Greenland or Alaska might seem like a South Pacific dream resort. Together, they form the base for an experimental radar project, operated by RCA for the Air Force, to study the reentry into the atmosphere of ICBMs fired from Vandenberg Air Force Base in California some 3,000 miles away. The project is known as TRADEX (Target Resolution and Discrimination Experiments).

On Kwajalein, some 3,000 men, women and children live in a community that resembles a small suburb transplanted from the United States. It has duplex cottages and trailer homes, elementary and high schools, churches, movies, TV and radio stations, a daily newspaper, swim clubs, a hospital, and a store so well stocked with toiletries, household appliances, food and other merchandise that the local populace refers to it as "Macy's."

Bachelor personnel on the project live in dormitories on Roi Namur. Facilities there are comfortable but not so plush as on Kwajalein. On both, however, the environment lends itself to outdoor activities such as softball, fishing, boating, swimming and skindiving. Each day, an Air Force DC-4 flies Kwajalein-housed personnel to Roi Namur for duty on the radar base. Most are from RCA, but some are from other companies such as Sylvania Electric Products, Inc., which is also engaged in radar work, Global Associates, Inc., of Oakland, Calif., housekeeper for the site, and Kentron, a Hawaii communications firm.

The bachelors on Roi Namur encountered a phenomenon of the animal kingdom when they began to arrive in the early '60s. The island was inhabited only by a tribe of shaggy dogs, looking for all the world like the dog James Thurber made famous in his *New Yorker* cartoons. They were a crossbreed of dogs left behind by natives and others brought in by Japanese troops. Though they were running wild, they proved friendly and began to adopt their visitors. Today, the dogs live outside their adopted masters' dorms and wait for them to emerge each morning. Then they commute to the work site, traveling with the men on the buses and vans that serve the base. Some dogs even ride the rear seats of motor scooters or hitch a ride on a forklift.

A man seeking employment at a remote base must be more than a skilled engineer or technician. Each candidate faces a series of rigorous personal and psychological examinations to make sure he can take the strain of working in locations far from his fellow men.

For example, when Federal Electric took over the operation of the DEW Line in 1956, it retained the Klein Institute of Aptitude Testing in New York to create a series of tests to determine a candidate's personality, ability to get along with others, recreational interests, mechanical comprehension and general intelligence. Then come rigorous physical and medical examinations, including X-rays of the lungs, back and teeth. As one Federal Electric personnel executive put it, "A toothache in arctic weather can be a pretty fierce thing."

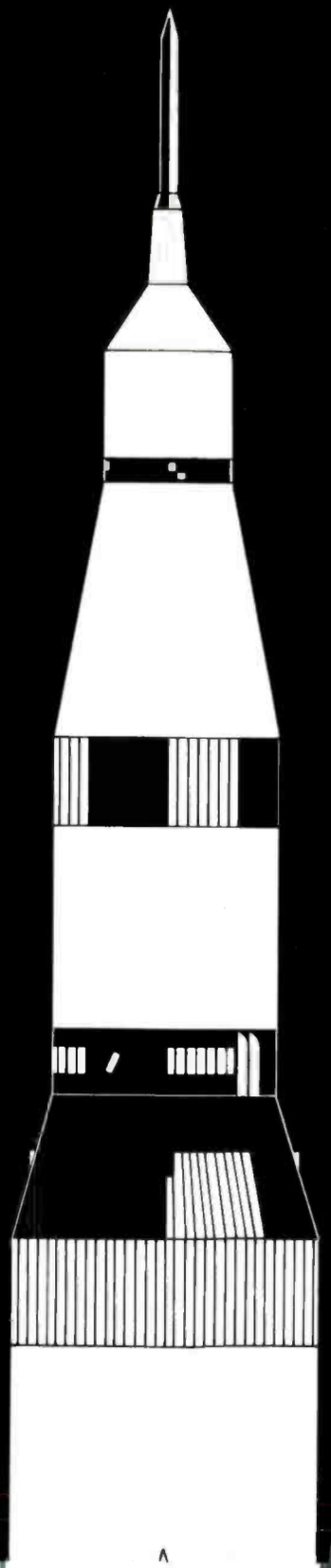
RCA has similar tests for candidates not only for arctic jobs but for remote tropical locations. These delve into much the same areas as do Federal Electric's, and they particularly check the reasons for a man's desire or willingness to serve in isolated posts. Money is the most common reason, but there can be others.

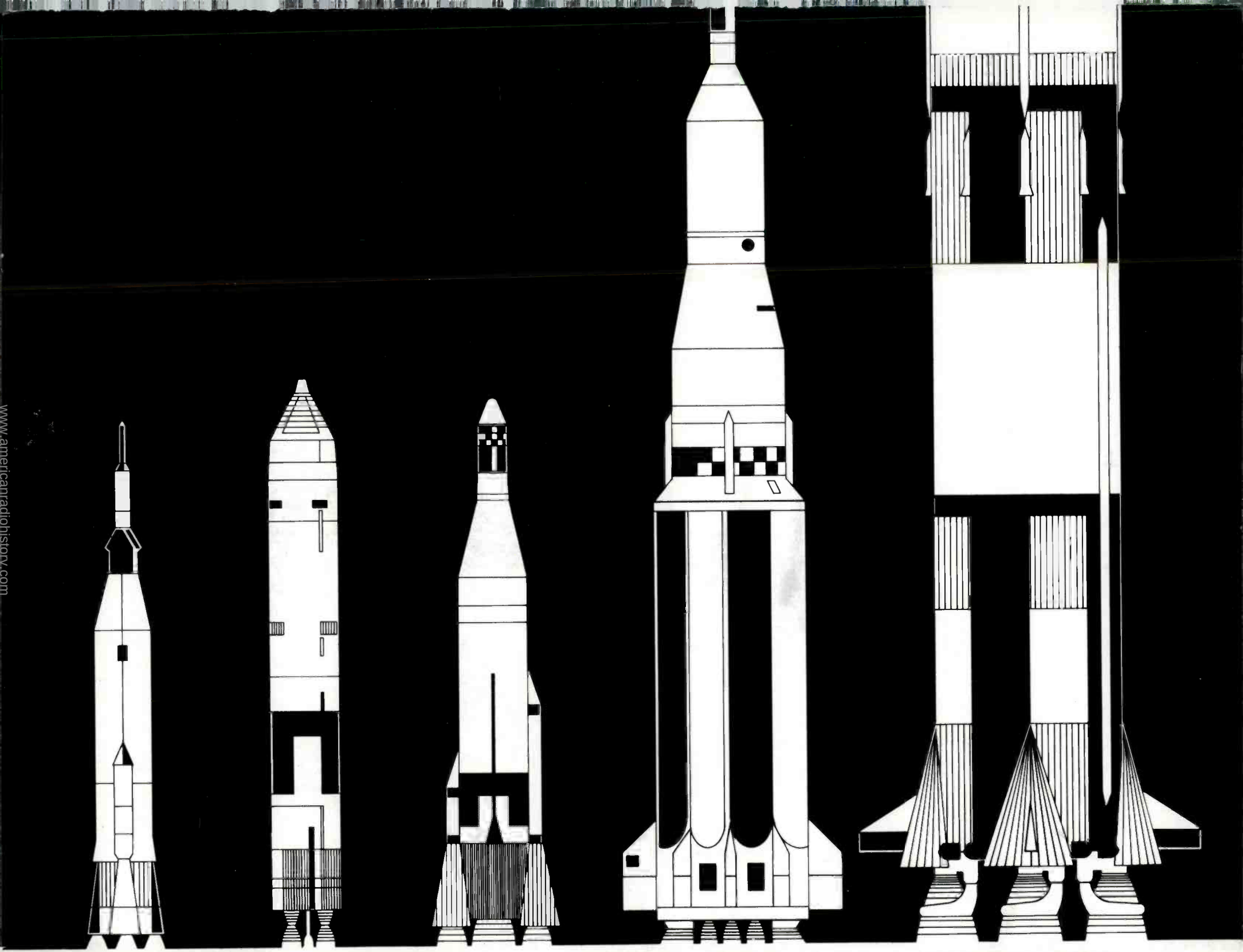
"Some are running away from something — a business upheaval, a shop problem, maybe even a wife," says an RCA personnel man. "The ones running away from a wife or a girl friend we want like a hole in the head." ■

Reflections on Apollo

Two scientists who have been a part of the space program almost from its inception look back at the problems and triumphs of the project to land a man on the moon.

by Frank J. Gardiner and Sam Holt
as interviewed by Norman H. Solon





Atlas rocket that powered the Mercury spacecraft, inaugurating the man-in-space program.

