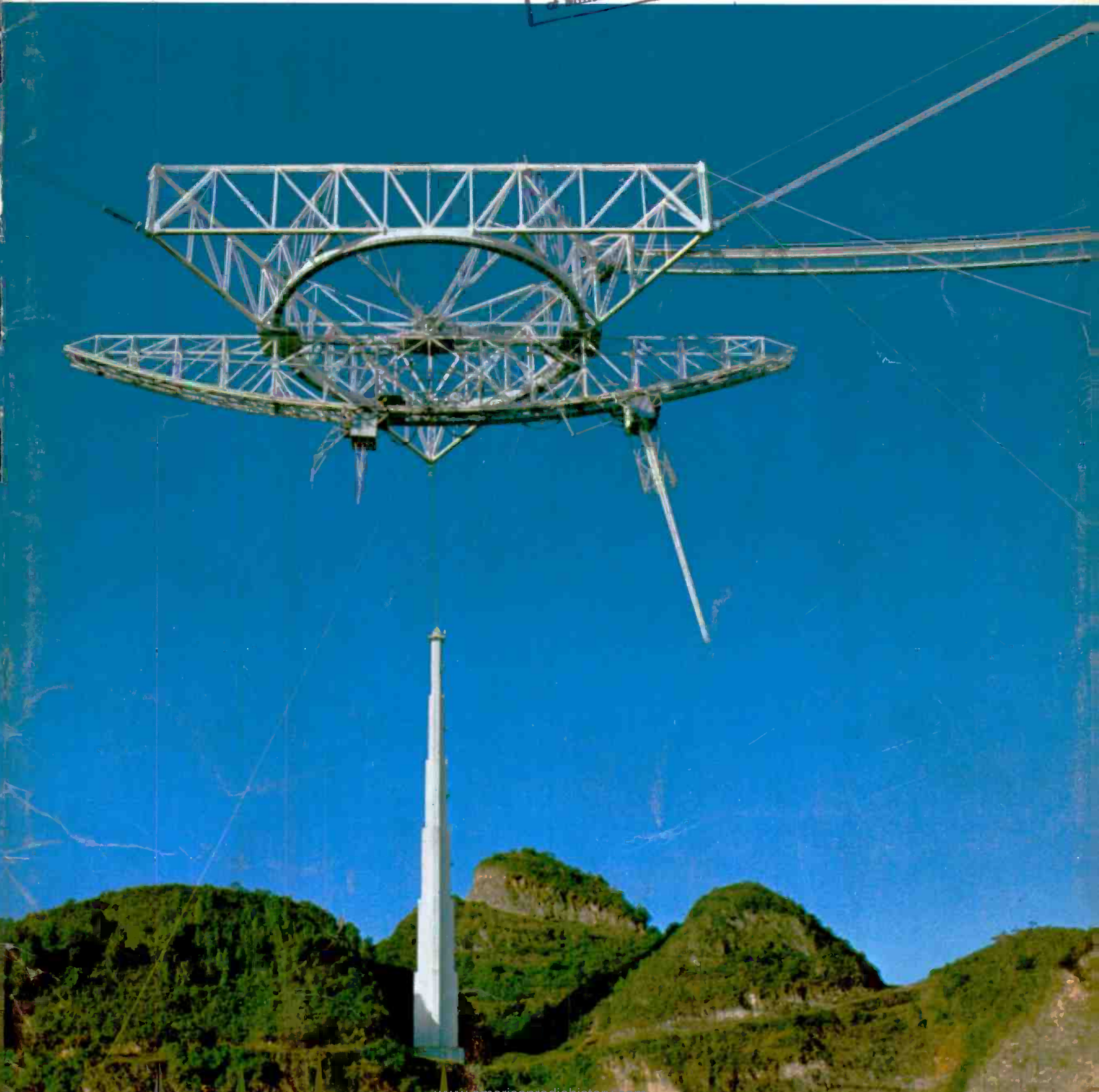
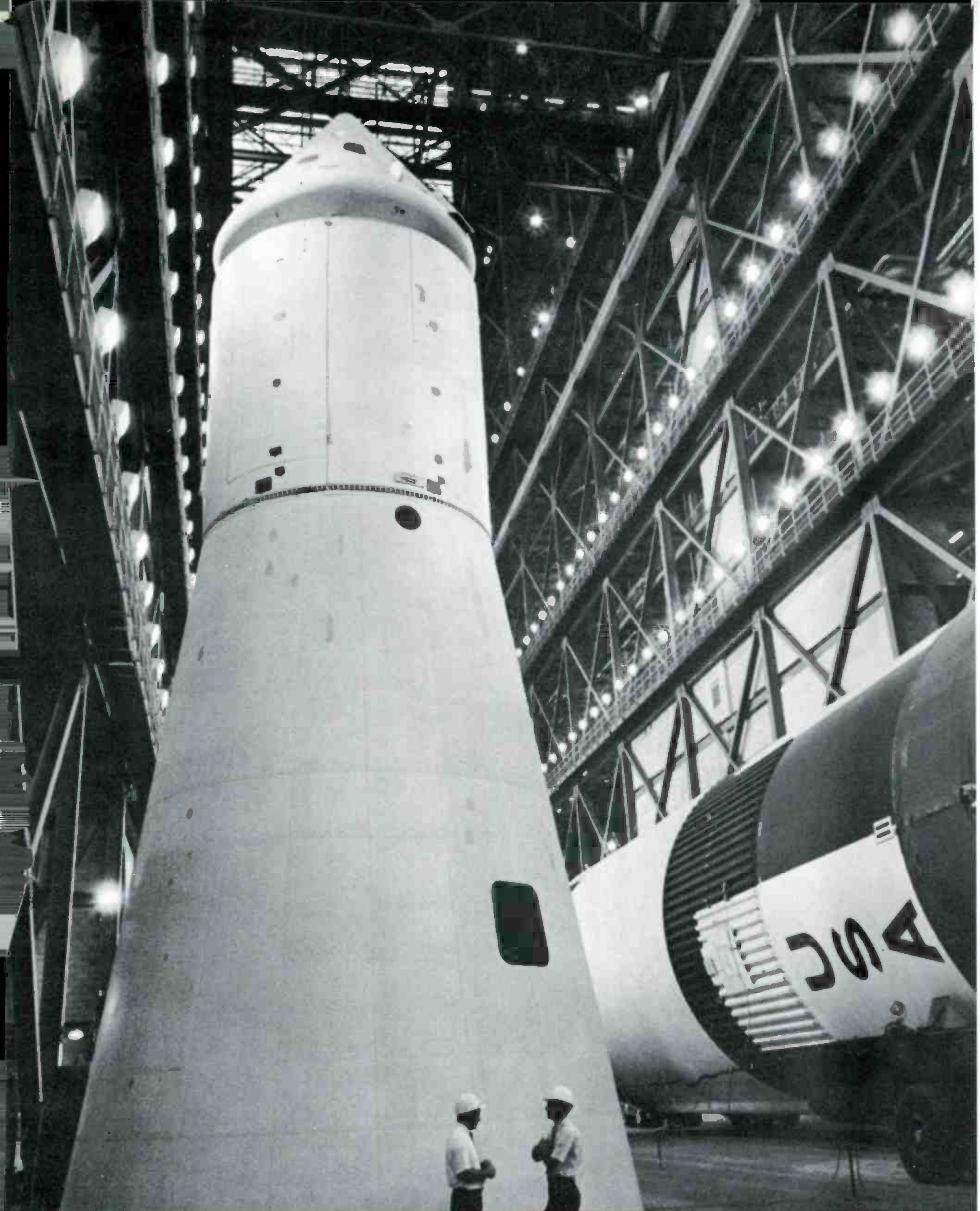
ELECTRONIC AGE

RCA Winter 1966/1967

Electronic Star-Gazer: the Arecibo Radar Telescope





Standing almost five stories tall, a mockup of the spacecraft that will carry American astronauts to the moon rests on the floor of the huge vehicle assembly building at NASA's John F. Kennedy Space Center in Florida. RCA has a key role in Project Apollo, providing ground support, communications, and control equipment for the lunar module vehicle that will land the astronauts on the moon's surface, as well as computer checkout systems for the Saturn 5 launch vehicle. On the right is a test model of the Saturn first stage. Scale models of both spacecraft and rocket are used in various preflight testing programs.

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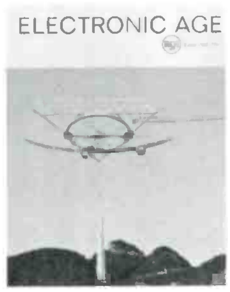


Cover: This odd structure suspended on cables above a crater in the hills of northwest Puerto Rico is the movable wave-guide platform of the Arecibo Ionospheric Observatory, world's largest radio-radar telescope. The wave-guide, a slender metal shaft pointing down from the platform, sends radio waves down to a 19-acre expanse of steel mesh which bounces them out into space to be reflected back from planets, stars, or other objects under study. An article on how electronics has led astronomers to revise concepts of the solar system begins on page 2. (Department of the Air Force photo.)

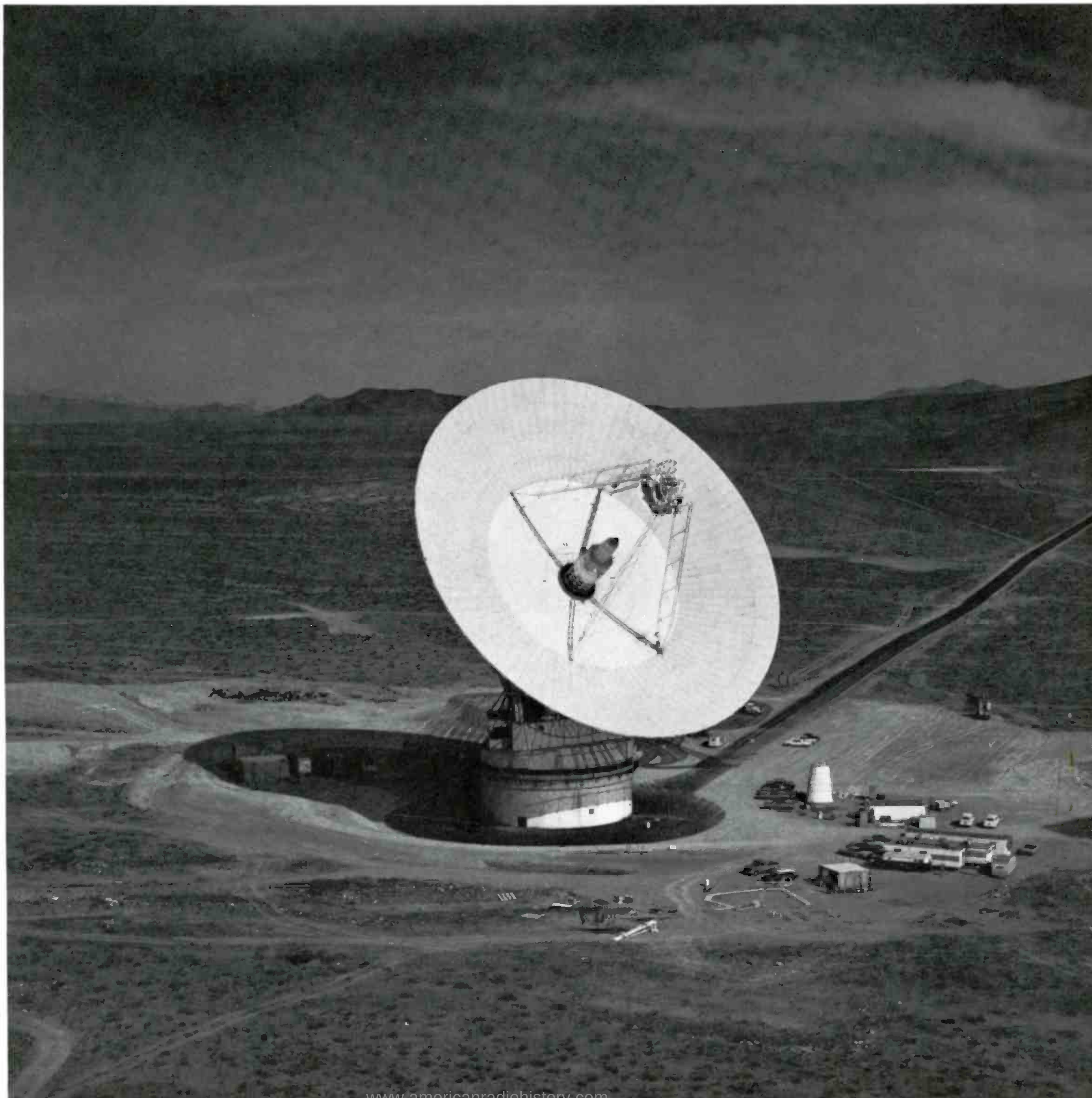
ELECTRONIC AGE

RCA Vol. 26/No. 1 Winter 1966/67

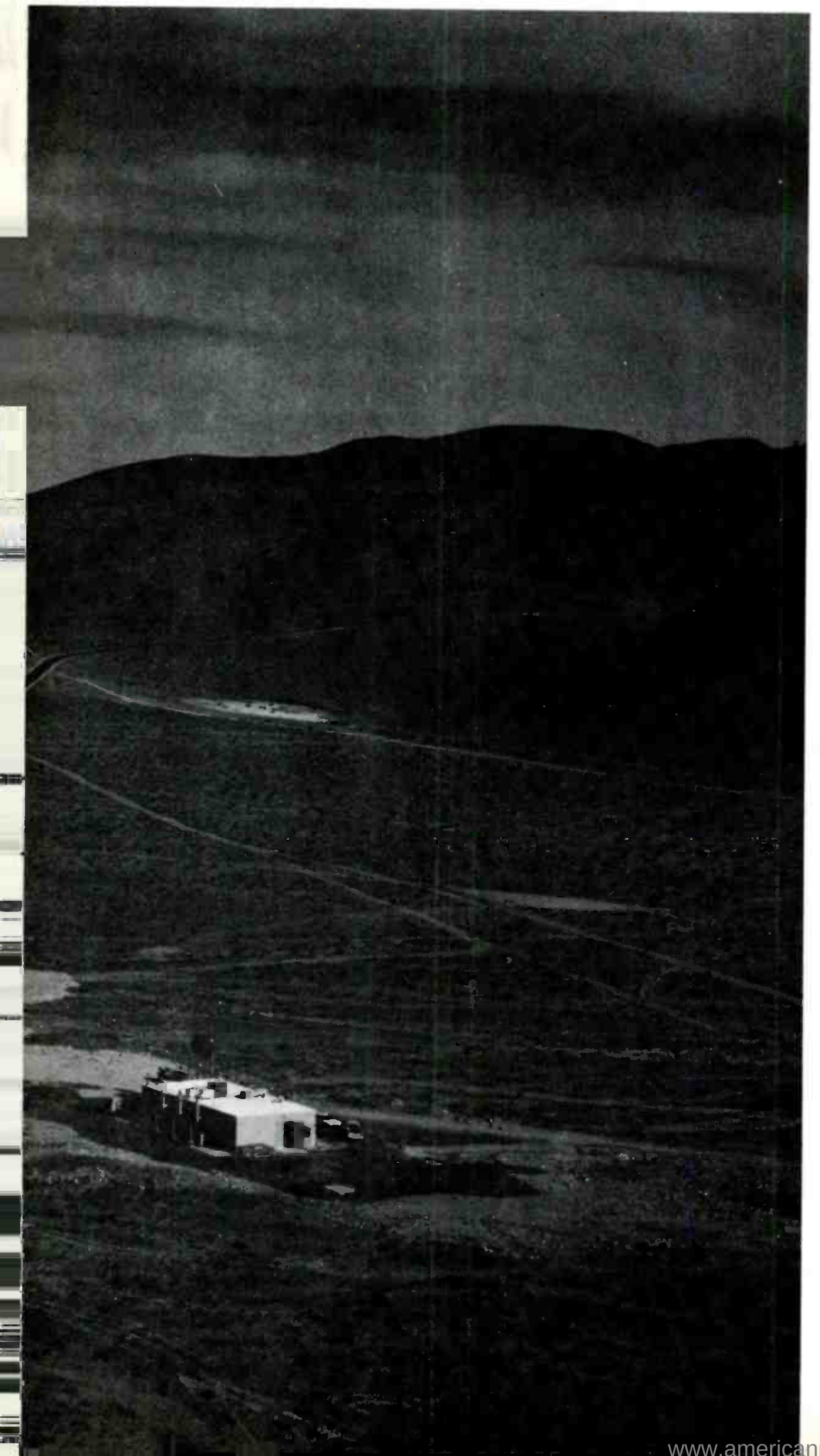
Electronics and the New Astronomy

Through radio and radar astronomy and space probes, electronics is changing drastically our knowledge of the inner solar system.