Titan (left) and Agena D rockets propelled the two-man Gemini flights into earth orbit.

Saturn 1 rocket, with 1.5-million pounds of thrust, was used in the early Apollo test missions.

Saturn 5 rocket, which generates 7.5-million pounds of thrust, propelled the Apollo 11 spacecraft on its voyage to the moon.

"In almost every communications subsystem of the LM, you will find two black boxes in parallel, performing essentially the same function, or two signal routes. If one component should fail, there's almost always a secondary path that the signal can follow to complete the mission."

Frank J. Gardiner and Sam Holt were among the scientists from NASA *and many of the 2,000 companies that have been a part of America's space program who witnessed the launching of Apollo 11. That July morning, these usually calm scientists sounded more like cheerleaders than objective observers. It was as though they believed that the sound of their voices could add a little more thrust to the rocket — could in some way help the spacecraft through the atmosphere.*

To Gardiner and Holt, this mission to the moon was both the climax and the affirmation of eight years' work. The two RCA scientists collaborated with their counterparts at the Grumman Aerospace Corporation in submitting a proposal to NASA *giving specifications for a vehicle that would separate from the rest of the spacecraft in lunar orbit and then proceed to the surface of the moon. This proposal set forth the conception of the Lunar Module (LM), the bug-shaped craft from which Neil Armstrong stepped onto an alien world.*

"Although the Apollo program dates back to the 1950s, the Lunar Module concept was not even contemplated until 1961," Gardiner says. "Until that point, our space program was geared toward going to the moon by means of an earth-orbit rendezvous technique. This would have involved launching the payload of two Saturn rockets, uniting them in earth orbit and sending one giant spacecraft to the surface of the moon. In fact, RCA became involved with this earth-orbit concept quite early. We had a contract with the Air Force to develop a satellite inspector. The idea was to send an unmanned vehicle into orbit equipped with television and radio sensors to examine existing satellites. However, in order to inspect a satellite, you have to catch it first. So, we worked out and tested various earth-orbit rendezvous techniques. The program was canceled, but based on know-how gained on this project, we made a study for NASA — Dr. Wernher von Braun, in particular — in which we outlined our proposal for adapting these rendezvous techniques for the lunar program.

"While our study was being considered, we heard of Dr. John C. Houbolt, chief of theoretical mechanics at NASA's Langley Research Laboratories at the time, who by sheer persistence was forcing the space agency to take a look at his lunar-orbit rendezvous idea. The idea looked good on paper, and one evening I sat down with Dr. Leslie Matson, then my close associate at RCA, and we computed the trajectories and weight requirements for lunar-orbit rendezvous. Immediately, we saw that this technique was clearly superior to earth-orbit rendezvous, both in terms of reliability and the time required to build a spacecraft capable of landing a man on the moon. However, NASA seemed committed to go the earth-orbit route, and I was sure nothing could change the situation. But frankly, my interest in the earth-orbit tests dropped off appreciably."

Holt: "We found that many NASA officials were intrigued with the possibilities of lunar orbit, and the space agency authorized a study. RCA was very much interested, and we made a bid for this study. So did Grumman."

Gardiner: "Neither of us was successful, apparently because each of us alone lacked some of the experience and particular capabilities that appeared necessary for the project. Yet both companies were more convinced than ever of the superiority of lunar orbit. In January, 1962, we decided to join forces and make a parallel study on an unsolicited basis for submission to NASA. In this way, we were able to consolidate the advantages of our respective backgrounds: RCA in electronics and Grumman in aircraft manufacturing. We went to NASA, and a top official there bluntly told us, 'Fine, go ahead. We have Ling Temco-Vought doing this study for us, but we'll be happy to look at yours. Of course, there will be no government money involved.'

Sam Holt (foreground), Manager, RCA Aerospace Equipment Programs, and Roger Devantier, Communications Equipment Manager, in the control room for the Apollo 12 mission.

Frank J. Gardiner, Manager, RCA Systems Development Applications Department, stands in front of the Apollo 12 spacecraft at the Vehicle Assembly Building at Cape Kennedy.

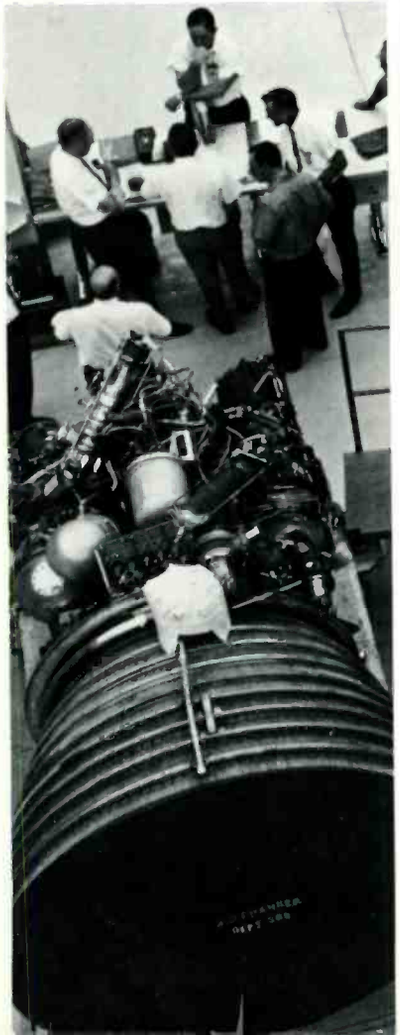
Frank J. Gardiner and Sam Holt are with RCA Defense Electronic Products. Norman H. Solon is on the RCA Public Affairs staff.

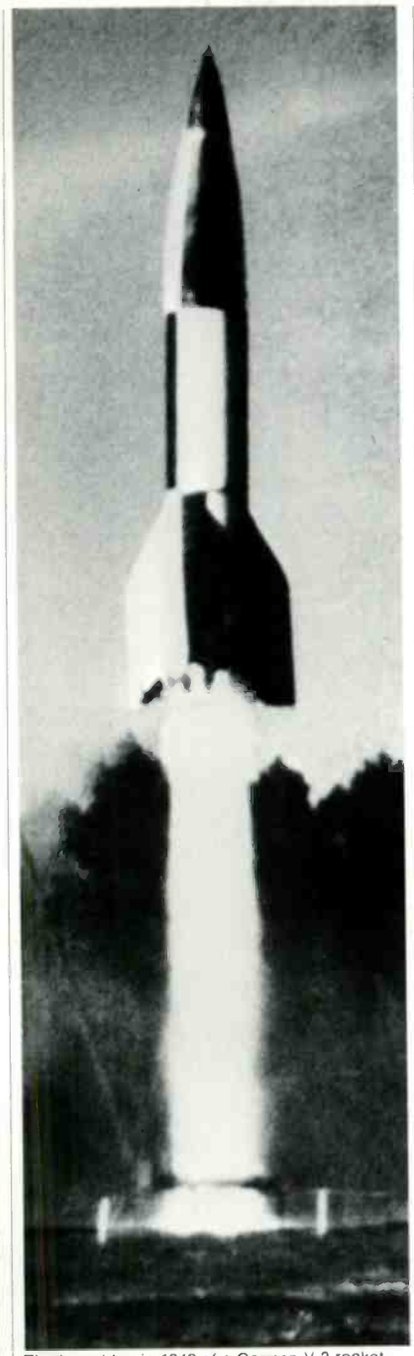
"Under these circumstances, we were a little nervous about approaching our top management for permission to make a lunar-orbit study. But we finally got the go-ahead, and our Grumman counterparts also received approval from their executives. We participated in a joint study, and, in the six-month period between February and July, 1962, we made a complete design of the Lunar Module and its mission.

"After we submitted our study, complete with the LM design, a heated debate took place between the backers of the earth-orbit technique and those of us who supported the lunar-orbit route. At that time, the mainstream of thinking favored the former, largely because of inertia. Millions of dollars already had been earmarked for earth-orbit rendezvous vehicles, and schedules had been laid out. To change direction at that point seemed like a monumental waste. All the design work that had been completed on the Command Module (CM), for example, would have to be changed radically in order to accommodate a connection to the Lunar Module at the tip of the cone.

"In addition, many people objected to splitting the three-man crew. They claimed that every hand and every head would be needed to ensure a successful lunar landing and takeoff. To counter this argument, we drew accurate time lines that accounted for every second of planned action for each astronaut aboard the LM and proved that two men could easily handle all necessary maneuvers without sacrificing reliability.

Rocket engine under construction.





The launching in 1942 of a German V-2 rocket, similar to the one above, heralded the age of modern rocketry.

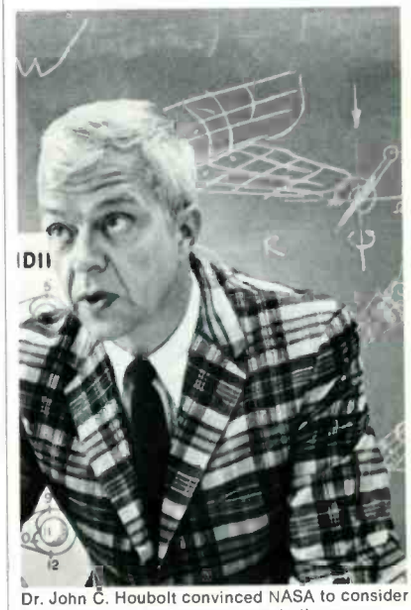
"In the end, NASA recommended that the lunar-orbit technique be adopted, and the White House concurred. Evaluation studies and trade-off analysis indicated to the space agency that this was the most reliable system and also the one that could be built most quickly.

"The flight of Apollo 11 bears out my conviction that the people who had the courage to make that decision did the right thing. I have no doubt that, had we gone in the direction that was originally contemplated, we would still be talking about manned lunar landing in the future tense. And the entire Apollo program would have been much more costly because of the great problems involved in landing a huge Command/Service Module (CSM) on the surface of the moon. For instance, the last-minute maneuver made by LM commander Neil Armstrong to avoid landing in a rough crater would have been much more difficult to perform in a weighty CSM with limited ground visibility. It would have been like piloting a 747 jumbo jet instead of a helicopter.

"By the end of July, 1962, NASA had issued invitations for bids on the construction of the LM. We teamed with Grumman for this implementation phase and submitted our proposal in late August. The following month, we received word that Grumman would be named prime contractor and RCA would design and build much of the electronic subsystem. During October, November and even into December, we were almost constantly down in Houston, attempting to finalize our role in the program and refining some features of the design that we had originally submitted in accordance with NASA's evaluations and requests.

"As I remember, it was around Christmas, 1962, that the contract was actually awarded. Two weeks later, we got to work under the terms of the contract. Our initial tasks were to participate in the systems engineering and in the trade-off decisions among the various electronic components."

Holt: "We ran into large numbers of problems right away, particularly in regard to weight. In addition to making a lunar landing and taking off again, the LM had to perform all the same basic communications functions as the CM. And all this had to be done with a vehicle weighing only some 33,000 pounds, with most of this weight solely for fuel. We conducted numerous studies in the electronics area trying to determine and define the best techniques to achieve weight conservation while preserving high reliability. In order to accomplish this, we first neeced to obtain the most reliable components. We screened standard components off a production line so that only parts with the highest reliability factor were used. In addition, components rated at, say, 220 volts were used at voltages in the order of 50 to 80 to assure a large safety factor. However, we still were faced with many unknown factors that could affect the design of the communications system. For example, in order to determine the amount of vibration to which our equipment would be subjected, we designed and built a LM secondary structure simulator. With this test equipment,



Dr. John C. Houbolt convinced NASA to consider the lunar-orbit rendezvous route to the moon.

we were able to simulate the expected vibration levels of the Saturn 5 engine and to measure the actual levels. In this case, it turned out that the levels injected into our equipment were considerably lower than we had originally assumed. If you err, you'd better err on the side of greater safety.

"However, despite all this scrutiny, our detailed reliability analysis, made after the program was under way for nine months, showed us that we would not be

able to achieve a 99 per cent probability of maintaining communications throughout the mission. It became apparent that in order to meet this goal we would have to parallel our equipment or use redundant equipment. We did both. In almost every communications subsystem of the LM, you will find either two black boxes in parallel, performing essentially the same function, or two signal routes. If one component in a subassembly should fail, there's almost always a secondary path that the signal can follow to complete the mission."

Gardiner: "We also had to know something about the surface of the moon in order to determine its radar reflection characteristics. In other words, we had to make sure that we could get a return radar signal. Originally, we had only speculation and hardly any data about the characteristics of the lunar surface. So, we consulted with the nation's leading selenologists and astronomers before making any decisions.

"The altitude and velocity of the Apollo 11 LM with respect to the moon were obtained by bouncing radar beams with frequencies of 10 gigahertz off the lunar surface and having some of that energy reflected back to the LM. In retrospect, we probably overdesigned by a goodly margin, but there again it was a matter of simply playing it safe.

"Speaking of radar, one of our biggest problems was to make sure that the LM and CM pilots knew their positions relative to each other at all times. Radar aboard the LM does this very well, but we really had no reliable backup system. If the radar had failed, the astronauts could have relied on a redundant system on earth. But it is very difficult to obtain accurate measurements with such a system during powered phases of the mission. This can be done during coasting, but the procedure is quite slow, with significant time delays. Furthermore, radar ranging from earth fails completely when either space vehicle is behind the moon because the lunar mass blocks out all communications. The problem could not be solved by adding sophisticated hardware to the LM since weight considerations were critical.

"Finally, Ed Nossen, an RCA communications specialist, thought of a clever way of adding a small number of circuits to the communications channels that are normally used for voice transmission between the LM and CM, and this gave us accurate ranging. This method was implemented in 1967 and incidentally earned the David Sarnoff Outstanding Achievement Award for Nossen. Here was a case in which an improvement in technology allowed us to make an important change in the vehicle that we could not have thought of in the original concept."

Holt: "Looking back at the Apollo program, what impresses me most was the rapid dissemination of technical data among the thousands of companies and government agencies that were involved. Right from the beginning, there were almost continuous technical coordination meetings of NASA people, prime contractor personnel and their subcontractors. In this way, problems involving Apollo needed to be solved only once since the answers were passed down the line.

"Especially striking has been the tremendous cooperation of a technical nature that was required and did occur among participating companies. We frequently found some technology at other firms that was much more readily adaptable to specific needs in the LM communications subsystem than what we had in our own house. We awarded subcontracts to these companies to take advantage of their areas of expertise. In the same fashion, Collins Radio, which was responsible for the communications subsystem in the CM, let out subcontracts to RCA because of our strong technology in the very-high-frequency and ranging equipment areas.

"This kind of detailed technical cooperation was needed to ensure that each of the hundreds of subsystems on Apollo 11 melded together so that the spacecraft operated as part of a single huge system."

Gardiner: "I realize that talking about teamwork is almost like reciting a cliché, but you can't get away from the fact that Apollo has been basically a people program. I am sure that tons of contract documents have been written involving NASA and the myriad prime contractors and subcontractors. However, in the end, I find that these contracts are useful reminders of what has to be done, but that's about all when it comes to problem solving. The cooperation that you need in getting out of difficulties comes from people.

"For that reason, it was imperative that engineers and managers from companies involved on the same project should know one another personally and establish a feeling of mutual faith. And that was a major purpose of all these meetings during the past eight years.

"You know, we tend to think only of hardware when we discuss the technical fallout from the Apollo program, but I don't think that is the important thing. What should be stressed are the ways that thousands and thousands of people — engineers, craftsmen and managers — have learned the most advanced state of their art on a broad front and the fact that now they are beginning to spread this knowledge throughout the economy. I can think of many instances of fellows who have worked on this program and have now gone off, let's say, into the commercial computer business. In a small way then, their particular application of Apollo know-how may benefit that company in which the computer is installed. Multiply this by thousands of cases, and you will find a major reason why the United States will continue to enjoy its over-all technical superiority in the future. French author Jean-Jacques Servan-Schreiber, in his book *The American Challenge,* expresses frank envy of U.S. technology and of our ability to manage it. And he attributes the continuously widening technological gap between America and the nations of Europe in part to such programs as Apollo."