The Goldstone Deep Space Tracking complex in the Mojave Desert, Calif., receives pictures and other information telemetered from vehicles in space.



by Willy Ley



Our atmosphere is the protector and friend of all living things, but it is the enemy of two groups of professionals: the vacuum technologists and the astronomers.

That the atmosphere, by its very existence, makes life miserable for vacuum technologists (who try to create space without atmosphere) is easy to understand. The reasons why it hampers astronomers need explaining. By being virtually opaque to all radiation except the narrow band of wave lengths that has been dubbed "visible light," the atmosphere permits little of the information carried by other wave lengths to reach the ground. For a long time, for example, it was doubtful whether or not the sun emits X-rays.

But being opaque to most radiation is only one of the drawbacks of the atmosphere; the fact that it contains a great deal of water vapor is another. True, water vapor is only slightly more opaque than nitrogen and oxygen, the main constituents of the atmosphere. But water vapor usually condenses into droplets and then forms an overcast. When that happens, the opaqueness of the atmosphere is virtually complete; on a really cloudy day it is difficult even to locate the sun. And when there was a cloudy night, or just fog on the ground, the astronomer had to close shop and spend his time as fruitfully as he could by going over old calculations and making some new ones.

Percival Lowell of Boston circumvented part of the problem by building his observatory on a mountain in an area which the early Spanish explorers had named *arida zona*. Construction of the observatory began in 1893, and, in retrospect, one can only wonder why it took so long for someone to realize that the proper place for an observatory is a mountaintop. By that time, Heinrich Hertz had already demonstrated—in 1886—the existence and discovered some of the properties of radio waves, but no one then was farsighted enough to predict that the "Hertzian waves" might have anything to do with astronomical research. But "Hertzian waves" grew into electronics in about half a century, and during the last three decades electronics has made very considerable inroads into the practice of the oldest science. In fact, electronics has changed the concepts held by astronomers about the inner planets of our solar system to such an extent that it is no exaggeration to speak of a new solar system.

The astonishing success of the application of electronics to astronomical work is due mainly to the fact that radio waves of certain wave lengths can penetrate the atmosphere and even a thick overcast. And the fact that even the shortest usable radio waves are far longer than the longest wave length still visible to the eye, is useful in overcoming the third nasty property of our atmosphere, which is that it never "holds still" for any length of time. To a layman, a nice clear night, when the stars are scintillating brilliantly, may look promising as a fine night for observation; the astronomer, however, knows that this pretty scintillation means trouble. The poetically useful twinkling is caused by an unsteady atmosphere. Viewed in a telescope, the objects will seem to be jumping around, and they may even temporarily jump out of the field of vision. It is obvious that this condition is

WILLY LEY is a noted author and authority on astronomy and space travel.

alleviated by the use of longer wave lengths.

Although electronic techniques are applied to astronomical work in a multiplicity of ways, there are three main lines of approach.

The first is to "observe" the natural radio waves coming from space and to establish radio sources that may then be identified with visible objects. This is what is now called radio astronomy. As compared to optical astronomy, it has the advantage that it does not matter whether the sun is in the sky or whether the sky is cloudy (or both). But because of the longer wave lengths being observed, the equipment needed is much larger, and observations take more time.

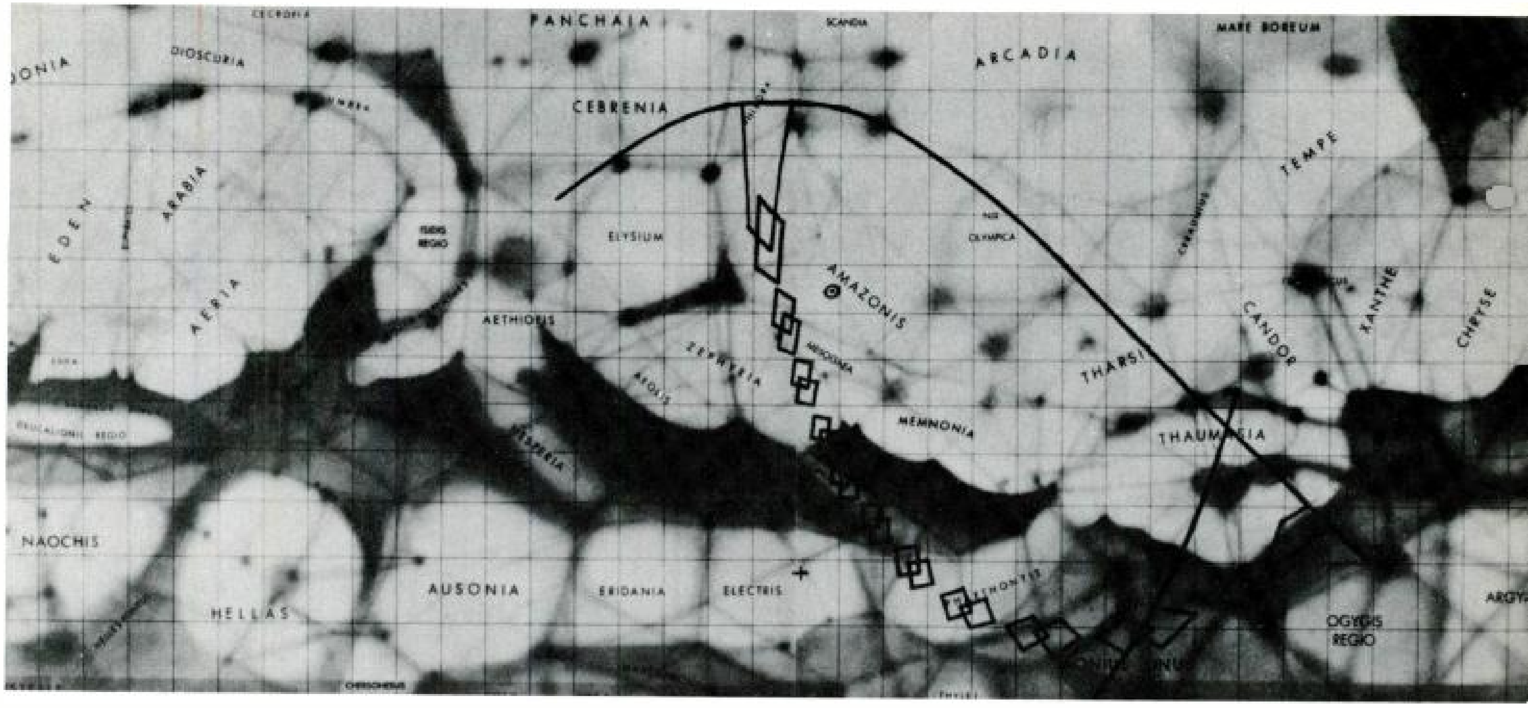
The second line of approach is to send out impulses, try to have them reflected by bodies in space, and then try to receive and analyze the reflections. This is radar astronomy. Of course, the method of radar bounces can be used only inside the solar system where the reflections will return in a matter of minutes or, at the most, hours.

The third line of approach is to avoid any interference by the atmosphere by lifting the research devices—such as telescopes, cameras, magnetometers, particle counters, and other instrumentation—into space, putting them into orbits around the earth, around the moon, or around the sun, and transmitting the pictures and readings to stations on the ground.

All three of these approaches have been intensively and successfully employed. To the public, the transmission of pictures over enormous distances (about 120 million miles in the case of the pictures of the Martian surface taken by spacecraft Mariner 4 on July 14, 1965) appears to be the most spectacular of these successes, but the other methods have yielded very valuable results, too.

Now, let us look systematically at the changes in our concepts of the solar system brought about by electronics, beginning with the planet nearest the sun—Mercury. Mercury is the smallest of the major planets, with a diameter of 3,100 miles. Its mean distance from the sun is 36 million miles, and it needs 88 days to complete one orbit. Because it is so near the sun, it has always been difficult to observe since it can never be seen against a completely dark sky. A little over 70 years ago, the Italian astronomer Giovanni Virginio Schiaparelli decided that observations in the daylight sky might bring better results than observations at twilight, since he would see the planet through a thinner layer of atmosphere. These daylight observations at least seemed to establish the period of rotation of the planet. Schiaparelli con-

Scientific team at the Jet Propulsion Laboratory, Pasadena, Calif., examines the world's first close-up pictures of the moon taken by Ranger 7.



Perhaps the most spectacular picture-taking project in space was the flight of Mariner 4 past Mars in July, 1965. Superimposed on this chart of Mars are overlapping rectangles indicating areas photographed by the spacecraft.

cluded that it was equal to its period of revolution. Mercury always turned the same side toward the sun, just as the moon does with regard to the earth.

This, in turn, led to the concept of a planet with three distinct zones. One was the night side, never struck by a ray of sunlight and correspondingly cold. The other was the bright side, where the sun never set and where the temperature of the ground was above the melting point of lead, approaching the melting point of zinc. Between them, there was the "twilight belt," an area running around the planet where the sun appeared above the horizon for a few days every 88 days. A Greek astronomer working in France, Eugenios-Marie Antoniadi, who spent much time observing Mercury about 15 years after Schiaparelli, confirmed the conclusions of the Italian astronomer.

We now know, thanks to radar bounces carried out by the American astronomers Gordon H. Pettengill and Rolf Dyce with the aid of the 1,000-foot radio telescope at Arecibo, Puerto Rico, that Schiaparelli and Antoniadi were wrong. Mercury does rotate on its axis, and its period of rotation is two-thirds of its period of revolution, or about 59 days. Hence, no permanent bright side, no permanent night side, and no twilight belt. Every point of Mercury's surface is illuminated and heated by the sun, and the center of the area that happens to have "day" does heat up to about 660° Fahrenheit. Another American astronomer, Kenneth Kellerman, used the Parkes radio telescope near Sydney, Australia, to measure the temperature of that portion of Mercury that happens to have night. Before this could be actually measured, it had been assumed that the temperature was approximately 350° Fahrenheit below zero; Kellerman found it to be about 30° Fahrenheit, or near the melting point of ice on earth. This result corresponds well with the slow rotation of the planet observed by the Arecibo telescope.

In the case of the next planet, Venus, the result of the application of electronics was even more surprising. Venus, about the same size as the earth (equatorial diameter 7,700 miles, as compared to 7,927 miles for the earth), orbits the sun at a mean distance of 67.27 million miles and needs 224.7 days to complete one revolution. Since this planet is forever shrouded in a dense cloud layer, no point of its surface could ever be observed, and, therefore, it was impossible to tell what the length of its day might be. Schiaparelli inclined to the belief that Venus, as he thought he had proved for Mercury, always turned the same side toward the sun. Others assumed a faster rotation, but there was no agreement. There also was no agreement about the surface conditions on Venus, except that they had to be somewhat uniform because differences in the surface conditions—such as oceans and continents—would give rise to vertical currents that should open a rift in the clouds, at least once in a while.

To explain the unbroken cloud layer, one could assume that all of Venus was covered by water though the depth of that water might be only a foot or so in some places. Or else one could assume that all of Venus was a dry desert, in which case the clouds probably did not consist of water vapor. The tentative assumption, advanced by some, that the surface of Venus was all desert and so hot that *all* the water on the planet was in the atmosphere, was too radical to be considered by many astronomers. However, it turned out to be the correct explanation. In 1956, a team of American radio-astronomers, headed by Cornell H. Mayer, turned a large radio telescope at Venus and found, to their great astonishment, that Venus radiated as if it had a temperature of about 570° Fahrenheit.

The result of the measurements could not be doubted, but so far there was no reason to be certain that this was the surface temperature of the planet. It could easily be the temperature of a high and probably ionized layer in the planet's atmosphere. Incidentally, the Russians soon repeated the experiment and, probably to their surprise, came up with the same figure. Whether it was the ground that was so hot or a layer in the atmosphere could not be decided by measurements from the earth; needed was a fly-by by a spacecraft. The spacecraft was Mariner 2 that passed the planet at a distance of 21,648 miles on December 14, 1962. The results, telemetered over a distance of about 60 million miles, not only increased the temperature to 800° Fahrenheit but also showed that this had to be the temperature of the surface. This was established as follows:

Let it be assumed that the surface of the planet is cool and that the heat originates in a layer high up in the atmosphere. To a spacecraft, there would then be a pronounced difference to the heat received from directly below (that is from the center of the planet as seen from the spacecraft) and the heat received from the edge of the planet. Since the scan from the spacecraft would go through more of the hot atmospheric layer at a slant, these measurements near the edge should show higher temperatures. Astronomers refer to the edge of a planet as its "limb" and would say, therefore, that there should be a "limb brightening" in this case, speaking as if the heat rays were visible.

But, if the heat originated from the planet's surface and passed through a cool absorbing layer higher up, the scan would go through more of the cool absorbing layer, and the measurement at the center would be the "brightest," accompanied by a "limb darkening." And this is what Mariner 2 reported. The surface of Venus is hot enough so that it should glow to observers in a spacecraft flying through the atmosphere of the planet below the cloud layer.

Since the time when the telemetered reports from Mariner 2 were analyzed, radar bounces have solved another mystery of Venus, or added one, if you prefer. Although Mariner 2 could not detect any rotation, the radar bounces have shown that Venus rotates on its axis, though very slowly. The mystery is that it rotates clockwise. All the planets orbit the sun in a counterclockwise fashion (as seen from the celestial north pole), and those that rotate on their axes also rotate counterclockwise. Venus is the only known exception, and no one knows why.

The next planet after Venus is the earth-moon system which will be left to last. Farther out is Mars, 4,200 miles in diameter, orbiting the sun at a mean distance of 141.7 million miles, and requiring 1.88 earth-years to complete one revolution. Mars never presented the same difficulties as Venus. Its atmosphere is transparent to visible light, clouds are a rarity, and surface features are easily visible, though difficult to explain. Its period of rotation, 24 hours and 37 minutes, has been known for a long time. The most hotly debated question for nearly half a century has been whether there is life on Mars. The fly-by of spacecraft Mariner 4 did not settle this question nor was it intended to settle it. But it disclosed a number of surprising results. As the spacecraft passed behind the planet (as seen from earth), its radio signals went through the Martian atmosphere and could be used to establish the density of that atmosphere. It turned out to be only about 1 per cent of the density of the earth's atmosphere. That the spacecraft photographed large numbers of impact craters was surprising, but the fact that it failed to discover a magnetic field was even more so. It eliminated a theory that once sounded reasonable.

The story began on September 13, 1959, when the Russian lunar probe Cosmic Rocket 2 crashed on the moon. It kept sending reports until the moment of impact, and these reports showed that the moon lacked a detectable magnetic field. Then Mariner 2 reported that Venus was without a detectable magnetic field. Well, both the moon and Venus are slowly rotating bodies. Both the earth and the planet Jupiter were known to have magnetic fields, and both are rapidly rotating bodies. Hence, the existence of a magnetic field presumably had something to do with the speed of rotation of the body. Since the rotation of Mars is almost as fast as that of the earth, it surely had a magnetic field. We now know that it does not, and a new theory of planetary magnetism is obviously needed.

But now for the earth-moon system. Electronics has not changed the picture as drastically as it did in the case of Mercury or Venus, but many unsuspected items were added, the first one being the Inner Van Allen Belt discovered by the first American research satellite Explorer 1 which was launched on January 31, 1958. (It is now the oldest satellite still in orbit.) Lunar probe Pioneer 3, fired on December 6, 1958, failed to reach the moon, but it discovered the Outer Van Allen Belt. And various satellites and space probes later added the information that the earth has what is called a "magnetic tail."

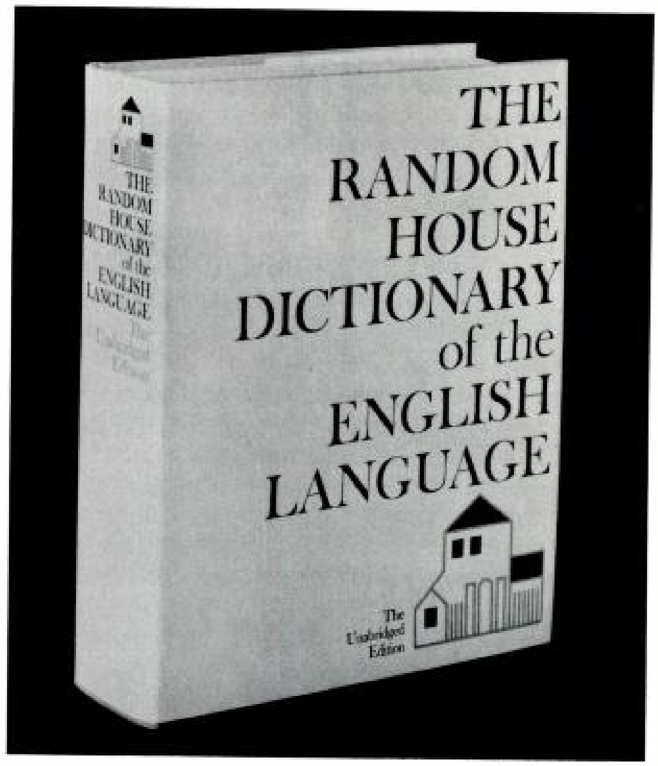
This "tail" is a result of the earth's magnetic field, as are the Van Allen belts. Our sun emits a steady stream of subatomic particles, mainly electrons, that would strike the earth's atmosphere if they were not repelled by the magnetic field. The earth acts like a boulder in a shallow river; the particle outflow from the sun (called "solar wind") avoids the earth and forms a kind of wake which does not come together again for quite some distance. It is believed that the "tail" reaches at least as far as the orbit of the moon, 240,000 miles away, but the precise length is not yet known.

As for the moon, astronomers now have very detailed maps of some areas, thanks to the Ranger lunar probes, whose RCA TV camera systems transmitted over 15,000 excellent pictures of the lunar surface, and the Lunar Orbiters. The number of areas known in such detail will steadily increase with the continued success of the Lunar Orbiters. But none of the fundamental concepts of the moon has been changed radically so far, mainly because the moon is so close that the facts can be established by visual observation.

But the moon is destined to play a more important role in the application of electronics to astronomical research. It must not be forgotten that our atmosphere is opaque to most radio waves, too, and this applies especially to the long waves that are reflected by the ionosphere. Obviously, the ionosphere reflects in both directions. Hence, a radio telescope outside the atmosphere will be much better off than a radio telescope on the ground.

There is an ideal place for such a radio telescope. It is the far side of our moon. ■

The Making of a Dictionary



Seven years in the preparation, "The Random House Dictionary of the English Language" is the first book of its kind to be produced with the assistance of electronic data processing.

by Laurence Urdang

The Random House Dictionary of the English Language, nine and one-quarter inches by 11 and seven-eighths inches, weighing 10 pounds, containing in its 2,091 pages a 260,000-entry dictionary with about 2,100 illustrations, a 64-page atlas with a 27,000-entry gazetteer, four foreign-language dictionaries, and a mass of other information, is the first book of its kind to have been produced with the aid of computers or, for that matter, of any automatic data processing equipment.

This is the first completely new dictionary in many years, and it represents the largest press production of its kind ever undertaken on a first printing. The initial run was 500,000 copies, the first one coming off the presses seven years after the start of work on the project.

Gone are the days—if they ever really existed—of the lonely lexicographer isolated in his ivory tower, handing down from on high his manuscript after years of seclusion, communing with some almighty authority on language. In their day, for their day, such savants produced works of historical interest, but of otherwise little use to us today. Today's dictionaries are produced by teams of highly skilled editors, trained and experienced men and women who trudge

LAURENCE URDANG served as Managing Editor of *The Random House Dictionary of the English Language.*

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05512000 hard' sauce', a creamed mixture of butter and confectioner's sugar, often with flavoring and cream, used on warm puddings, pies, etc.

05512050 hard·scrab·ble (härd'skrab'əl), adj. providing meagerly in return for much effort: the hardscrabble existence of mountainside farmers.

05512100 hard' sell', a method of advertising or selling which is direct, forceful, and insistent; high-pressure salesmanship (opposed to soft sell).

05512200 hard-set (härd'set'), adj. 1. firmly or rigidly set; fixed: a hard-set smile. 2. in a difficult position: The army was hard-set for quite awhile before their supplies came. 3. determined; obstinate. [ME; see hard, set]

05512300 hard-shell (härd'shel'), adj. 1. Also, hard'-shelled'. having a firm, hard shell, as in a crab in its normal state, not having recently molted. 2. having a firm, hard shell, as a crab in its normal state, not having recently molted. —n. 3. See hard-shell crab. Also, hard'-shelled'. [hard + shell]

05512330 hard'-shelled clam' (härd'sheld'), quahog.

05512350 hard'-shelled crab', a crab, esp. an edible crab, that has not recently molted, therefore having a hard shell.

05512400 hard·ship (härd'ship), n. 1. a condition that is difficult to endure; suffering; deprivation; oppression: a life of hardship. 2. an instance of this; something hard to bear, as severe toil or need: They faced bravely the many hardships of

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frontier life. [ME; see hard, -ship]

—Syn. 1. trouble, affliction, burden, suffering, misfortune. Hardship, privation, austerity are terms for something hard to endure. Hardship applies to a circumstance in which excessive and painful effort of some kind is required, as enduring acute discomfort from cold, battling over rough terrain, and the like. Privation has particular reference to lack of food, clothing, and other necessities or comforts. Austerity not only includes the ideas of privation and hardship but also implies deliberate control of emotional reactions to these. —Ant. 1. ease.

05512430 hard' sign', 1. the Cyrillic letter .... as used in Russian to indicate that the preceding consonant is not palatalized. 2. the same symbol used for the back vowel of Old Slavic from which this Russian usage and phenomenon are historically derived.

05512450 hard' sol'der, a solder fusing at temperatures above 1200°F. Also called brazing alloy. Cf. soft solder.

05512500 hard-spun (härd'spun'), adj. (of yarn) compactly twisted in spinning. [hard + spun]

05512600 hard·tack (härd'tak'), n. a kind of hard biscuit formerly much used by sailors and soldiers. Also called pilot biscuit, pilot bread, ship biscuit, ship bread. [hard + tack]

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through the language, from A to Z, defining—but not refining—as they go. The amounts of information in a dictionary and the efforts that are made to codify that information are prodigious—so prodigious that it seemed obvious when plans for the editorial work on *The Random House Dictionary* were first drawn up in 1958 that computers or, at least, some form of data processing equipment could be used to eliminate much of the tedious work. Naturally, computers could not be expected to write definitions, to transcribe pronunciations, or to research etymologies, but preparing a dictionary involves a tremendous amount of sorting of research data, arranging and rearranging of definitions into subject fields, alphabetizing of entries, and so forth. If a computer could be programmed to do such work, there would be fewer errors and a more efficient use of the staff and, as a result, a lower price for a better dictionary.

The practice in the past has been to enter each unit of information—that is, each main entry word, pronunciation, definition, variant, etymology, and so forth, on a separate slip or card. Some entries consisted of as many as 200 or more such slips. Depending on the editing requirements of this information, the slips were separated from one another to be worked on by various editors, often not to be filed into sequence again until just before the preparation of the final manuscript.

For a dictionary the size of *The Random House Dictionary*, more than 1 million such individual slips would have to be sorted, re-sorted, and re-sorted again—clearly a task anyone not a glutton for tedium and error would want to avoid.

Just the bare fact that millions of factual elements had to be subjected to certain kinds of uniform processing—alphabetization, for example—was sufficient indication that there was *something* that the computer could do. The question in this particular case was whether the computer could do alphabetization economically. Investigation showed that no program then in existence could alphabetize words in the sequence desired. (Dictionaries usually alphabetize letter for letter while phone books alphabetize word for word. Thus, a dictionary sequence like *New Ark*, *Newark*, *New York*, would appear *New Ark*, *New York*, *Newark* in the phone book; such a sequencing in a dictionary would lead to confusion, for an entry like *Old Fashioned*, the cocktail, would appear in a completely different column or page from that containing *old-fashioned*, the adjective.) Since the cost of writing a special alphabetizing program was quoted in the neighborhood of $50,000 and would have occupied a fair amount of expensive computer time, it was decided to number the entries. These numbers then served as the computer key for the sorting and final assembly of all entries. A similar

(Continued on Page 10)

The final manuscript for *The Random House Dictionary* was produced by a cathode-ray-tube printer driven by 36 magnetic tapes containing all of the dictionary text. On the left are two sample pages of the manuscript.

DICTIONARIES FROM THE 12TH TO THE 20TH CENTURIES

Codification of language has been a scholarly interest for more than 700 years. Used in classrooms, the first dictionaries were characterized by exotic titles. There was a *Promptorium Parvalorum* (storehouse for the little ones), as well as an *Ortus Vocabulorum* (a garden of words), and *An Avearie* (aviary or beehive). The *Avearie* marks the beginning of collective effort in compiling a dictionary. The editor, a Cambridge pedagogue named Baret, appointed his students to "gather a number of phrases ... and to set them under severall titles, for the more ready finding them againe their neede." Baret called his students his "busy bees," and noted that "Within a yeare or two they had gathered togither a great volume."

In the 17th century, dictionaries did not include all words, instead listing "hard usuall English wordes" or "expounding ... strange words." By 1676, dictionaries began to make some concessions to popular usage. Elisha Coles listed a small collection of slang expressions in his *An English Dictionary*. The first lexicographer to list and define words in common usage was John Kersey, whose *New English Dictionary* appeared in 1702.

In 1721, Nathaniel Bailey's *Universal Etymological English Dictionary* was published. Bailey's dictionary listed more words "than any other dictionary before extant." The shape of the modern general-reference dictionary began to evolve in 1730, when Bailey's *Dictionarium Britannicum*, containing "not only the Words, and their Explications, but the Etymologies," and "Illustrated with near Five Hundred Cuts" was published. Bailey was also the first lexicographer to add flippant comments to his definitions. Bailey's dictionary was used by Samuel Johnson in the preparation of his monumental *A Dictionary of the English Language*, and the influence is apparent.

Johnson combined scholarship with an innate feeling for words and their meanings. He was the first lexicographer to use examples from "the best writers" to illustrate his definitions. His definitions are clear, concise, and remarkably perceptive. His contributions to lexicography were outstanding. A recently published abridged version of the 1755 edition, although definitely a period piece, still holds interest for the modern reader.

The first English dictionary compiled by an American appeared in 1798, when *A School Dictionary*, compiled by Samuel Johnson, Jr., (no relation to his British namesake) was completed. It was followed, in 1800, by *A Selected, Pronouncing and Accented Dictionary*, jointly written by Johnson and John Elliott, pastor of a church at East Guilford, Conn. The Elliott–Johnson dictionary was given the imprimatur of 19 educators, clergymen, and other scholars, perhaps the first time that testimonials were employed as a promotional device in American publishing.

With the 19th century came the large unabridged dictionaries that we know today. The first of these was *The Columbian Dictionary*, compiled by Caleb Alexander. It contained more than 32,000 entries and listed such American words as *cent, dime, dollar, elector, and minute-man*. American spelling was also represented by *color, favor, honor*, and *checker*. Pronunciation was indicated by a simple form of phonetic respelling. *The Columbian Dictionary* included simple words current in everyday usage, providing a word list that was reasonably complete.

Noah Webster was the dean of the American lexicographers and, although he died more than a century ago, his name is still synonymous with the word "dictionary." His first dictionary, published in 1806 as *A Compendious Dictionary of the English Language*, contained approximately 40,000 words with concise definitions. Twenty years later, Webster's masterpiece, *An American Dictionary of the English Language*, appeared. It listed about 70,000 entries and was almost immediately accepted as a standard authority.

Work began in England during the 19th century on a new English dictionary of the English language, a monumental project that involved the cooperation of both British and American lexicographers before it was completed in 1928. Later known as the OED, or *Oxford English Dictionary*, this dictionary listed and defined all recorded English words from the 7th century to the 20th.

Of almost similar stature is *The Century Dictionary: an Encyclopedic Lexicon of the English Language*. Originally published in 6 volumes in 1889, *The Century Dictionary*, although out of date, is still interesting for the richness of its literary examples and the distinction of its style.

New versions of the Webster dictionary, published in 1890 and 1934, continued to maintain the authority of the original work under the title of *Webster's International Dictionary*. A third edition, however, published in 1961, created a lively and sometimes bitter controversy over its principles and style.

practice was followed in the numbering of definitions and of run-in entries.

People frequently belittle consistency, calling it the "hobgoblin of little minds." However, Emerson's words were "A foolish consistency is the hobgoblin of little minds. . . ." In any reference book, consistency is a virtue to be pursued doggedly, for in itself consistency can convey information. For example, consistency in the style of certain kinds of definitions, say chemical compounds, informs the user of the *RHD* after he has looked up only one of them, that he can rely on finding uniform, applicable information on them all:

1. physical appearance (color, crystalline structure, powder, etc.)
2. solubility in water
3. chemical formula
4. source and (usually) method of extraction
5. use or application

Needless to say, in addition, the user can count on learning spelling, syllabication, pronunciation, part of speech, etymology, adjectival and adverbial derivative forms, variant names, and variant spellings. If the compound occurs as a member of a set of three or four members, he is often referred to the names of other members of the set.

Were a reference book to provide information in random fashion, omitting or including appropriate information as the spirit moved the editor, its usefulness would be severely limited; in fact, using such a book would be irritating, to say the least.