Holt: "I agree that Apollo is almost a monument to the imagination and know-how of man. This is the first case that I know of where one can walk into an area and see the result of the efforts of thousands of scientists and engineers, and probably millions of other people, all wrapped up in one wonderful machine. I feel proud to have been a part of this venture.

"The success of Apollo 11 certainly ushers in a new era of manned exploration of space. Just two years ago, on a visit to Grumman, I had the opportunity to get inside both the LM 4 and LM 5. Looking at the controls of these vehicles, the thought occurred that I might just be standing in the 1960s' version of Columbus' ships.

"When the program was announced by the late President Kennedy eight years ago, I really didn't know whether landing a man on the moon in this decade was feasible or not. However, I happen to be a radio and communications specialist, and I did know even then that it was perfectly possible to design, build, develop and test communications equipment capable of supporting such a mission if the other subsystems could be developed."

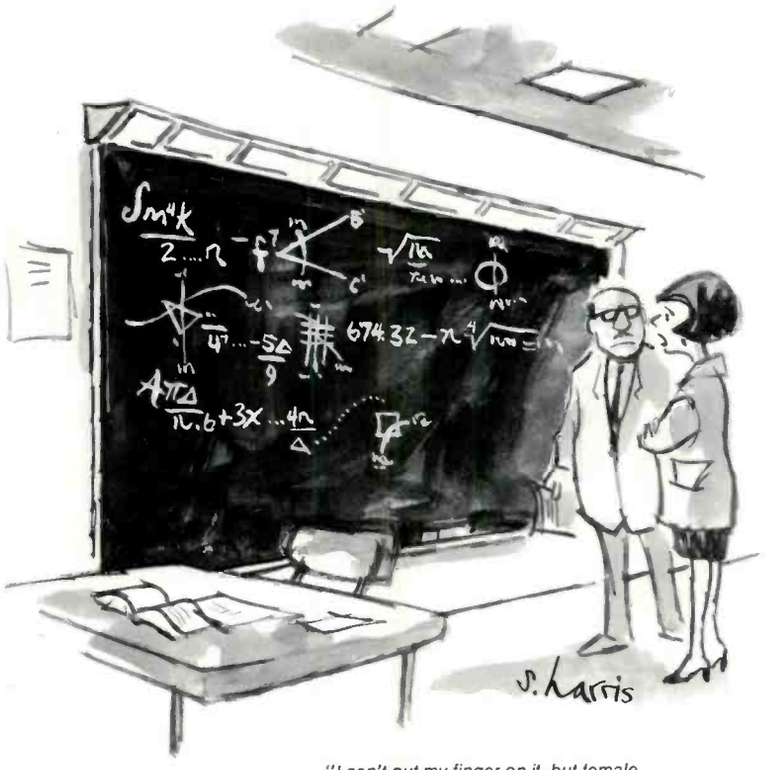
Gardiner: "I'm a classic optimist. I never had any doubt that Kennedy's goal would be met. In fact, I thought that we would easily beat the goal and get there in '67 or '68.

"I am sure that future historians will consider the Apollo 11 mission and the manned voyage to Mars *the* dramatic events of this century. However, there will be many other space ventures to capture the imagination of the world. RCA is teamed with Martin-Marietta in the Viking program, a NASA effort to soft-land an instrument package on the Martian surface. In addition, I am confident that a large earth-orbiting space station housing at least 15 men will be launched. I am not sure when, but this is a necessary precursor to interplanetary travel. There also will be flybys past all the planets in our solar system, which will send close-up TV pictures back to earth.

"I am sure that the Russians also will push their space program hard. They have already indicated that they are going far and fast in interplanetary exploration, and I would say that, at this point, they are ahead of us in that respect. I wouldn't be at all surprised if they had a manned space station in orbit well before we did. I hope there will be Russian-American space ventures, but I wish the Soviets would show just some sign of cooperation and openness."

Holt: "Certainly the Apollo program is only a beginning. However, it does show what can be accomplished when American industry is called upon to join forces toward a common peacetime goal. There have been other programs of a more gigantic nature, but these were made necessary by war. Apollo is the first time in the history of mankind that a massive undertaking of this size has resulted in a machine of peace — a spacecraft aimed not at conquest but at the enrichment and advancement of man." ■

This Electronic Age...



"I can't put my finger on it, but female intuition tells me it's all wrong."

"Take a flier on a glamour stock in the oceanographic field."

"Looks like metal fatigue."

Leontyne Price: Portrait of a Prima Donna

The artistry of Miss Price has established her as one of the great sopranos of all time.

by Mary Campbell

American soprano Leontyne Price ranks with Sweden's Birgit Nilsson, Australia's Joan Sutherland and Italy's Renata Tebaldi in the highest esteem of devotees of the famed Metropolitan Opera in New York City.

This year, Miss Price has been asked by the Met to sing on opening night for the third time in her career — a rare honor. Very few sopranos have ever opened the Met more than twice; the most recent has been Yugoslav soprano Zinka Milanov in 1940, 1951 and 1952.

The opening night of a Metropolitan Opera season is an important, elegant, cultural and social occasion. It isn't primarily a night for the cast or for the opera itself or even for the audience. It is the soprano who sings on that night who is spoken of as "opening the Met season."

However, in the case of Miss Price, her opening nights — so far — are not turning out to be the brightest gems in the prima donna's crown. This season, she was scheduled to sing Aida, perhaps her best-known role in grand opera, and it should have been the most felicitous of her three Met openings. But negotiations between unions and the management of the Met went on long past the old contract expiration date of July 31, and the opening night was delayed, with the possibility at this writing that the entire season will be canceled.

Miss Price had her first Met opening in 1961, in the title role of Puccini's *The Girl of the Golden West*. This was just one season after she had made her Met debut as Leonora in Verdi's *Il Trovatore*, for which she received a 35-minute ovation. Winthrop Sargeant of the *New Yorker* magazine, who has reviewed the performances of all contemporary opera greats including Kirsten Flagstad's United States debut in 1934, called the Price debut "one of the great operatic triumphs of recent years."

However, at her first opening night at the Met, many of the critics admired Miss Price's voice but thought she was miscast as Minnie, the Girl of the Golden West who opens the Polka Dot Saloon. She doesn't sing the part any more.

Her second Met opening night was also the opening of the new Metropolitan Opera House at Lincoln Center in 1966. The old house, built in 1883, had staged its closing-night gala the April before, and Miss Price was one of the artists chosen to sing an aria. She sang "D'Amor sull'ali Rosee," the beautiful fourth-act aria from *Il Trovatore*.

The new Met's first opera was the world premiere of U.S. composer Samuel Barber's *Antony and Cleopatra*, with Miss Price heading an almost entirely American cast. Both she and Barber were enthusiastic over the project, since they have admired each other for a long time. Miss Price sang the premiere of Barber's "Hermit Songs" at the Library of Congress in 1953 and has recorded that work as well as his beautiful *Knoxville: Summer of 1915*. She feels that Barber's music is perfectly suited to her voice.

The presentation of an untried American work on opening night was an admirably daring move for the Met, though one that did not pay off. *Antony and Cleopatra*, music and elaborate, heavy, expensive costumes and scenery included, was almost universally panned by the music critics. Even from a mechanical standpoint, it proved a fiasco. At one point, Miss Price entered a pyramid that was supposed to close behind her and glide offstage. It didn't glide. Worse still,

Mary Campbell is an Associated Press staff member who has written extensively on the musical world.

Left to right: Leontyne Price with the NBC-TV Opera Company in 1955, in *Tosca*, on the Bell Telephone Hour and preparing for TV appearance.

the doors became stuck, with Cleopatra inside about to have a fit.

"I don't expect to duplicate the feeling I had at that time," Miss Price says, her eyes flashing in retrospective amusement. "It was most traumatic. I was supposed to have a three-and-one-half-minute costume change. Let's not get into that. Let's just say there was never a dull moment."