The only way such consistency can be ensured is by having all related material in one place. To this end, high-speed electronic computers were employed to divide and subdivide the data, making it possible to employ editors who were specialists in the many subject fields into which the material was "exploded" and, further, to make their work simpler, more accurate, and more consistent by segmenting it into smaller, viable units.

In all this, the computer played an essential role by relieving the staff of the tedium involved in the addition, deletion, and changing of data, and, finally, in the sorting of all these million or so units of data into dictionary order. All of this required merely hours on the computers rather than the many man-months otherwise necessary for manual sorting.

Provision, of course, had to be made not only for the addition, to the basic word list, of entries like *splashdown*, *quasar*, *LSD*, *Telstar*, *Black Muslim*, *medicare*, *overkill*, *freedom ride*, and *frug*, but, within existing entries, the expansion of definitions from a basic list of 104 to 172 for the longest entry, the word *run*. By so doing, the basic set of information was expanded by a factor of about 10. These lists of data units were produced on punched paper tape that was converted to magnetic tape for input into a computer. After passing through several editing programs to verify the completeness and consistency of the sorting data, the tape was updated by a series of similarly produced correction tapes. The corrected data units, more than 1 million in all, were finally sorted into alphabetical, then into dictionary order.

For processing the data into machine-readable form, a punched paper tape typewriter was selected and modified to accommodate the large number of different typefaces that a dictionary normally uses to signify various kinds of information. Modification was necessary because the only machines in existence could encode no more than 88 discrete characters. Two of the 13 machines were so modified as to enable 160 discrete characters to be coded and typed in any of 20 fonts of type—and read back with ease from hard copy—an effective input of 3,200 characters. Tape corrections can be made quite readily by producing a fresh tape, stopping the run to skip over deleted or incorrect data, or punching in new data on the fresh tape. These machines were used to encode some 65 million characters on more than one-half million feet of punched paper tape.

Since technology had not yet progressed to the point where an automatic typesetting machine could be used to reproduce the data, how was a manuscript to be obtained? Computer printouts, even those chain printers capable of producing capital and small letters, were inadequate to the task of providing hard copy of sufficient character versatility for both proofreading by the staff and reading by an outside compositor. Investigation turned up a cathode-ray tube printer capable of producing characters at speeds of up to 17,250 per second from magnetic tape input. This machine, using a Charactron tube, generated characters in three modes: from a postage-stamp-sized matrix built into the tube, as many as 64 characters could be generated, or an unlimited number of characters or symbols could be generated either from a series of dots or from a series of vectors (straight-line segments produced by moving a dot).

In order to drive the cathode-ray-tube printer, the master magnetic tape containing all of the text of the *RHD* had to be formated in keeping with the machine's input requirements and, in so doing, the seven densely packed master tapes were expanded into some 36 tapes. Inserted also were page numbers and other information; formating included provisions for producing lines of text in which no end-of-line breaks appeared in words, for indenting matter as required, and for showing type fonts by means of standard underlining symbols used in proofreading.

The text was generated, one frame at a time, on the face of the cathode-ray tube, in much the same way that a single static image is produced on the face of a television screen. As each frame was generated, a picture of it was taken on 35-mm. film by a self-contained camera equipped with an automatic film advance. In this way, the entire manuscript of more than 20,000 pages was produced, in microfilm dimensions, within a few hours. The legible 12″ x 12″ manuscript for editing, final proofreading, and typesetting was then made by enlarging and xerographing the microfilm.

One inevitable question is: Did the use of computers mean that the project cost Random House less? The answer is both yes and no. Yes, money was saved because time was saved—many man-years of it. And, no, the project did not cost less because part of the money saved was spent on better and more thorough research, editing, and expertise. The balance of the money saved served as effective assurance that the selling price of *The Random House Dictionary* could be kept within reach of a great number of people.

Although it required only a millisecond or so to push the button to start the computer, let no one overlook the hundreds of man-years of editorial, lexicographic, and technical preparation preceding that millisecond. ■

New Challenges for the Electronics Industry

Manufacturers are devising new production and training techniques to satisfy an almost limitless consumer appetite for electronic goods.

by Robert E. Tolles

Last January, a bulldozer began scraping frozen red earth on a 180-acre one-time cotton field on the outskirts of Memphis, Tenn. In September, only nine months later, the site was occupied by the largest television receiver assembly plant in the South, and a work force of ordinary citizens of Memphis—many of them housewives—were mass-producing color television sets, the most complex electronic instruments ever devised for the home.

The transition illustrates a most remarkable aspect of modern electronics. Not only are new production facilities built with record speed but they are staffed just as swiftly with highly skilled teams of production workers recruited from among men and women who have had no prior experience, or even acquaintance, with the manufacture of increasingly sophisticated electronic products.

The chronology of the new RCA television plant at Memphis is even more impressive than this record would indicate. The recruiting and training of men and women for the production lines did not begin until February. With the aid of instructional facilities established in a former discount store and bowling alley not far from the site, a nucleus of 800 workers had been trained sufficiently by mid-June to begin mass production of black-and-white portable television receivers in the newly erected plant. Within two more months, the training program had graduated another 1,500 skilled men and women, and Memphis was ready for its new role as a major source of RCA color television receivers for a waiting market.

In its combination of challenge and achievement, the Memphis story typifies the experience of the electronics industry in general. As electronic systems and instruments continue to grow in complexity, cost, and sophistication, new

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Assembly of electron guns for color TV picture tubes is typical of many electronic production tasks calling for skill and precision.

demands are placed upon designers and production engineers. Much of the equipment of modern electronics must be manufactured to very high standards of tolerance and purity: a speck of dust adhering to the electron gun of a color picture tube, or a misalignment of a fractional thousandth of an inch in an integrated circuit, can result in operating failure. Furthermore, in order to achieve mass production of these and many other products, it has been necessary to devise step-by-step manufacturing and assembly techniques that can be easily mastered after relatively brief training by persons without previous experience.

In developing new facilities for increased mass production, the industry has had to meet the most rigid standards of manufacturing and quality control. Consider, for example, the procedures that are involved in the manufacture of integrated circuits. Typically, a scene such as this is being enacted around the clock at dozens of electronics plants around the country.

A white-smocked young woman, head wrapped in a white turban, peers intently through a microscope-like device at a barely visible chip of silicon in a pronged metal case less than a half-inch square. With her left hand, she deftly manipulates a lever that bonds a hair-thin gold wire to a dozen or more connections on the silicon chip. The operation —the bonding of the contact points of the chip to the prongs of its enclosing case—is completed in less than 10 seconds, and the woman removes the completed integrated circuit and replaces it with another chip and case.

Today, only a few years after the development of the transistor, the integrated circuit has begun a massive penetration of existing electronics technology. By reducing many of the basic building blocks of electronics to the size of a pinhead, microelectronics promises improved reliability and greater speed and compactness for a wide variety of electronic products and systems. At the same time, increased demand for complex electronic products, ranging from color television to computers to complicated military and space systems, has placed an unprecedented strain on the industry's productive facilities.

As the industry has responded to these new challenges, a major problem has emerged. Electronics is a labor-intensive industry, requiring a relatively high labor component per unit of production. Its need for engineers and technicians is also prodigious. In an economy already overextended by

Computer plug-in boards are assembled by a worker.

Color television components are checked at various stages of production.

booming domestic and military demand, the thousands of new workers required by the industry have become increasingly hard to find.

Electronics is also somewhat special in that it needs a large supply of not only technically skilled labor in general but female labor in particular. This is so because the assembly of the many components that make up an electronic product is a tedious job that calls for infinite patience, dexterity, and tolerance for repetitive work. Since women are more capable than men in performing this work, manufacturers have had to seek out areas where there is a large reservoir of available female labor. The industry has thus become increasingly dependent upon the independent American housewife who works not so much out of absolute necessity but because she wants to supplement the family income.

Stimulated by rapidly expanding sales for consumer, industrial, and military and space electronics, manufacturers are looking all over the country to find areas of surplus labor supply. The selection of a particular site is virtually dictated by the availability of female labor, engineers, and technicians. Frequently, these sites are found in regions that have been depressed economically.

The greatest challenge of the moment for the electronics industry is in meeting the explosive demand for color television. As the nation's largest manufacturer of color television sets, RCA is now engaged in a massive buildup of its production facilities in such diverse locations as Lancaster and Scranton, Pa.; Marion, Bloomington, and Indianapolis, Ind.; Memphis, Tenn.; and Juncos, Puerto Rico. Thousands of workers have been and are being trained to perform hundreds of separate assembly operations ranging from the delicate hand assembly of the electron gun to the inspection of minute holes through which electrons pass to excite the color phosphors on the face of the tube.

This latter process calls for extreme precision, since the slightest deviation in the size of these holes will distort color reproduction of the tube. Equally demanding is the process by which the color phosphor dots are applied to the face of the tube. Arranged in triangular patterns of red, blue, and green, thousands of these dots are applied to the inside face of the tube in a continuous, automated process in which physical handling is kept to a minimum.

At RCA's Lancaster plant, a $20-million expansion program has enabled the doubling of tube production in the last

Microscopes are used to inspect a wafer of silicon on which have been etched a number of tiny integrated circuits.

two years. Three shifts of workers labor around the clock to produce thousands of tubes a day. A portion of this production goes to RCA television set assembly plants in Memphis and Bloomington with a substantial quantity sold to other set manufacturers.

At an adjoining facility in Lancaster, RCA's conversion tube activity is expanding production of the television receiver tube's counterpart in the TV camera—the image orthicon and vidicon tubes. These devices convert light into electronic impulses that are then sent via antenna and the airwaves to the home receiver. Assembly of these tubes is carried out in an enormous facility where the air is continuously exhausted and filtered to produce a virtually dust-free environment.

The Lancaster plant also has played the role of training ground for engineers, foremen, and technicians who were recruited for a new RCA tube facility in Scranton. Through lectures and films, these men first received an over-all orientation in tube production at the Lancaster plant and then went out onto the production line where they were given participating assignments with their Lancaster equivalents. They later trained hourly workers, using a mock production line at the still-incomplete plant. A trained force of workers was thus available when the first tube production line was started up at Scranton.

Mass production of integrated circuits involves equally complex problems, requiring considerable technological inventiveness. The tiny chips are made through a diffusion process in which precise amounts of gaseous impurities or "dopants" are deposited in multilayered patterns on a wafer of silicon. The molecular interaction of these dopant-treated regions with the pure silicon enables the chips to perform the same functions of control and amplification of bulkier components.

Diffusion is carried out in furnaces under conditions of precise temperature and atmospheric control. The process is difficult to regulate, and some units fail to meet inspection standards. To get around this problem, industry engineers maintain a rigorous quality control, eliminating faulty units early in the production process through the use of ingenious automated probes that seek out and apply test currents to the minute contact points of the circuits.

Although the military and space programs have made use of integrated circuits for several years, the large manufacturers of consumer electronics, for reasons principally connected with cost, have only recently acted to include them in their products. RCA, for example, is now manufacturing black-and-white and color television with integrated circuits in the sound section that replace some 20 transistors and components. General Electric also has announced a line of battery-powered portable radios using silicon circuits.

Although manufacturers constantly seek to mechanize production and thus reduce their need for labor, they still require the agile hands of many women to produce these circuits. For instance, at RCA's Somerville, N.J., facility, scores of women work three shifts in a yellow-lighted "clean room" diffusing, etching, bonding, and testing an output that has grown in just a year from a standing start to millions of units. For new workers, an eight-week training program is prescribed to develop their finger dexterity and the necessary confidence for the exacting assembly tasks that lie ahead.

The integrated circuit made its appearance in 1962 when design and manufacturing techniques had been sufficiently perfected to permit their mass production. That year, the industry turned out 60,000, and since then output has been increasing rapidly. In 1966, some 35 million of them worth $150 million will be produced. By 1970, production valued at between $350 and $400 million is estimated.

Manufacturers of industrial semiconductors are in almost as challenging a position. Whereas integrated circuits control the signal responses in an electronic system, the larger industrial semiconductors perform the technically more demanding function of regulating the power in an electronic device. The product of the older, transistor technology, the industrial semiconductor has been operating in a market of constant change and expansion, occasioned, first, by the changeover from germanium to the electronically purer silicon and, second, by its growing use in such products as radios, automobiles, television sets, and industrial control devices.

Dr. D. J. Donahue, Manager of Industrial Semiconductor Operations for RCA, estimates that the basic market for the product expands by 20 to 60 per cent a year, depending upon how rapidly manufacturers use them to replace other components in their equipment. As manufacturing processes have improved, the cost of these units has dropped to where they now sell for one-third of what they did four years ago. The demand is so great, according to Dr. Donahue, that, if a manufacturer cannot produce 25 per cent more units per year and thus attain the cost advantages of volume production, he may find himself going out of business.

A new market for industrial semiconductors of the power variety is in the replacement of electromechanical devices. These are the units that control the power supply for electric stoves, sewing machines, power tools, electric blenders, and many other household items. The big advantage of the semiconductor is that it can provide continuous power control, from low to high. The standard household electromechanical device only turns the power on or off. Since the typical household contains from 15 to 20 electric motors, all of which could be operated with considerably greater economy and convenience with continuous control, the potential market for power-control semiconductors is huge.

While the market for electronic products continues to expand, the search goes on for more efficient and reliable production methods. This search is usually directed toward more sophisticated process equipment that can eliminate steps in the production process and absorb functions now performed by human hands. In the long run, however, the manufacture of electronic equipment as complex as a television receiver can only be simplified by reducing the number of individual components that go into the set.

The hoped-for breakthrough in component reduction undoubtedly lies in the tiny chips produced by the deft hands of the white-clad women of Somerville and other electronics facilities. By combining many discrete electronic functions in its miniscule dimensions, the integrated circuit promises welcome relief to the hard-pressed electronics industry as it strains to feed an almost limitless consumer appetite for new and improved electronic goods. ■

This series of photos was taken of Toscanini during a rehearsal with the NBC Symphony a few months before his retirement in 1954. The photographer had set up his camera near the bass viols, and the Maestro was unaware that he was being photographed.

Toscanini at 100

A century after his birth, the reputation of the world's supreme conductor continues to grow through the medium of recorded music.

by Leonard Meyers

The facts and accomplishments of Toscanini's life and career add up to an impressive total. But it still does not explain the motivation behind this remarkable man and artist. Through the nine decades of his life, there emerges again and again one word—dedication. This is the real key to understanding Toscanini.

During his lifetime (1867–1957), the public was attracted not only by his superb music-making but also by the drama of his life and activities. He did not seek drama, it seemed to seek him out. His consistent fight against political dictatorship, his running battles with orchestras and singers and opera managements stemmed from his refusal to compromise with what he felt were false standards or improper practices. His famous temper was not aroused when honest effort went into the rehearsal but only when he had to contend with stupidity or egoism or laziness.

He who detested political dictatorship was himself a dictator on the podium. Although his mind was not closed to suggestions from singers and musicians, he realized that only one person could be in ultimate authority. He did not

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Toscanini with the NBC Symphony—the orchestra that was created for him in 1937.

think of himself as being that person, however. He felt it was the composer; he was merely the composer's representative.

Over and over again in rehearsals, he referred musicians to the score. Look at the score and see what the composer said was his continuing admonishment when musicians strayed or questioned. No matter how often he had conducted a piece, he restudied it with great care each time he performed it. He expected this same devotion from the men and women who worked with him. And it was often because his own energy and preparation were not matched by the singers or players that scenes of temper would follow.

But these were only the more dramatic aspects of his working method. There were the endless hours of patient hard work not only by himself in preparation but also with the players at rehearsals and private conferences. Those who participated in or watched his rehearsals will recall his endless patience when trying to achieve a particular effect. He could spend hours building a crescendo or balancing a complex orchestral passage in which he sought a special color. He worked tirelessly to find the correct tempo.

Humor, too, was often an aspect of a Toscanini rehearsal. His uncanny sense of the mood of the musicians often led him to relieve a tense situation with a funny remark. But just as often, he found humor a simple and direct way of communicating his musical ideas. Once he remarked to the musicians in a New York studio that he wanted a faraway effect. "But," he added, "not too far, about Brooklyn." On another occasion, when a musician repeatedly played several wrong notes, an offense that might have brought on a storm, he merely said, "What are you playing, something you composed yourself?" He could be graphic, too. Once while conducting Debussy's "La Mer," at a point where he wanted a diaphanous color, he threw a silk handkerchief into the air, and, as it floated gently down, he said serenely, "Like that." During a rehearsal for a Mozart symphony, he wanted elegance. "Not staccato," he said, "but elegante, like you are wearing lace cuffs."

He detested the word "genius" being applied to him. He said that Beethoven, Verdi, and Wagner were the geniuses. "All I do is wave the stick." And while he was probably correct in this, it was a composer with whose work Toscanini was intimately associated who gave the truer description. Giacomo Puccini, three of whose operas—"La Bohème," "The Girl of the Golden West," and "Turandot"—were premièred by Toscanini, said of him: "He is able to bring out in performance what the composer had in mind but didn't know how to put on paper."

The span of Toscanini's life and career was vast. The above-mentioned première of "La Bohème" took place in 1896, and in 1946 Toscanini conducted the NBC Symphony

His 17 years with the Symphony were among the most fruitful of his musical career.

Orchestra and soloists in the 50th-anniversary performance of the work. He had conducted the world première of "I Pagliacci" in 1892 in Milan. He also gave the first performance in Italy of Wagner's "Götterdämmerung" in 1895 and of "Siegfried" in 1899. The American première performance of Shostakovich's "Symphony No. 7" was given in New York during a broadcast by the NBC Symphony Orchestra.

Toscanini was born to a poor family of tailors in Parma, Italy, on March 25, 1867. His father, Claudio, had been a follower of Garibaldi in his youth but was now settled in the simple daily life of a poor craftsman. As a child, Arturo showed an easy ability with music, learning from a grade-school teacher and practicing on her piano. At nine, his family was persuaded to let him enter the Parma Conservatory. With relatively little training and preparation, he took the exams and was admitted. The life of the student there was austere and difficult, but much to the taste of the young Toscanini. His great facility led his fellow students to call him genius, which stirred him to strong anger. After two years, he won a scholarship and spent seven more years at the Conservatory until his graduation "with distinguished praise." He had highest scores in all his musical studies.

Toscanini took jobs as a cellist to aid his family, doing some coaching and conducting wherever possible. In 1886, he went to South America on tour with an opera company as a cellist in the orchestra and as assistant chorus master. In this latter capacity, he often worked with the singers in rehearsals. The reception of the company was not good. The Brazilian conductor Miguez resigned and in a published article blamed the Italian singers. This was in Rio de Janeiro, and the public was clearly with him. On the night of the "Aida" performance, the Italian conductor Superti was hissed off the podium, as was the chorus master Venturi, who attempted to take up the baton. Toscanini was then urged by the weeping members of the chorus, who feared being stranded without money, to make a try. He went to the podium, opened his score to page one, and gave the downbeat. Whether it was the youthful appearance of the 19-year-old, or his authoritative manner, one cannot know. But the audience quieted, and the performance went on. Prejudice or no, the audience recognized a fine performance, and the evening was a great success. At the end of the performance, Toscanini's score was still open to page one. His ability to memorize long and complex scores astounded audiences. But for him, it was the best way to conduct.

During the remainder of the season in Rio, Toscanini conducted many other operas. On his return to Italy, he did not attempt to capitalize on the events. But the singers did not forget and all over Italy told of Toscanini's triumph. The tenor Figner especially remembered, and recommended

"It is the existence of Toscanini's recorded performances that keeps him alive in the minds and hearts of today's music lovers."

Toscanini as conductor for the world première of Alfredo Catalani's opera "Edmea" in Turin. This was the beginning of a close friendship between the composer and conductor, and also the first of many performances Toscanini conducted in Turin for the next 12 years. Later that year, he also conducted the world première of Leoncavallo's "I Pagliacci." Many other premières were given under his baton, but most notable was the first performance of "La Bohème" in 1896.

Toscanini's interests were also turning to symphonic music, and he directed concerts whenever possible. He conducted concerts at La Scala as early as 1896 and his first opera at the venerable house in 1898. His association with La Scala on an on-and-off basis came to an end in 1928, not to be resumed until 1946 when he conducted a concert to reopen the theater which had been damaged during the war.

His first association with La Scala lasted until 1903, when he walked out in protest over the audience demand for encores, which he would not allow. It was not until 1906 that he returned at the invitation of Gatti Casazza to become principal conductor. In 1908, he left again, this time to accept Gatti's invitation to join the conducting staff at the Metropolitan Opera in New York. He made his American operatic début with "Aida," the same opera with which he had started his career in 1886. During his years with the Metropolitan, Toscanini conducted music of the Italian, French, and German repertoires. Many New Yorkers were astonished that an Italian conductor could outdo the Germans in conducting Wagner. The late Olin Downes often spoke of Toscanini's performances in 1910 of Wagner's "Tristan and Isolde" as the finest he ever heard of this superb score.

In 1915, Toscanini left the Metropolitan because of disagreements that were never explained. He returned to Italy and conducted concerts for the army but was not too active in music. In the postwar years, he was again invited to La Scala and trained a new orchestra, which he took on a successful tour of this country in 1921. The following year, he began an association with La Scala as artistic director and conductor, which lasted until 1928. During this period, usually referred to as La Scala's golden period, he achieved many artistic triumphs. But he was constantly irked by the restrictions of Mussolini. In 1926, he became a guest conductor of the New York Philharmonic, dividing his time with La Scala. In 1928, when that orchestra combined with the New York Symphony to form the New York Philharmonic Symphony Orchestra, he became its principal conductor, a post he kept until 1936.

Tours seemed to stimulate Toscanini, and he worked hard despite the rigors of traveling. He had previously conducted the Metropolitan Opera on tour in Paris, and in 1930 he took the Philharmonic on an extensive tour of Europe. The audiences and critics were wild with admiration. Royalty, noted authors, and artists rubbed elbows with the ordinary music lovers who were able to secure tickets.

Toscanini's bouts with political dictators were soon to come. His continued refusal to conduct Mussolini's "Giovinezza," the Fascist national anthem, made more and more trouble, until Toscanini was finally roughed up in the streets of Bologna in 1931. Although he lived part of the time in Italy, he did not conduct there until after the war.

Toscanini had conducted for two seasons at the Bayreuth Festival, but when Hitler became chancellor in Germany he would not accept any further invitations. He enjoyed conducting at the Salzburg Festival, but in 1938 refused when Hitler came to power there. Instead, he went to Palestine to conduct the first concerts of the new symphony orchestra organized there by Bronislaw Hubermann.

In the summer of 1936, he decided not to accept any more regular posts, wanting only to accept engagements here and there as the offers attracted him. But when NBC invited him to conduct an orchestra formed especially for him, the temptation was too strong, and he returned to the United States. On Christmas night, 1937, he conducted the first concert, which started his 17-year association with the great orchestra.

A printed score is not music. Music exists only in sound. So it is the existence of Toscanini's recorded performances that keeps him alive in the minds and hearts of today's music lovers. Youngsters who never had an opportunity of hearing the broadcasts write to his son Walter Toscanini and RCA Victor Records expressing their joy in discovering Beethoven, Wagner, and Verdi through the still-available Toscanini recordings of these composers' works. Although he did record with the La Scala Orchestra in 1921 at the Victor Talking Machine studios in Camden, N.J., and later with the New York Philharmonic Symphony Orchestra, the bulk of his recording activity was done with the NBC Symphony Orchestra in Studio 8H and Carnegie Hall.

Those 17 years on the podium with "his own" orchestra were among his most fruitful. He had an orchestra of exceptional musicians who were meticulously trained to the Toscanini standards. They were a responsive instrument to his most demanding requirements. Although the major part of the concerts was given over to the standard works of the symphonic repertoire, nevertheless Toscanini did present some new works and some less known from established composers. But the most important of his forays from the mainstream of the symphonic repertoire was his presentation of complete operas. It had been as an opera conductor that Toscanini established his career. And it was to opera that he had devoted the larger portion of his time from his début as a conductor in 1886 to his assumption of the Philharmonic podium in 1926.

Some Americans still remembered his notable performances at the Metropolitan Opera, while others had heard about them. So, in 1944, the music world eagerly awaited his performance of Beethoven's opera "Fidelio." In 1946, he again turned to opera with Puccini's "La Bohème." Others followed, including "La Traviata" in 1946, "Otello" in 1947, "Aida" in 1949, "Falstaff" in 1950, and "Un Ballo in Maschera" in 1954. All of these as well as many excerpts from other outstanding operas are still available on records.

The 100th anniversary of Toscanini's birth will be marked with many articles and tributes in newspapers and periodicals, but more significant will be two special tributes, one the release by RCA Victor of a five-record album of Toscanini performances with the NBC Symphony Orchestra of material never before available, and the other a full-hour film tribute on the "Bell Telephone Hour" to be telecast next spring on the NBC Television Network.

The RCA Victor album will include Haydn's "Symphony No. 99," Leopold Mozart's "Toy Symphony," Brahms' "Gesang der Parzen," "Liebeslieder Waltzer" (Op. 52), and "Serenade No. 2 in A," Sibelius' "Symphony No. 2 in D" and "Pohjola's Daughter," and Shostakovich's "Symphony No. 7 (Leningrad)" and "Symphony No. 1." All of these performances have been taken from NBC Symphony Orchestra radio broadcasts. The film for the Toscanini tribute on the "Bell Telephone Hour" is being taken partly from films in the private archives of Walter Toscanini.

Toscanini once naively asked his son, "Why don't they forget me and just let me conduct?" Toscanini was not a man to be overlooked then, nor is he now on the 100th anniversary of his birth. He is still conducting and will continue to do so as long as there are electronic means of reproducing sound. ■

ARTURO TOSCANINI—AN APPRECIATION

by David Sarnoff

[From the Foreword to the RCA Victor Toscanini Centenary Album]

Many people regard the years 1937 through 1954, when the NBC Symphony performed under the direction of Arturo Toscanini, as the golden age of the symphonic orchestra in America. There were indeed many circumstances—some of them unique—that made these 17 years an era of unforgettable musical splendor.

We had succeeded, finally, in inducing Maestro Toscanini to return to this country for what became the most productive period of his distinguished musical career. Although he was 70 when he again raised his baton before an American audience and 87 when he reluctantly laid it down forever, he seemed to be immune to the vicissitudes of time. Music conferred on him a sort of immortality, and he, in turn, repaid it by bringing to each orchestral work the vitality and freshness of a première.

The orchestra which Toscanini came to conduct was unique among its kind for it was created to serve expressly as the instrument of one man's genius. No effort was spared in combing the world for the finest instrumentalists. Individually, they had few peers. Collectively, under the Maestro's exacting standards, they became a legend.

A medium already existed that was to bring the music of Toscanini and the NBC Symphony directly to the largest audiences in the world. Radio had created a concert hall that extended across the continent and, by means of short wave, circled the globe. The performances of the NBC Symphony, listened to by millions and capable of being heard in every living room on earth, established radio as the most powerful instrument developed up to that time for cultural extension.

But there is nothing in the world of art more transitory than a musical performance. It exists at the instant it is being played and thereafter only in the memory of the listener. The final task, therefore, was to assure the preservation of the works performed in the NBC broadcasts, many of which Toscanini had never recorded. Thus, at the time that the music of the NBC Symphony was being transmitted over the airwaves, it also was being transcribed on tape or disks. Most of these transcriptions have never been made public.

Thirteen years after Toscanini's last performance with his beloved orchestra, 100 years after his birth, and on the 30th anniversary of the founding of the NBC Symphony, the Maestro and the men who made music with him come to life again in these hitherto unreleased recordings.

Here is history as well as art—not only musical history but literally a record of an era. Listen, for example, to the defiant sweep of Shostakovich's "Symphony No. 7" as it was performed for the first time in America by Toscanini in July, 1942, when the Nazi hordes were slashing through the Russian heartland. To hear it again is to share in one of the sublime experiences of the spirit, for this is art forged from the anguish and hopes of the human soul.

I believe there is no tribute more fitting to the memory of Arturo Toscanini and the NBC Symphony than the release of these great musical performances. They dissolve the barriers of time and become again part of a living generation. ■

The Data Bank—Information on Demand

High-capacity computer memories are proving essential to organizations that require the rapid location of a particular fact among many.

by John Ott

A man sitting at his desk trying to recall his mother's birthday and his secretary leafing through her correspondence file to uncover the name of the purchasing agent he wants to see on his next trip to Seattle are engaged, basically, in the same process. Both are conducting a search through a mass of stored data in order to retrieve a needed fact.

Both will undoubtedly be rewarded with success. The secretary will consult only a few folders before she finds the document she wants and arranges for an appointment. Her boss, on the other hand, may be forced to query another memory unit—his wife—for the information.

Tens of millions of such transactions, all dependent upon the swift and accurate retrieval of information, take place each day. The needed fact may be dredged from the memory of an individual, it may lurk in a file drawer, be recorded on a ledger, printed on tape, stored on microfilm, or locked in any one of the many repositories devised by the ingenuity of man to hold the information he considers essential to the conduct of his affairs. But no matter where it is hidden, it must be accessible and, today, a premium is placed upon the speedy location of a particular fact among many.

A utility company customer with a telephone inquiry about his latest bill will chafe if he is kept waiting as files are searched for his account. That he is one among perhaps a million is of absolutely no concern to him. The airline that delays confirmation of a flight reservation risks the loss of a customer. We have become an exceedingly impatient people, and prompt, if not immediate, service on routine matters is now expected.

This has proved a serious problem for large complex organizations that attempt to serve a diverse public scattered over a large area. In order to perform to satisfaction, they are forced to maintain constantly updated central files that may hold tens of millions of discrete facts. And each fact or piece of information must be readily accessible.

No conventional filing system, even if manned by an army of clerks, could successfully cope with such demands. Electronic data processing systems, however, linked to mass storage equipment, can and do handle this work load regularly at speeds that seem to border on the impossible.

RCA's 3488 mass random memory unit, for example, has a storage capacity of more than 340 million characters and can produce information upon inquiry within a fraction of a second. Moreover, these units can be hooked up in tandem to increase on-line storage to nearly 5½ billion characters, or approximately 20 characters of information on every man, woman, and child in the United States.

These high-capacity random access storage units are commonly known as data banks. They are being used increasingly by credit associations, banks, insurance and util-

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Motor vehicle records are displayed directly from a data bank onto the screen of a video display device. The system is part of the California Department of Motor Vehicles huge computer-communications network.

ity companies, and other organizations that number their customers in the hundreds of thousands and that must maintain a ready reference file of essential information on each one of them. Government agencies, on the municipal, state, and national levels, have found that computer banks are the only efficient way of dealing with masses of statistics on millions of people.