Miss Price first sang Aida at the San Francisco Opera House in 1957, which was only her second stage appearance in grand opera. (Her first was in *The Dialogues of the Carmelites* by Poulenc, also in San Francisco earlier that year.) At the Vienna State Opera House in 1958, she sang Aida at the request of Herbert Von Karajan, who also conducted the performance. In May, 1960, she repeated the role at Milan's famed La Scala.

The *Concise Oxford Dictionary of Opera,* in its concise way, has this comment under *Price, Leontyne:* "considered by many the finest contemporary Aida." The Price voice, often called "the perfect Verdi voice," is a lyric *spinto* — a high lyric soprano with dramatic feeling. It has a big range, wonderful control and is large enough to fill a house as big as the Met without any strain. Her voice has a splendid legato line. Phrases are spun as a smooth, fine thread instead of a jerky series of notes. It is a voice with color, which means that emotional shadings as well as pure tones are communicated.

The quality of a voice is difficult to describe, but I always hear the Price voice as a tapestry made of multicolored threads, shot through with glints of silver and gold. During a vocal slump (singers are like baseball players with unexplained slumps in performance) a few years before the old Met closed, the silver and gold were missing. But they came back and have been part of her voice ever since.

Because of her dramatic quality, Miss Price is sometimes asked whether she intends to go into heavier dramatic roles. She answers, "I haven't the slightest interest in pushing my voice along those lines or the slightest interest in pushing it at all. I'm a juicy soprano. I can deliver in lyric dramatic quality, but it's basically a healthy lyric voice. There is enough literature that fits me without putting me into something that doesn't."

Miss Price, whose voice was praised as "sure and strong" by critics when she

Rehearsing *Aida* with conductor Georg Solti.

Performing with soprano Shirley Verrett.

"I always hear the Price voice as a tapestry made of multicolored threads, shot through with glints of silver and gold."

"Leontyne Price can portray a slave or a princess on stage and make either character come alive."

made her Met debut eight years ago, is now, at age 42, singing better than ever. Too honest for false modesty, but modest enough often to understate the case, she says, "My last five years, I would say, have been my most successful. I sing well most of the time.

"You bet your life I can hear myself on stage. That's what makes the voyage necessary and pleasant. It's a very original feeling, very personal, to enjoy your own voice, the best way you can be an individual. I unabashedly admit that, occasionally, I've dismissed myself from myself and thought, 'Whoever this girl is, she really gets to you.'

"You know, Puccini heroines are quite real. I have always found them tricky to do because I identify so. Audiences are supposed to do that; you're not supposed to. I found myself crying on stage. That's one of the reasons I stopped doing Madame Butterfly."

But her humor pops out when she talks about the Verdi roles that she loves. "It occurs to me that since I began in opera I'm either begging somebody for mercy or dying. There are only three roles in which I stay alive — but it's not worth it. Elvira in *Ernani* doesn't die, but the tenor does, so there you are. Verdi heroines lose out. Verdi complicates things in plots, and the sopranos usually never get their men. It takes all of four acts to get nothing straightened out from the personal point of view. However, there are many fascinating vocal moments that make it worthwhile.

"I've often found myself terribly involved with Aida. There are many facets in the character that are poignant for me. Many times I've seen myself as that captive Ethiopian princess representing black people in situations like that. It's very difficult for me not to be terribly emotionally involved."

Miss Price's career is often singled out as *the* success story of an American Negro in classical music. In 1955, Marian Anderson became the first Negro to sing at the Met, but by that time her voice was past its prime. Miss Price was the fifth to sing there, but the first to become a star — the first to have an opening night. But no matter how many opening nights, she knows that, as a Negro, she has trouble hailing a taxi in the street. She once wryly advised the baritone singing her father in *Aida* to wash his brown body makeup off before he left the opera house in a southern town where the Met was on tour, adding that she planned to walk back to the hotel.

Leontyne Price can portray a slave or a princess on stage and make either character come alive. Because of her regal bearing, most people expect this prima donna to be taller than her 5 feet 6 inches. One is moved to address her respectfully as "Madame Price," and that impression remains strongest. But the next instant, when she is wholeheartedly delighting in wit, one wants to call her "Leontyne."

She dresses with exquisite taste and is much prettier, both from the distant stage and face to face, than any of her pictures. She eats her filet of sole, which she explains is an interview lunch since it is delicate enough to chew while answering questions at the same time, and calls it soul food. Then she catches herself, saying, "But this was going to be my serious year."

She says, "I have three sets of my own costumes, but they prefer to use house costumes at the Met. In that way, nobody gets in trouble with various prima donnas — one likes blue, another likes green. Perhaps with so many people involved during a given season, and changes of cast, it is the best way." Arching an eyebrow to indicate that it is far from being the best way but that she is being sweetly reasonable about it, Leontyne demurely adds, "This is the new me."

However, one part of her Aida costume is her own, even at the Met. She wears "an old pair of sandals put together with Scotch tape and nails. They've been with me since my very first Aida. They have to be gone over every season. Yes, they've fallen apart on the stage. In Verona, I once did Aida barefoot. It was nice and warm, and no splinters."

Mary Leontine Price, daughter of a carpenter and a midwife, was born in Laurel, Miss. (Leontine became Leontyne after French lessons in college.) After graduation from Central State College in Ohio, she received a scholarship to the Juilliard School of Music. The Alexander Chisholm family of Laurel contributed to her living expenses so she could accept the scholarship. At Juilliard, she was assigned to Florence Page Kimball, the only voice teacher she has ever had, although she has a vocal coach in New York and one in Rome. "You have to have people to be your ears, to let you know when you are getting into bad habits," she explains.

Miss Price began her professional career in 1952 when composer Virgil Thomson selected her for a role in a revival of his *Four Saints in Three Acts* after hearing her in a student production. Later that year, she landed the part of Bess in *Porgy and Bess,* which ran on Broadway and toured Europe under State Department auspices. Marriage to William Warfield, who played Porgy, did not last.

From then on, it was serious music: a Town Hall recital in 1954, a role in *Tosca* with the NBC-TV Opera Company in 1955, then San Francisco, Vienna, London, Milan and finally the Met. "My career has had a certain sense of direction," she comments. "Everything sort of connected. I've had good advice, good friends, good recordings. The European part was just right for launching me in New York with the proper prestige."

Operatic roles that Miss Price would like to sing include the Countess in *The Marriage of Figaro* and Desdemona in *Otello,* in which the plot concerns a Moor married to a white woman. "I've given an enormous amount of thought to Desdemona. It's most provocative." She would also enjoy doing more concerts to keep from becoming stale in the same operatic roles sung again and again. This season at the Met, Miss Price is scheduled for four performances each of *Aida* and *Il Trovatore* and will concentrate on concerts and recitals.

Late in 1968, Miss Price said, "My favorite role is whatever I'm doing at the time. This year, I have Leonora on the brain, and I don't mind because it's my favorite right now." She was then singing Leonora in a new production of *Il Trovatore* at the Met, with tenor Placido Domingo, baritone Sherrill Milnes and mezzo Grace Bumbry. The voices were glorious, and Miss Price scored a personal triumph with her fourth-act aria "D'Amor sull'ali Rosee," which has long been one of her most famous vocal passages.

"That aria is one of those few moments when I just plain enjoy the sound of my own voice. There is a nakedness about it. I'm up in the air, and I see how long I can stay there. It's rather thrilling from a personal point of view. It's the challenge of how fine I can make a vocal line. How well I can do something legato, how lyric I can be. It is living a challenge and enjoying it.

"My interpretation of Elvira in *Ernani* matured after my debut in Salzburg under the baton of Von Karajan in 1962," said Miss Price. "The cast, which included Franco Corelli and Ettore Bastianini, was great, and for me it was there that the role began to be molded into its present shape.

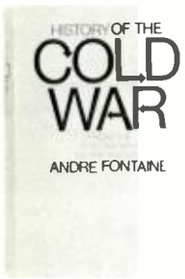
"My singing and acting have grown because I think my vocal instrument itself has grown. I have more control. I'm a lot more flexible, both histrionically and vocally, in any parts that I do than I would have been even five years ago. I've been in different productions and have been able to adjust to the director's conception of the opera — stylized tragedy or realism."