Although they are not formally classified as such, data banks can be divided into two general types. The more familiar and more widely used consists of a repository of facts that do not change materially, or that change so slowly that their content can be updated with relative ease. These could be called static data banks.

Far more sophisticated are data banks that form the information base for a highly flexible enterprise. Ideally, these "dynamic" data banks should contain the constantly shifting information needed by a business organization to formulate policy in a keenly competitive and changing environment.

An example of a fairly static data bank is one that is part of a system recently put into operation by Chrysler Corporation, utilizing an RCA 3301 computer system and an RCA 3488 random access memory capable of storing 680 million characters. The purpose of the system is to give Chrysler customers better service under the company's five-year or 50,000-mile warranty program. At the heart of the network is a data bank that holds vital statistics on 3 million Chrysler cars and trucks. Information in this centrally located master file includes the latest mileage, dollars spent on warranty claims, vehicle manufacturing date, serial number of the car or truck, the body type, and a list of accessories. Under the warranty plan, the car owner must agree to observe a few simple maintenance routines—an oil change at least every three months, or 4,000 miles, new oil filter every second oil change, air-filter cleaning every six months, and replacement of air filter every two years. As these maintenance tasks are performed, the information file on each vehicle is updated.

A complete case history of his car is immediately available to the owner, no matter where he makes a claim for warranty benefits. The dealer can telephone or send a teletypewriter message to the nearest Chrysler regional office to ask for all available information. Using a visual data display unit and an electric typewriter, the regional office will query the data bank for the latest facts on the car. Within moments, the system will respond by flashing all the required information on a television screen in the regional office.

Sizable as it is, Chrysler's computer bank and electronic data processing system is dwarfed by a network RCA is currently installing for the California Department of Motor Vehicles. The hardware, which will be put into place over a five-year period, totals more than 200 devices, including 130 video displays and 27 mass storage units, each with a capacity of more than 500 million characters. Total storage for the system will be well over 15 billion characters.

When fully operational, the network will be able to call up on a moment's notice any item of information concerning California's millions of registered vehicles and licensed operators. The huge system will tie together 144 branch offices of the California Department of Motor Vehicles and will plug into another RCA computer installation in California's Department of Justice, which has a file second in size only to that of the FBI in Washington.

In addition to answering more than 8 million inquiries annually from Department of Motor Vehicles field offices, law enforcement agencies, and the courts, the computer system also will keep close watch on accidents and traffic violations. Drivers whose records indicate gross negligence will be spotted by the computer and corrective action taken.

For the public, it will virtually eliminate the traditional waiting period it has taken to register new vehicles or to secure licenses. Under the new system, it is estimated that an individual can apply for a license at any one of the Department's branch offices and walk out with one within eight minutes, provided, of course, that all requirements have first been met.

While computer systems and large-scale data banks find their natural application in the routine procedures of sizable enterprises, they are also proving practical for a wide variety of operations. One of these involves the marriage of random access memory banks and international telecommunications. Known as AIRCON, an acronym for Automated Information and Reservations Computer Operated Network, it is a new service offered by RCA Communications, Inc., to operations with information and reservation requirements, such as the hotel, auto rental, shipping, railroad, airline, and travel industries. Among its applications is a service that

"The data bank is a repository to which management can repeatedly refer for help in that most difficult management process – making decisions."

provides a central clearinghouse for airline reservations and other flight information.

Due to be operational early next year, the AIRCON system initially will handle administrative and reservations traffic. Subscribers to AIRCON flying routes within North America will be able to interrogate seat inventories of subscribing intercontinental airlines and arrange through-bookings within seconds. Intercontinental airlines will be able to obtain information on the passenger inventories of North American airlines as well.

The function of systems such as AIRCON, the one installed to manage Chrysler's warranty program, and the network planned for California's Department of Motor Vehicles is to describe and monitor an operation in which a large volume of information is processed and available for near instant recall. The operation itself is not subject to the effects of a rapidly changing environment and is often only part of a larger enterprise.

The computerization of Chrysler's warranty program, for example, does not encompass the full spectrum of the corporation's activity. However, it is descriptive of an area that is of interest to management. Similar information systems could be fashioned for other areas, such as financial control, production scheduling, and parts inventory, to name but a few. If this were to be done throughout the corporation, and the functions combined to provide a single output, a unified system would emerge that could furnish full operating information about the complex enterprise that is Chrysler and that would be responsive to dynamic change.

Such networks, generally known as Management Information Systems, are perhaps more of a dream than a reality, but a number of larger companies are currently wrestling with the many problems inherent in assembling them.

Interestingly, most of these problems are conceptual in nature. It is an accepted fact that electronic data processing has long ago produced all the needed hardware. High-speed computers and mass memory units, together with communications techniques and display devices, can perform any management information function that is required of them. The difficulty lies in programming.

The construction of a data bank or base, for example, is a particularly trying task. It is not easy to decide what data a system must know in order to perform as a total Management Information System. While there is general agreement that a data bank or base for any such system should be limited only to significant operational and behavioral data that affect the enterprise, this raises the question of what is "significant" and what is superfluous. It also raises the question of where to start in the construction of a data bank for a comprehensive, highly dynamic information system.

E. R. Dickey, Jr., Manager, Consultant Relations for RCA Electronic Data Processing, feels that the best way to approach the problem is from the top. As he puts it: "You first ask those responsible for long-range corporate strategy what they want the company to accomplish or what they want the company to be. Then you go down through all levels asking each manager what he wants his particular operation to accomplish in order to contribute to the over-all corporate goal. You also ask him what information he considers vital to the performance of his job." These questions, Mr. Dickey points out, are not easy to answer because managers are forced to describe their functions with extreme precision.

To show how complicated the assembly of a data base can become for even a small enterprise, Mr. Dickey has postulated a men's retail clothing outlet known as BestFit Suits, located at the Crossroads Shopping Center and owned by a Mr. Smith. Mr. Smith will first be asked about the future. What does he want BestFit to become? After giving the matter much thought, Mr. Smith decides he wants BestFit to be the largest retail suit outlet in the shopping center in terms of sales volume.

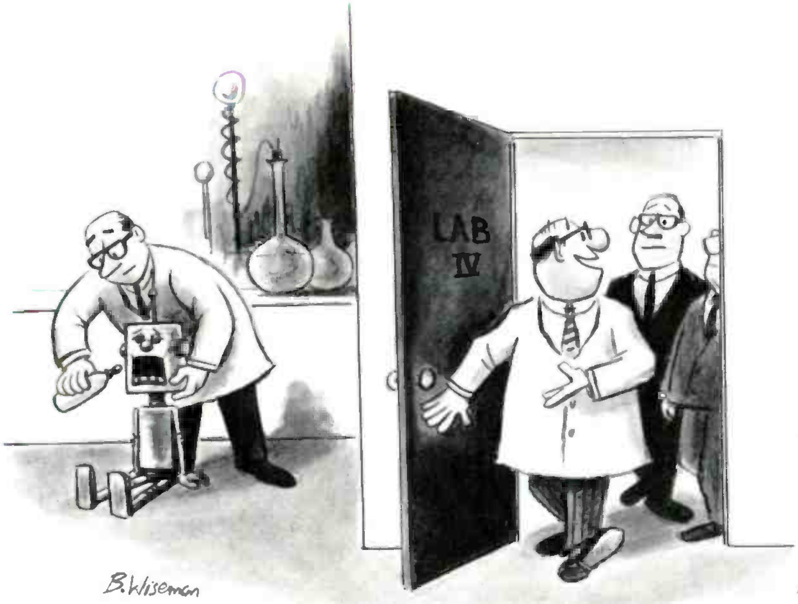
This decision is a nonlogical one, that is to say, it is entirely the desire of BestFit's top management—in this case, Mr. Smith's personal aim as an entrepreneur and businessman—and it may or may not be a good one. In any event, the data base for BestFit's Management Information System must be assembled in such a way that it contains only the information that will help the company achieve its target.

The list of attributes or factors that will have a bearing on BestFit's ultimate goal must now be reviewed. In order to achieve the company aim, maximum and minimum parameters must be established for advertising, personnel, inventory, and ratio of cash to credit sales. Clearly, the list can be continued, but what makes the job so difficult is that each of these factors that may bear on BestFit's goal must, in turn, be measured by a set of criteria. And this, once more, means making difficult decisions.

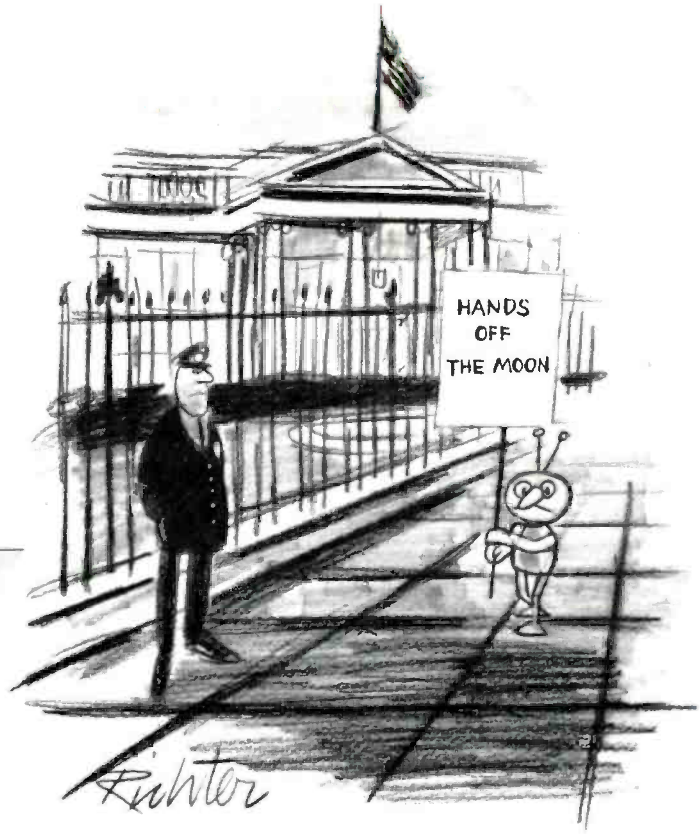
For example, after the optimum ratio of cash to credit sales has been decided, further policy must be laid down in the general area of credit. Should there be a credit charge? What credit limits should be established? What meaningful relationship, if any, exists between the cost of money and BestFit's credit sales policy? What is the maximum acceptable number of loss accounts? As any other organization, BestFit operates under external constraints, and so the data base should include information on legislation against credit sales to minors, on usury laws, on conditional sales, and deficiency judgment laws.

Altogether, this is a laborious procedure, and one that is staggeringly complicated for a large and diversified enterprise. But it is evident that information of this type is essential to the construction of a data bank for a total Management Information System of a dynamic business. Once it has been assembled, however, a data bank becomes the foundation upon which policies are built and guidelines set.

Whether static or dynamic, it becomes a repository to which management can repeatedly refer for help in that most difficult management process—making decisions. How well these decisions turn out will, in the last analysis, depend largely on how wisely the data bank was put together. ■



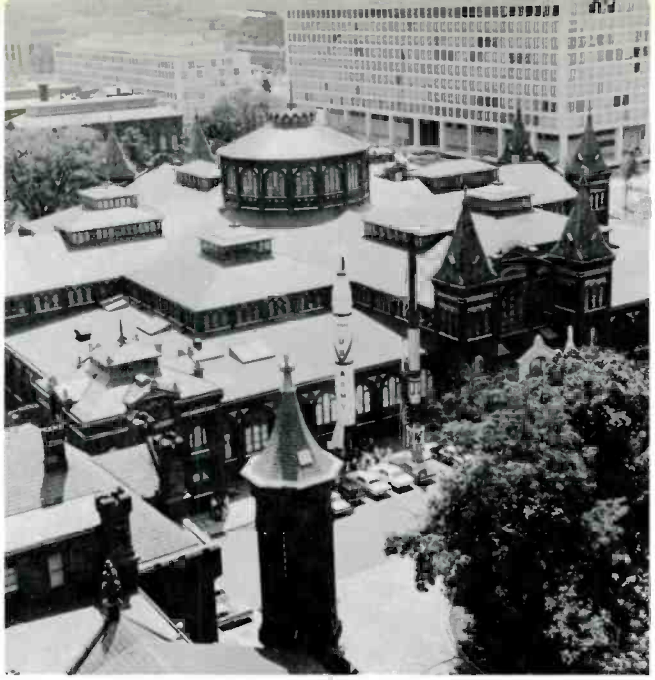
"I must warn you, gentlemen, it's in quite an early stage of development."



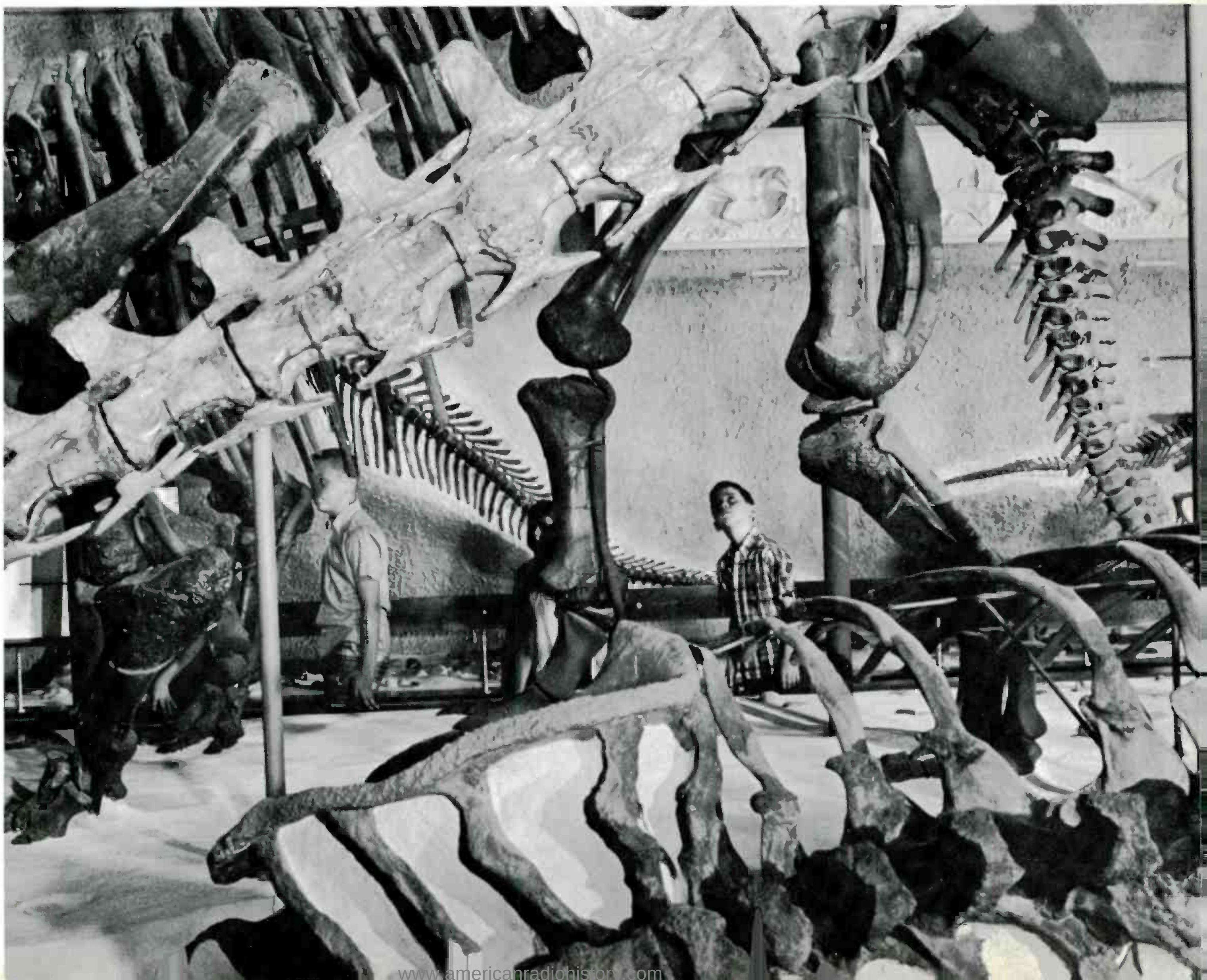
THIS ELECTRONIC AGE...