Thousands of music lovers have thrilled to the singing of Miss Price on the opera stage, and millions more have enjoyed her voice on RCA Red Seal records since 1957. Her favorite recordings are "Prima Donna I," "Prima Donna II" and "Right as Rain" with André Previn — "because it's off the beaten track of the things I've done." (I like the Price-Leinsdorf-Boston Symphony recording of *The Egyptian Helen* by Strauss best because it conveys a warm, sensual Helen with no loss of tonal perfection and seriousness.)

Leontyne Price has recorded *Carmen* but has never done the opera on stage. "I'm not going to do *Carmen.* The difference between sustaining something on stage and painting a picture in a recording studio is slightly like night and day."

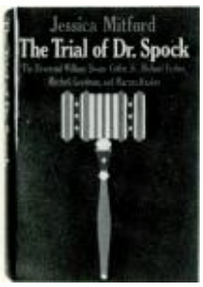
But sometimes, she admits that when she is at home by herself she takes off her shoes, puts *Carmen* on the stereo and says softly, "Leontyne baby, you sure can sing." ■

Books at Random...



History of the Cold War
André Fontaine (Pantheon)

The second volume of Mr. Fontaine's *History of the Cold War* takes the reader from the beginning of the Korean war to the present day. This period coincides with the author's tenure as foreign editor of *Le Monde*, a newspaper thought by many to have the best foreign coverage in the world. By carefully reconstructing the major crises from Korea to the present, Fontaine shows the enormous complexity of conflicting factors on both sides of the Cold War. Yet, from the very complexity comes a new and essential clarity, refocusing such crucial conflicts as the Hungarian uprising, the Suez incident and the Cuban missile crisis.



The Trial of Dr. Spock
by Jessica Mitford (Alfred A. Knopf)

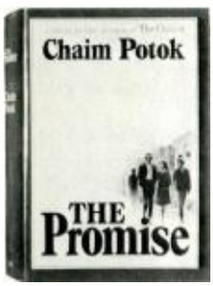
This book is a firsthand account of the 1968 trial of the well-known baby doctor and his four codefendants on a charge of conspiracy to counsel, aid and abet violations of the Selective Service Act. Miss Mitford had extensive interviews with the accused, the defense lawyers, prosecutors, Justice Department officials, court personnel and, after the trial, with several of the jurors. With the clarity of mind and pungency of expression that are her distinguishing gifts, Miss Mitford plucks out the meaning of the trial as she reconstructs the legal framework and life of the courtroom.

Fun While It Lasted
by Barnaby Conrad (Random House)

Mr. Conrad, author of the best-selling novel *Matador,* reminisces about his exciting career, which began when at 19, full of youth and tequila, he jumped into the bullring in Mexico. Among the anecdotes contained in this volume is one in which Conrad became Sinclair Lewis' secretary and learned how to lose at chess. The author also recalls how he became the most ineffectual code clerk in the State Department and got promoted to the post of Vice Consul in wartime Spain. He relates, too, how he fell in love with his Spanish housekeeper and turned the affair into a novel.

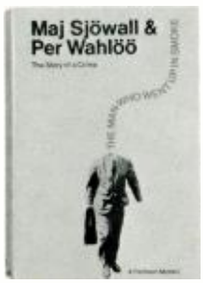
Shimoda Story
by Oliver Statler (Random House)

Townsend Harris was the first American Consul General to Japan, the man who opened the door to that nation after Commodore Perry had unlocked it. Harris' journal and copious correspondence as well as detailed records kept by the Japanese serve as the basis for this volume. But the *Shimoda Story* is much more than a chronicle of negotiations. It is both a political and social history of Japan during the 1850s. The cast of characters is varied and colorful, from government officers whose careers were shaped by Harris' mission to the townspeople of Shimoda whose lives were only incidentally affected by the foreigner in their midst.



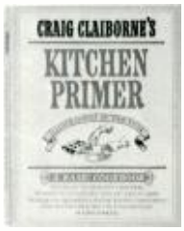
The Promise
by Chaim Potok (Alfred A. Knopf)

This work is a continuation of the author's first novel, *The Chosen,* which examined the traditional world of the Hasidic Jews of Brooklyn. The two boys whose growing up in this world was told in the first novel are now in their twenties and at turning points in their lives. Reuven Malter is studying to be a rabbi and is challenged by a great but unbending teacher, Rav Kalman. Danny Saunders has torn himself away from his destiny as a spiritual leader and is about to risk the brilliant beginnings of his career as a clinical psychologist to save a young boy's sanity.

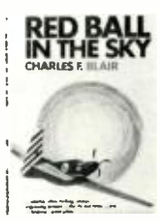


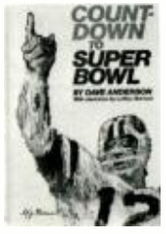
The Man Who Went Up in Smoke
by Maj Sjowall and Per Wahloo (Pantheon)
Translated by Joan Tate

This new adventure of the dedicated Swedish policeman Martin Beck begins as his long, leisurely summer holiday is cut short by the top brass at the Foreign Office who decide to pack him off to Budapest. The mission turns out to be one of the most exasperating assignments of Beck's entire career: the search for Alf Matsson, a well-known journalist who has vanished without a trace. With the aid of some efficient policemen in Budapest and Stockholm, Beck converts his wild-goose chase into a coolly systematic and suspenseful manhunt.



Other Recent Random House Books





"Laser light compares to white light as a fine silk sheet compares to a patchwork quilt."

red wavelengths), were prohibitively expensive and emitted a light that was only grossly coherent.

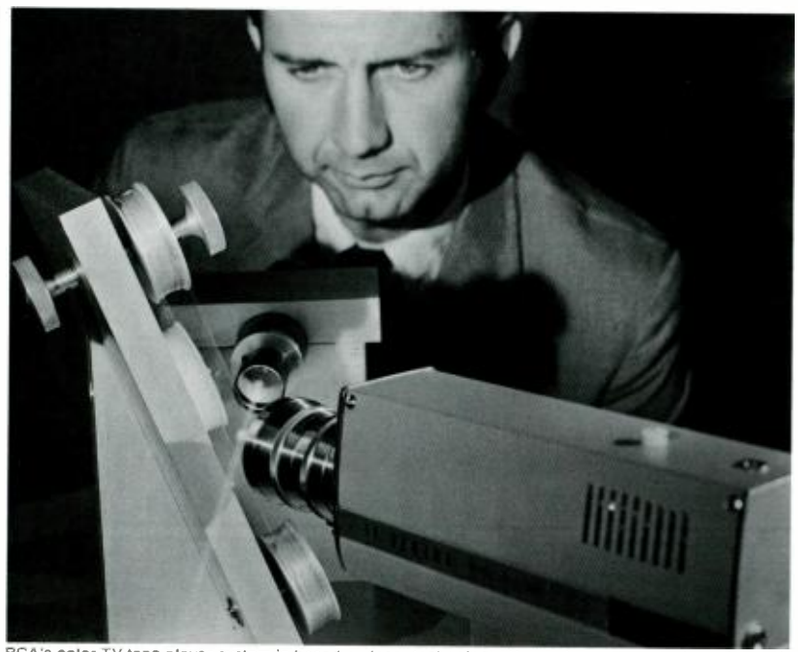
It is both a measure of the progress made in the past seven years and a tribute to the scientists and engineers who have made this progress that all these problems have been greatly ameliorated, if not eliminated entirely. Taken together, the three basic laser types now emit light across the optical spectrum from infrared to ultraviolet and generate power from thousandths to thousands of watts. In addition, they operate in either a pulsed or continuous manner and have an operational life expectancy of at least 1,000 hours without failure. In all cases, efficiency has been greatly improved. For example, the efficiency of the gas laser, which formerly measured a few hundredths of 1 per cent, now registers as high as 16 per cent in the case of the recirculating carbon dioxide type. And lasers have come down in price, too.

Another reason for the growing acceptance of lasers in commercial life derives from the rapid strides being made in developing auxiliary components that can exploit more fully the coherent quality of laser light.