"LEARN!"

"Say, Forbes—Take 14 years and check this answer."



Exploring America's Treasure House



Each week, television is examining some aspect of the accumulated knowledge and activities of the largest museum complex in the world—the Smithsonian.

by Arthur Oppenheimer

The Hope diamond and hummingbirds' eggs, the Wright brothers' Kitty Hawk Flyer and a whale skeleton, one of the finest collections of Western art, antique cars and locomotives, the original Star-Spangled Banner that inspired our national anthem—these just hint at the entrancing array of exhibits that millions of visitors see at the Smithsonian Institution in Washington, D.C.

It is the largest museum complex in the world and one of the world's great centers for scientific research. Its varied collections range across the natural sciences, art, history, and technology.

Mark Twain once called the Smithsonian a "mildewed old fossil." Today, vigorous new life stirs within; its new halls are handsome, its old ones updated. It is spoken of as America's showcase, the nation's treasure house, the conservator of the country's cultural heritage.

Each year, more than 16 million persons view its exhibitions. As the guidebooks say, few, if any, other attractions surpass it as a magnet for tourists in Washington. A man with a statistical bent has estimated that, if a visitor spent one minute looking at each exhibited object,he would be a steady viewer for two and a half years. Yet, what he would be viewing represents but the choicest fraction of the 53 million catalogued treasures which the Smithsonian preserves.

The Smithsonian complex in Washington includes the Museum of History and Technology, the National Air and Space Museum,the Museum of Natural History,the National Zoological Park, and four art galleries: the National Gallery of Art, the Freer Gallery of Art (for ancient art of the Orient), the National Collection of Fine Arts, and the National Portrait Gallery.

More, the Smithsonian is a kind of functioning university. It runs a huge library and a publications division that issues scholarly books and monographs. It sponsors scientific expeditions. It operates a radiation biology laboratory. It maintains an island in the Panama Canal Zone where biologists study plants and animals in a natural environment. It has an astrophysical observatory at Cambridge, Mass., that runs 12 space-satellite tracking stations throughout the world. Its Traveling Exhibition Service circulates art shows to smaller musems and to universities throughout this country and Canada.

The Smithsonian was created by an Act of Congress in 1846 under the terms of the bequest of James Smithson, an English scientist. He left funds for the establishment of an institution for the "increase and diffusion of knowledge among men." Ever since, the Smithsonian has concerned itself with adding to the body of human knowledge and finding new ways to communicate this knowledge.

Now the electronic sight of television, the most comprehensive mass communications medium ever devised, is enabling the Smithsonian to fulfill the goal of its founder to a degree that he could not have conceived more than a century ago. Each week, a color television program is carrying some aspect of the Smithsonian and its varied activities to Americans in their homes across the nation, communicating its accumulated knowledge and discoveries to far more than the 16 million who are able to visit its museums in Washington each year.

The program series is being produced by the National Broadcasting Company, and it reflects a recognition within the Smithsonian that the Institute must meet the rising need for popular education and that it must use the popular agencies of television and motion pictures to reach those who do not visit its museums.

Last year, the first major Smithsonian motion picture was produced. This year, through NBC, the Institute is involved in its first major television activity. Its curators, exhibits staff, and other specialists are actively cooperating with NBC in the creation of programs drawing upon its vast resources and reflecting the wide range of its interest.

Sharing the Smithsonian's concern for quality and accuracy, NBC has assigned to this television series an outstanding NBC News production unit headed by Craig Fisher. It was Fisher who conceived the series. He is producing and directing the programs and writing most of them as well. An NBC News producer since 1962, he also conceived and produced "Exploring," a charming TV program for the young and the winner of a long list of awards.

NBC's educational consultant for the new series is Dr. Gerald Lesser, Director of the Laboratory of Human Development and professor of developmental psychology at Harvard University. He is a specialist in child development and motivation and in personality theory whose professional interests lie in applying psychology to the education of children.

The new enterprise, titled "The Smithsonian," is designed to be a lively and colorful program and is meant to entertain, inform, and, above all, stimulate the intellect. It is aimed primarily at the young, but, like the earlier "Exploring," it is certain to attract many adult viewers, too.

"The Smithsonian has in the past been called 'the nation's attic' and perhaps justifiably so," Craig Fisher says.

ARTHUR OPPENHEIMER is with the NBC Press Department.

"One of the aims of the series is to reflect the new, dynamic look and feeling of today's Smithsonian. Our approach in choosing as host an NBC newsman, Bill Ryan, is to treat the Smithsonian as today's news. Bill is covering the Smithsonian, both in Washington and on location, as other NBC newsmen cover the White House or the Pentagon or the latest science story which might well originate in the Smithsonian anyway. What we are attempting is to show the Institution as a place where the action is, where things of interest and concern in today's world are happening."

The new program got under way as a 26-week series on the NBC Television Network last October with "Treasure under the Sea," an adventure in underwater archaeology.

Following it, subjects being explored in individual shows include American inventors, American ships, American folk art, the artist George Catlin and his paintings of the American Indians. Going further, it is dealing with ecology, physical anthropology, systematics, meteors, solar radiation, conservation, aviation, osteology, political campaigns, Smithsonian expeditions, First Ladies, and sports.

Each of the programs originates from one of the Smithsonian's museums in Washington or from such Smithsonian research centers and field locations as the Chesapeake Bay Center for Field Biology and the Astrophysical Observatory at Cambridge, Mass.

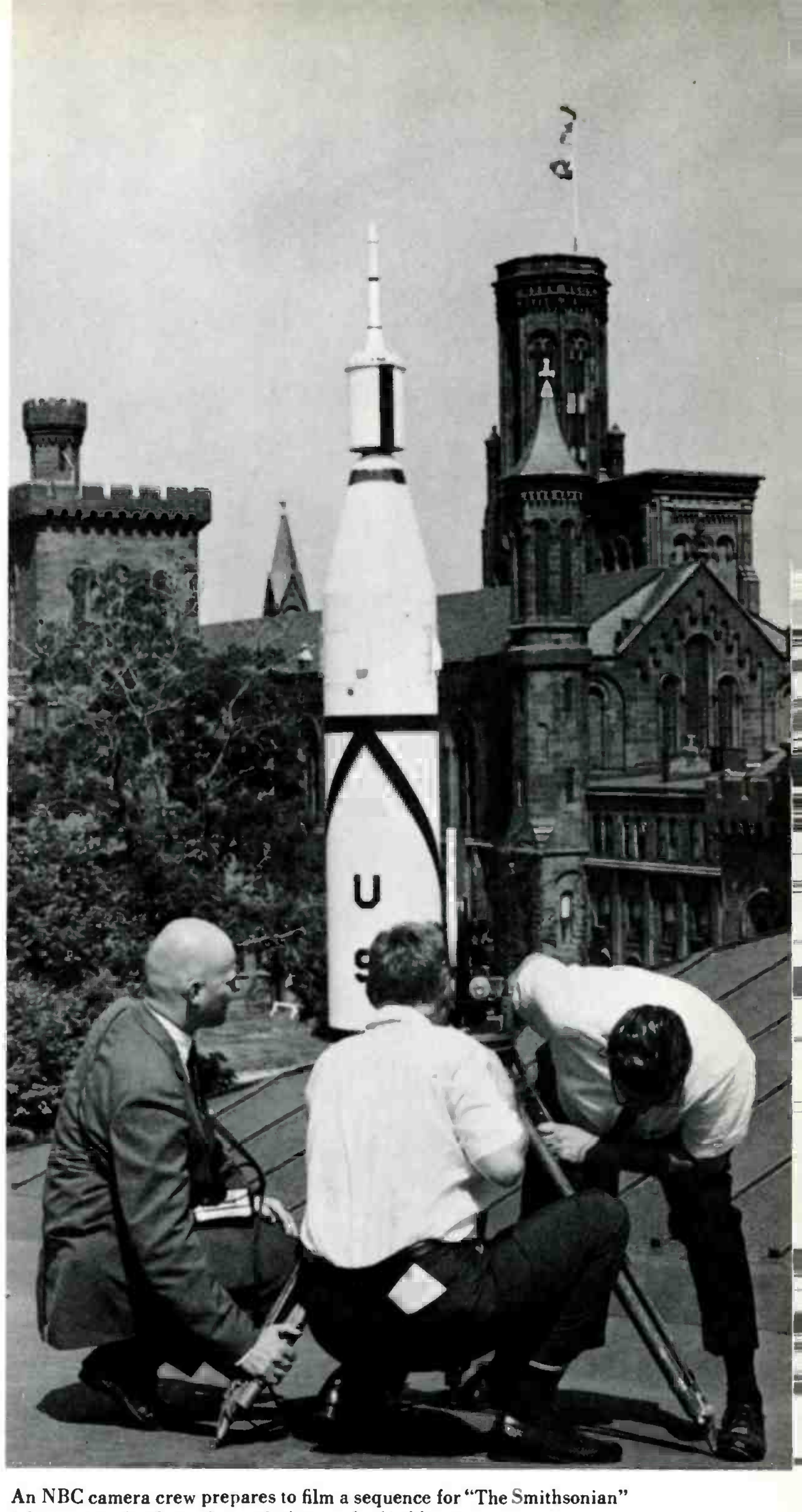
Television can excite the imagination far more than any exhibit. It can show the viewer field and laboratory work never seen by the museum-goer, and can correlate this background material to the subject. Television's camera close-ups enable the viewer to examine objects closely. In one program, television can bring together the knowledge and skills of many different scholarly disciplines.

But to exploit these possibilities requires unusual sensitivity and creativity, not to mention a great deal of labor, on the part of the production unit. And it requires a whole new range of skills in museum interpretation on the part of the Smithsonian. On a limited basis, the Smithsonian has already begun to develop a group of specialists who will assist the scholars in translating intellectual concepts and complicated bodies of knowledge into the popular media of television and motion pictures.

It is plain that what is wanted is more than simply opening the doors of the museum, photographing the exhibits, splicing it all together into a program, and expecting the result to leap into life. The exhibits, designed to be seen in a leisurely personal visit, would lose much in this way. The eye of the television camera must be accommodated. What is wanted is a *television experience*.

The producer's view of the Smithsonian as television experience was evident in "Treasure under the Sea." A Spanish galleon sunk off the coast of Bermuda in 1621 with a cargo of gold and silver was explored under water. The Smithsonian treasure ship is the *San Antonio*, one of hundreds of ships sailing between Spain and New Spain in the 16th, 17th, and 18th centuries. Bill Ryan joined a Bermudian diver and a Smithsonian curator at the site in Bermuda as the cameras took the viewer into the world of underwater treasure.

"Underwater shipwrecks are like accidental time capsules," Bill Ryan told the audience. "There, preserved in

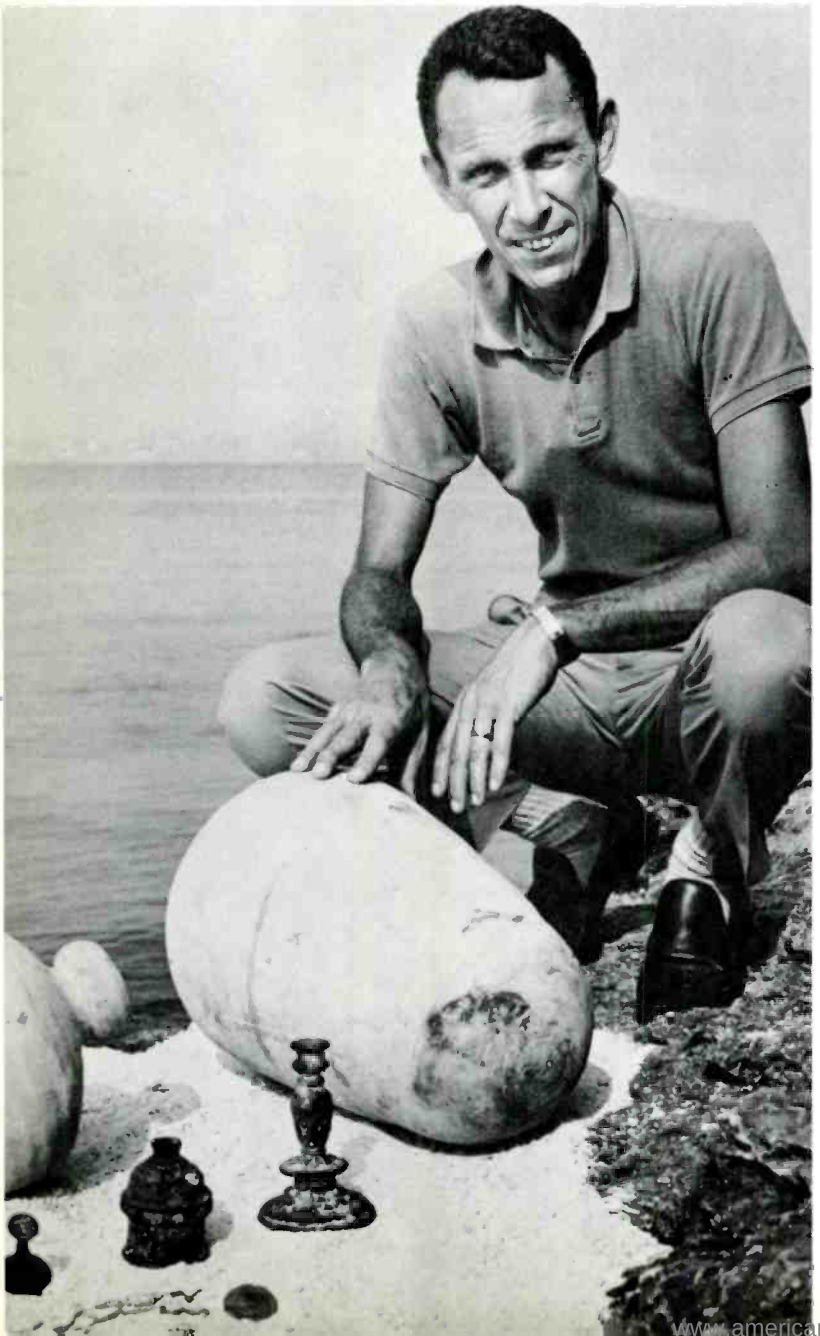


An NBC camera crew prepares to film a sequence for "The Smithsonian" television series from the roof of a nearby building.