Coherent light is to the ordinary variety of light from the sun, incandescent bulbs, fluorescent lamps and the like what FM radio is to static. In other words, ordinary, or white, light is the "noisiest" kind of light there is. Like radio static, it is a jumble of electromagnetic wavelengths (colors, in this case) having various frequencies (periods of vibration), amplitudes (strengths) and phases (positions in space relative to one another).

In contrast, because of the precise way it is generated, laser light consists of electromagnetic waves of only one color having almost exactly the same periods of vibration, the same amplitudes, and the same positions relative to one another over considerable distances, even though each wave is moving at a speed of 186,000 miles a second. Although not perfect, laser light has an electromagnetic weave of remarkable consistency and uniformity. It compares to white light as a fine silk sheet compares to a patchwork quilt.

It is these properties that make laser light so bright. For example, even though an ordinary helium-neon gas laser may produce a mere half-thousandth watt of red light — hardly more than is produced by a standard flashlight — it is 10,000 times brighter than the intense mercury-vapor lamps installed along the interchanges of the nation's newest superhighways. These properties also keep laser light from spreading very much. Again, using the helium-neon laser to illustrate, the light beam starts out measuring only a few hundredths of an inch in diameter and spreads only one foot for every 2,000 feet it travels. Moreover, if a lens is used to narrow the diameter still further, the rate of spreading will be correspondingly reduced. This has made it possible for scientists using the huge telescope at the Lick Observatory in Pasadena, Calif., to bounce a laser pulse off the reflector left on the lunar surface by the Apollo 11 astronauts and detect its return even though the round-trip distance is almost a half-million miles.



RCA's color TV tape player system is based on laser technology. Here a low-power gas laser (center) sends a beam through the holograms on a vinyl tape. The result is picked up by the TV camera and deciphered to produce color pictures on a standard television receiver.

One further point. All light is electromagnetic. It consists of tiny, alternating electric and magnetic fields propagating in space. Normally, these fields are too weak to be observed, even when the light is focused. However, when the light is coherent and therefore able to have nearly all its energy focused and concentrated to a point a few hundred-thousandths of an inch in diameter, these fields begin to manifest themselves directly.

In one such instance, the Korad Corporation has used a ruby laser system to produce light so intense that it creates electrical sparks in the air along its path. The possibility of using such a laser "ignition system" is now under study as a means for firing solid-fuel rockets.

A far more awesome possibility also is being investigated. It involves the use of a laser ignition system to achieve the long-sought goal of controlled thermonuclear fusion. The idea is not farfetched if it is realized that, when pulses from the most powerful lasers currently available are focused to a point, they produce an oscillating electric field on the order of 30-million volts per centimeter and an oscillating magnetic field of 1-million gauss. (The magnetic field of the earth is measured to be about half a gauss.) In theory, these electric and magnetic forces should be sufficient to confine and heat a small sample of hydrogen to a thermonuclear temperature of about 100-million degrees Centigrade.

Experiments to test this idea have been carried out at the Lebedev Institute in Moscow and at the United Aircraft Corporation and the Sandia Laboratories in the United States. These tests have already shown that showers of neutrons — probably produced by fusion — are generated in a hydrogen gas exposed to laser pulses of sufficient intensity.

But no account of the sudden change in attitude towards lasers in the commercial world would be complete without reference to the exciting new phenomena they are producing. Take holography, for example.

Since the electromagnetic warp and woof of laser light are so uniform in time, space, density and texture, it was known that a slight change in any one of these properties — introduced by some sort of optical or electrooptical mechanism — would be immediately apparent to the eye or other photosensitive device. Furthermore, it was realized that such a change could be made in a code-like, periodic way to make possible such applications as communications, measurement and data processing. What was not fully appreciated at first was that any object from which coherent light is reflected will produce similar changes, which can be detected and reconstructed to form an image of the object.

The trick is to split the laser beam so that part of it is reflected from the object and then recombined with the unaffected part on a photographic film or other photosensitive surface. This has the effect of representing the object as a matrix of interference patterns recorded on the film. It is something like creating an image on a series of parallel lines by introducing cross-hatching. A visual reconstruction of the object is obtained by directing light from the same or a similar laser against or through the recording. Surprisingly, this procedure can be used not only to obtain a flat image of the object but, if desired, a three-dimensional view as well.

This dazzling effect is the first that is virtually unique to laser light. Since its discovery, holography has become almost a separate discipline from laser technology, and pell-mell efforts to exploit it are under way in several key areas of measurement, data processing, imaging, communications and scientific research.

The phenomenological treasure chest opened by the laser has not yet been emptied, however. Recently, scientists have begun to explore how laser light interacts directly with the atomic and molecular structures of matter. Nonlinear optics is the blanket term used to designate this work. These studies are based on the fact that the character and behavior of light of sufficient intensity can be influenced directly by the electric, magnetic, acoustic, thermal, vibrational and spin characteristics of these structures or their atomic components.

Nonlinear optics already has produced such electromagnetic "witchcraft" as converting infrared light to green by passing it through certain crystals, transmitting light through apparently opaque crystals, focusing light without lenses, producing light pulses that last less than one-trillionth of a second and tuning laser light like a radio by passing it through a crystal to which heat is applied.

In one recent nonlinear experiment, Dr. Arthur H. Firester of RCA Laboratories demonstrated a technique that makes it possible to illuminate an object with invisible infrared light from a laser and then to view it through a special crystal that converts it to a green image.

Laser technology is no longer just a promise, in short. After nine years of intensive research and development, lasers are in transition from the laboratory to the marketplace. ■

For the Records...

Highly Distinct
The Friends of Distinction LSP-4212

Having made their debut in the summer of 1968 at the Daisy, one of Hollywood's top discotheques, The Friends of Distinction have rapidly become a popular recording group. Their first RCA album, "Grazin'," featured the group's hit song "Grazin' in the Grass," which sold over 1-million copies when released as a single record. In their second album, The Friends are featured in group arrangements of such currently popular songs as "Light My Fire," "Workin' on a Groovy Thing" and "We Got a Good Thing Goin'." In addition, the quartet sings its way through a number of original songs that highlight contemporary soul music.

Beethoven: Symphonies No. 9 and 5
Schoenberg: A Survivor From Warsaw, Op. 46
Jane Marsh, Josephine Veasey, Placido Domingo and Sherrill Milnes
Erich Leinsdorf conducting the Boston Symphony Orchestra, Chorus Pro Musica and New England Conservatory Chorus
LSC-7055

"A Survivor From Warsaw" is a short, intense musical drama, told by a survivor, of a group of Jews in the Warsaw ghetto and is narrated by baritone Sherrill Milnes. This performance conveys a full understanding of Schoenberg's purpose and style, and is presented with the two Beethoven symphonies in a two-record set.

Debut!
Henry Mancini conducting the Philadelphia Orchestra Pops LSC-3106

This Red Seal release marks the first recording by the Philadelphia Orchestra Pops as well as the debut of Mancini on the Red Seal label. The album also offers the world premiere of a number of Mancini's works, including a major orchestral suite that represents the composer's impressions of his early teen-age years in Pennsylvania —"Beaver Valley-'37." Also featured are six other Mancini originals, written primarily for various soloists in the Philadelphia Orchestra and designed to demonstrate what has become world renowned as the "Philadelphia sound."

Takemitsu: Asterism for Piano and Orchestra, Requiem for String Orchestra, Green for Orchestra (November Steps II) and the Dorian Horizon for 17 Strings
Yuji Takahashi, pianist
Seiji Ozawa conducting the Toronto Symphony Orchestra LSC-3099

This Red Seal album features the first recordings of four works by Toru Takemitsu, the foremost contemporary Japanese composer. "Asterism for Piano and Orchestra" was commissioned by RCA Records in 1968 and received its world premiere in January, 1969, with Ozawa conducting the Toronto Symphony. "Green for Orchestra" was also introduced to North America by Ozawa and the Toronto Symphony in October, 1968.

A New Sound From the Japanese Bach Scene
Tadao Sawai, first koto; Kazue Sawai, second koto; Hozan Yamamoto, shakuhachi; Sadanori Nakamure, guitar; Tatsuro Takomoto, bass; Takeshi Inomata, drums VICS-1458

This recording presents a fascinating reinterpretation of 12 works by Johann Sebastian Bach, performed with remarkable fidelity to the originals and featuring a combination of traditional Japanese instruments as well as those to which Western ears are more attuned. The koto is essentially the Japanese equivalent of the piano, and the shakuhachi is a bamboo flute that was once used as both instrument and weapon by samurai.

Schubert: Piano Quintet in A, Op. 114, D. 667 ("The Trout")
Brahms: Piano Trio in B, Op. 8
Poulenc: Sextet for Piano and Woodwind Quintet
Webern: Concerto, Op. 24
Martinu: Nonet for Flute, Oboe, Clarinet, Horn, Bassoon, Violin, Viola, Cello and Double Bass
Dahl: Duettino Concertante (1966) for Flute and Percussion
The Boston Symphony Chamber Players LSC-6189

Two of the best-known pieces of chamber music have been brought together with a cross-section of the contemporary repertoire in this three-record Red Seal release.

Other Current RCA Releases

Electronically Speaking...

News in Brief
of Current Developments
in Electronics

An Oceangoing Robot Sailboat May Soon Chart the Seas

A robot sailboat that can be navigated by radio direction to any point on the world's seas to perform a wide range of oceanographic, meteorological and intelligence missions may soon be charting the oceans. The unmanned sailing craft developed by RCA is capable of remaining on station automatically for up to a year without being moored. Called SKAMP (Station Keeping and Mobile Platform), the buoy-like boat can perform its missions more effectively and at less cost than present oceanographic research vessels.

SKAMP's servo-controlled airfoils and rudders respond to radio commands from ship or shore stations or from systems such as the Navy's navigation satellites. Once on station, SKAMP sails a tight back-and-forth course within 0.2 nautical miles of its true position. Since it is wind driven, it sails silently, with no internal power required for propulsion. Its sails are rigid, foam-filled, curved plastic structures with the same aerodynamic characteristics as cloth, and the vessel is designed to sail even in hurricane-force winds.

SKAMP has a disk-shaped hull consisting of a deck plate and a bottom plate with a layer of elastomer foam sandwiched between. The versatility of the SKAMP platform enables it to accept virtually any type of sensor, so it can chart ocean currents or monitor surface weather at remote points. SKAMP can function alone or as part of a widespread, precisely positioned network. It can also accompany research vessels or serve as a navigation station for ships, submarines or aircraft.

Hard-Core Unemployables Trained for Jobs in Electronics

Once considered hard-core unemployables, 31 young men from New York's ghetto areas have completed a training course and begun promising careers in electronics. The special 12-month course with classroom and laboratory instruction in basic electronics is part of the President's Job Opportunities in the Business Sector program and is one of a number of projects at RCA to help the hard-core unemployed.

The graduates have started working as apprentice technicians with the RCA Service Company in its various metropolitan-area branches. After a period of on-the-job training under skilled technicians, they will become fully qualified radio and television repairmen.

In another part of the country, classes in basic electronics will be held in a mobile training center to prepare displaced farm workers for jobs in radio and television repair.

The mobile training center, housed in a 10- x 45-foot trailer that accommodates eight students per class, is fully furnished and includes a specially designed self-study curriculum, student tests and laboratory materials, tools, test equipment, television receivers and accessories. There are also a reference library and electronic trainers designed to fit the curriculum. The unit has been purchased by the Choanoke Area Development Association (CADA), an antipoverty agency in North Carolina involved in retraining seasonal farm workers for jobs in industry. The training center is one of four types of mobile facilities offered by RCA for use by vocational schools or for other training situations.

Digital Display Device Can Be Read at High Noon

A low-cost digital display device bright enough to be visible even in sunlight has been developed for a variety of commercial applications. These include uses in medical electronics and instrumentation, desk calculators, cash registers, automobile dashboard instruments, floor indicators for elevators, gas-pump indicators and computer displays.

Four types of the NUMITRON read-out devices are being manufactured by RCA at present, which are of the high-brightness, low-voltage incandescent type. They have wide-spectrum light emission that permits a large choice of color filters so as to give a display of any desired color.

A seven-segment configuration is used to make up the numerals, which are 0.6 inches high—the standard height of most digital indicating devices. If a broader stroke is desired, an etched glass may be inserted in front of the numerals. When a designer requires larger numerals, a Fresnel lens may be used in front of the display.

The NUMITRON device utilizes a rugged, single-plane unit construction resulting in a highly reliable device with a very long life expectancy. The display surface with its black background permits a wide viewing-angle display that is free of clutter and residual images, and brightness is completely adjustable.

High-Resolution Holograms

A technique for producing magnetic holograms that can be recorded in 10 one-billionths of a second has been developed. The significance of this new RCA technique is that, with its high resolution and ease and rapidity of recording, it could create an optical computer memory able to store 100-million bits of data on a one-inch-square piece of film that could be read out, erased and reused repeatedly.

The phase holograms, as they are called, are produced on a magnetic surface through the interaction of the heat and light inherent in a laser beam.

Apollo Ranging System Adopted for Air-to-Ground Measurements

An electronic ranging system like the one used by the Apollo astronauts will soon be used by Army pilots to measure distances between their aircraft and ground forces. This compact electronic system, which will be attached to two-way VHF radios, is being developed for the Army by RCA.

The ranging equipment consists of two adaptors: a transponder for ground radios and an interrogator for aircraft radios. When the system is in operation, the aircraft radio transmits a tone signal to the ground radio and receives a return signal. This tone signal may be sent by itself or during voice communication over the radios. By measuring the time between the transmission and the return of the signal, the system automatically calculates the distance between the aircraft and the ground radio and flashes the information onto a display in the cockpit. It also is being studied for potential use in commercial aviation.

Electronic Clearinghouse for Messages

A high-speed message-switching and information-processing system will serve as a clearinghouse for more than 10,000 messages sent daily among the global offices of Mitsubishi International Corp. The heart of the AIRCON system consists of two RCA computers located at RCA Globcom's telecommunications center in New York City. Each computer is capable of handling more than 250,000 messages a day, and, together, the two provide the system with complete redundancy and uninterrupted service.

Mitsubishi's international and domestic communications networks have 16 private channels at present. Using AIRCON, Mitsubishi will save more than $50,000 a year by eliminating much of the equipment and related expenses previously required to operate these networks. In a typical transmission, one office may send a message to every other office via the computer. The message would then be received simultaneously by offices in Tokyo, London, Düsseldorf, Caracas, Toronto, New York and all other branches connected to the network, even though they may be closed. The system also permits the company to take advantage of the time differences between the stations connected in the network. Mitsubishi, which has its main office in New York, is a subsidiary of Japan's largest trading company, Mitsubishi Shoji Kaisha, Ltd., of Tokyo.

Shipboard Radar Can Track High-Speed Targets

A transportable shipboard radar that can track targets traveling more than 20,000 miles an hour at distances up to 500 miles will be installed on the U.S.N.S. *Wheeling*. The radar, developed by RCA, will be used mainly as a range safety instrument in tracking missiles during powered flight to ensure that they stay on course and do not endanger personnel or property. Data from the radar can be relayed to other tracking units down range to allow their instruments to pick up the missile as it enters their areas of coverage. The *Wheeling*, a veteran Navy missile- and spacecraft-tracking ship, forms part of the Navy's Pacific missile range and has supported a wide variety of missions including the Mercury, Gemini and Apollo manned flights.

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A page from the notebook of Dr. John C. Houbolt, a former NASA engineering chief who persistently advocated the lunar-orbit rendezvous route to the moon. For an account of the problems and triumphs of the Apollo program, turn to page 20.

32,000
÷ 2.58 = 12,400
12,400
26,500
÷ 2.35 = 10,550
−7700 = 1 49

3840
3534
7700

30,500
÷1.58 = 13,300
13,300
26,500
6,100
Δv = 3400

30,500
÷ 2.79 = 9100
9100
18,200
÷2.35 = 7750

÷1.58 = 26,800
÷1.32 = 11,340
÷2,700 = 1.58
Δv = 4100

$w_c = 5.1v \times 4000$
$= 20.4$

$90,000 = 2.4\ w_c + 8.96 \times 4000$
36,000
54,000

$h = \int v \sin\theta\, dt$

3540
3534
7370
e = 2.3

RCA

Electronic Age

Autumn 1969

Computer Time Sharing