"Smithsonian" host Bill Ryan examines objects recovered from a Spanish galleon sunk off the Bermuda coast.

one instant, in one place, is a mass of material that will tell historians and archaeologists about naval and commercial history that can be precisely dated. This is why the Smithsonian goes treasure diving."

Through animation, the program traced the voyage of the *San Antonio*, using the comments of contemporary seamen to describe the hardships, the poor charts, and finally the storm that drove her onto the Bermuda reefs. Tommy Tucker, a professional diver associated with the Smithsonian, described how he found the *San Antonio*. Dr. Mendel Peterson, the Smithsonian historian in charge of the expedition, explained the techniques used to find the artifacts left in the wreck. The cameras followed Tucker and Dr. Peterson in their underwater quest. An animated sequence traced the developments man has made to enable him to stay under the sea in diving gear. Other Smithsonian historians and technicians showed the new techniques they have developed to preserve the artifacts and wood, both at the site and at the Smithsonian. The program also explained how one goes about finding sunken ships and their treasures.



Another illustration of the Smithsonian as television experience was "The Flights of the Spirit of St. Louis and Friendship 7," which compared and contrasted Charles Lindbergh's transatlantic flight in 1927 with John Glenn's space flight in 1962. Historic film of both flights was shown. Both the Spirit of St. Louis, which carried Lindbergh across the Atlantic in 33½ hours, and the Friendship 7, which carried Glenn through the atmosphere for three orbits of the earth, are now in the Smithsonian, and viewers saw Colonel Glenn with them there. He talked about his space flight in the Friendship 7. Addressing himself directly to young viewers, he said: "Many people are afraid of the unknown, the future. If a man faces up to it, takes the dare of the future, with knowledge, he can have some control over his destiny. That's an exciting idea to me."

Political campaigns from the early days of the republic to the present were explored in "Tippecanoe and Lyndon Too." This was filmed in the Hall of Historic Americans in the Smithsonian's Museum of History and Technology. It showed the political campaign exhibit there—buttons, badges, cartoons, drawings, portraits, photos, and other memorabilia. It also utilized film clips to illustrate modern ways of campaigning.

American inventiveness was illustrated in "Build a Better Mousetrap." This was filmed in the Museum of History of Technology, where the cameras showed many of the inventions that have advanced America's technology, as well as models of others.

Bones—and the role they play in revealing the history of life on earth—was the subject of "Dem Dry Bones." This, too, was filmed in the Museum of Natural History and also along the banks of the Potomac River, where erosion by wind and water has worn down sedimentary rock and exposed prehistoric bones to view.

Sometimes filming within the Smithsonian creates problems. During one episode in the Dinosaur Hall, part of the hall had to be blocked off because of sound reverberation. A visitor appeared, asking, "Is the hall closed off?" Told that it was, he said to producer Craig Fisher, "Young man, I have come all the way from Ohio with my son to see this hall and we will not go back to Ohio unless we do see it." The curator, present during the filming, gave the man and his son a personally guided tour.

Dr. S. Dillon Ripley, who, as Secretary of the Smithsonian Institution, is its chief executive officer, believes that museums are more than repositories of the past. "Today's world," he says, "is one of rapid change, and perhaps if we interpret the role of museums correctly, we can bring them and their mission into far greater prominence in the world of tomorrow. Museums and their activities are playing a larger and larger part every day in our cultural scene."

The Smithsonian and NBC are determined that "The Smithsonian," an experiment in popular communication and education, will present a distillation of the Smithsonian's body of knowledge, and not a dilution. "We hope that our programs will maintain high standards of accuracy and quality," Dr. Ripley says, "and communicate to viewers, particularly the young audience, the excitement of the search for knowledge and greater understanding of man's intellectual and physical environment." ■

ANALYSIS
SIMULATI
PREDICTION
TEST AND
AUTOMATION

Computers and Engineering

by Bruce Shore

If the medieval bowman had been asked his opinion of the expected impact of gunpowder on archery, he might well have said that it would provide a faster, more accurate, and more flexible way of doing his regular job. A similar answer could be given by today's engineer if he were to assess the effect the computer will have on his profession.

Such a parallel should not be carried too far, however. Remember what became of the bowman after the Middle Ages! Gunpowder completely abolished him—or did it? Actually, it did not. It merely upgraded him from an archer to a rifleman and, ultimately, to the launch officer of a ballistic missile crew. In the process, the erstwhile bowman became better educated, better paid, and better equipped than ever before.

The stature and complexity of his profession have also gained. The launching of a Ranger payload to the crater Alphonsus on the surface of the moon—an extrapolation essentially of the bowman's art—is a far more exacting and intricate task than felling a deer in Sherwood Forest.

All of this is by way of saying that the computer will eventually have no less impact on engineers and engineering than gunpowder had on archery. It will be registered in several ways.

For one, the computer is going to intellectualize the practice of engineering to a degree inconceivable until now.

In the past, the engineer has resorted to pencil, slide rule, and T-square to fashion his new designs; a machine shop and mechanical skills to develop his prototypes; and a pilot line to evolve their manufacture. Now, in theory, all but the conception of the idea can be accomplished by computer in tandem with automatic tools.

Thus, instead of plotting his design on paper, the engineer will reduce it to a mathematical program. Instead of developing a physical prototype, he will construct a mathematical analogue and let it stand for his prototype. In addition, this analogue will take into account not only engineering matters but technological, operational, economic, and environmental factors that may be pertinent. The computer will then be asked to decide, in effect, whether the design is worth building. Waste and inefficiency in the design process will shrink to a minimum, hopefully, and ill-conceived products will never emerge from the computer.

There will be more to it than this, however. The computer will also make it possible for the engineer to consider the whole context in which his new design is to function. It will compel him consciously or unconsciously to think in systems rather than component terms. A greater emphasis on systems design will be the inevitable result. More and more, the engineer will conceive the system and let the computer work out the components.

Finally, there is the somewhat imponderable but intriguing matter of the modifications and innovations in his design which will stem directly from the man-machine interaction that results when he works with a computer. There is a modern anthropological theory that progress is the result of man's interaction with his own tools. It holds that the evolution of civilization has been and is a great boot-strap opera-

BRUCE SHORE is the staff writer at RCA Laboratories.

SYNTHESIS
ON DESIGN
MONITORING
CHECK-OUT
MIS

In a wide variety of engineering design, test, and manufacturing applications, computers are proving to be increasingly valuable.

tion that has seen man invent tools, which experience then causes him to modify and differentiate until ultimately they inspire the invention of still more tools, which then are modified by experience and lead to yet newer tools, and so on.

If this is so, and all evidence seems to indicate that it is, then an engineer interacting with a computer may not only find the best way to implement a preconceived design but may very likely come up with an altogether new design that he had not even considered at first. In other words, he may start out to design a particularly effective club and wind up inventing the hammer. Historically, it took many generations and much accumulation of experience over the ages for this to happen. Presumably, with a computer at his disposal, man will be led to such invention much faster.

Before matters reach this pass, however, there will have to be a long period of transition during which computers are sampled and tested in a variety of design and manufacturing applications. This is the stage in which many modern companies find themselves today. At RCA, for example, there are at least eight identifiable ways in which computers are being exploited to aid and abet the varied engineering programs of the Corporation.

Analysis—One of the key ways to improve a product or its performance is to analyze every detail of its structure and operation so as to discover any flaws or imperfections that may limit its ability to carry out its assigned task. RCA is doing this constantly with components that are used in the field of electron optics—a field that includes the cameras and kinescopes of television systems, the oscilloscopes used to display radar wave forms, and the video-scan type of equipment used to "read" bank checks and to recognize simple patterns without the intervention of a human operator.

Synthesis—There are many possible products, techniques, or systems whose potential value is uncertain. For this reason, they are never tried. Yet, if they were, they might prove of surprising usefulness. With a computer, it is now possible to synthesize and evaluate such items in the form of a computer program. RCA is currently doing just that with such esoteric communications paraphernalia as all-pass networks and their circuit elements, ladder networks, and novel radar wave forms. Soon, the technique may be applied to new semiconductor devices, new schemes for organizing computers, and new processes for making integrated circuits.

Simulation—How will a new product or system behave when it is installed in a work environment? What are its weak points? How long will it go before maintenance is required? These were matters that, until now, could only be guessed at, short of actually installing the equipment and watching to see what happened in the course of time. Now, it is possible to build a mathematical model of the product, plus its intended work environment, and to let a computer simulate the real situation. RCA recently did this with a new frequency-shift-keying (FSK) receiver destined for military application. The results were impressive and have given impetus to proposals to adapt the same technique to a growing list of our latest engineering designs. The savings which this technique promises in materials cost and engineering time are significant.

Design—At the moment, RCA is content to have its engineers use computers to assist in the design of components and subassemblies rather than of whole systems. Even here, though, computers are proving of enormous value. Some areas where they are being applied include the design of precision filters and telecommunications networks; heaters for the cathodes of certain vacuum tubes; solar cells for the highly successful Lunar Orbiter program and solar cell power supplies (including batteries) for spacecraft of all types; multilayer printed circuit boards crucial to the development of RCA's new Spectra 70 computer family; and for the design, development, and documentation of many other pieces of electronic gear.

It is also in connection with the use of computers in design that the "electronic sketchpad" has been developed as a new and very powerful tool to assist the engineer in creating new products.

Essentially, the electronic sketchpad is a TV console linked directly to a computer. When a so-called "light-pen" is moved by hand across the face of the TV tube, its position from moment to moment is sensed and recorded in the memory of the computer. This memory, in turn, causes an electron beam in the tube instantaneously to describe a light pattern on the tube face identical to that drawn by the engineer. Thus, a line drawing in light of the engineer's design is displayed and can be changed or erased at will by the engineer.

In addition, depending on the engineering data and instruction program which have been committed to the computer, the drawing can be blown up, rotated, put in perspective, or stored for later recall. With such a device, the engineer and the computer can interact directly with each other, and the chances for novel and realistic designs of new products are greatly enhanced.

Though RCA engineering has not yet turned to this highly sophisticated system for augmenting the design process, the basis for it doing so is already being laid with the development of a time-sharing computer in Cherry Hill, N.J., and a magnetic pen for "writing" information into it at its plant in Van Nuys, Calif.

Prediction—In electronics generally and in space electronics in particular, it is vital to be able to predict what will happen to a component or system under various conditions. In space, for example, it is imperative to know quickly and accurately what the launch trajectory of a missile will be, what the orbital position of an earth satellite will be at any given moment, what its lifetime will be, when retrofire should take place to bring it back to earth, and the like. These are critical questions on whose answers a man's life may depend. RCA is using computers to make such predictions all the time, especially as part of the RCA Service Company's role in operating the global communications and tracking network fanning out from Cape Kennedy. Furthermore, RCA is also using computers to predict the thermal characteristics of new and untried spacecraft presently under development.

Monitoring—How does the performance of a system or article of equipment change or degrade with time? When and in what sequence do these alterations occur? Notwithstanding the importance of knowing the answers to these questions, especially with regard to equipment that may have to operate unattended for months or years in remote locations or in space, it is extremely arduous, if not impossible, for a man to keep track of a gauge or a fluctuating column of mercury or a noise level that is changing ever so slowly in a process that may take days, or months, or even years. However, such a tedious monitoring process is routine for a computer. It is ever alert. Consequently, RCA has begun using computers to monitor the performance of photomultiplier tubes and other types of electronic components.

Test and Check-Out—At the systems level, where so many things can go wrong and everything must be followed simultaneously, the computer offers the only practical solution for doing such a multifaceted job. In this role, computers have been used by RCA to check out the performance of the A6A Navy attack aircraft, the Saturn rocket, and several missile systems such as the Mauler and the TOW. They have similarly been used to test all the subsystems of the BMEWS radar installations in Alaska, Greenland, and England.

Automation—If it is possible to use a computer in each stage of the product creation process from design to assembly line, it is theoretically possible to put the whole process under the control of one master computer, providing it has a big enough memory to store all the necessary data and instructions, and sufficient versatility to control a bank of automatic tools for acting upon them. This is the most difficult and least understood area of computer application. Still, RCA has made limited and impressive strides in this direction. For example, RCA has developed programs that adapt computers to the job of detecting, tracking, and identifying orbiting spacecraft automatically, and has made some progress in evolving a system that will help in the design, drafting, and blueprinting of a new product.

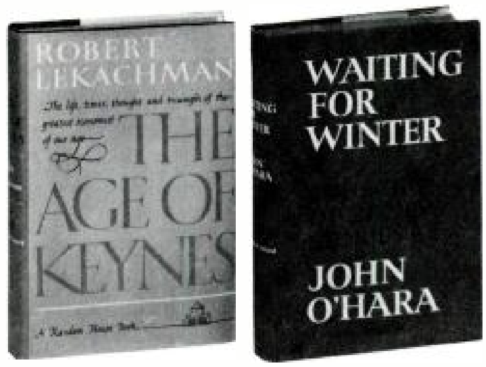
This latter application is based, in part, on the use of a machine known as an "automatic co-ordinatograph," a device that will take a computer-generated tape and convert its instructions to blueprint-type drawings as does an automatic draftsman.

Finally, there is still another—a ninth way in which RCA is planning to use computers in the engineering profession. This would be in the management of the company itself. If the work that engineers do can be rationalized and reduced to a series of computer programs, then so can the needs and relationships of the engineers themselves, at least insofar as their work is concerned.

To explore this interesting and complex area, RCA has recently established a program entitled Management Information Systems (MIS, for short). As presently implemented, the purpose of this program is to develop mathematical models which accurately represent and clearly describe the activities of the various product and service divisions of the Corporation. When these have been successfully developed and truly reflect the interplay of materials, costs, and personnel of any and all divisions on a monthly, semiannual, and annual basis, they will form an instant and powerful source of information on which both divisional and corporate management may depend for planning and decision-making.

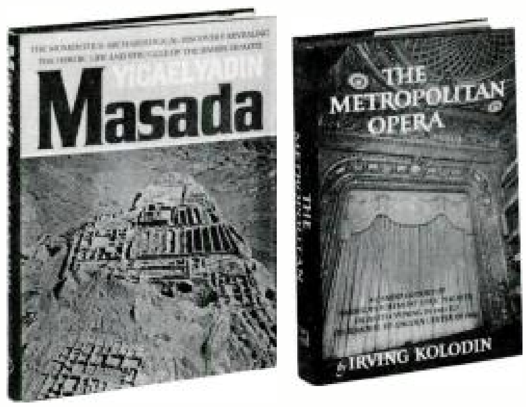
A rising level of abstraction in the practice of engineering, an accelerated use of automatic tooling, a growing shift away from component to systems design, and a mounting consolidation and integration of the management of these activities—these are just a few of the more immediate and far-reaching ways in which computers are going to influence engineering and engineering companies in the days ahead. ■

Age of Keynes, by Robert Lekachman (Random House). The first major work in 15 years on the life and ideas of the century's most influential economist, John Maynard Keynes, is also notable for its readability and general interest. It spans some 40 years in Keynes' public life. The author, who is Chairman of the Department of Economics of the State University of New York (Stony Brook), defines Keynes' concepts and their vast effect on the governments of Great Britain and the United States, and emphasizes Keynes' continuing importance as the progenitor of the Kennedy and Johnson tax cuts and such Great Society programs as the war on poverty, medicare, and aid to education.



Waiting for Winter, by John O'Hara (Random House). A new volume of short stories by one of America's greatest writers and acknowledged master of the short-story form. Four of the 21 stories are of novella length, and only nine have appeared in print before. It is his fifth volume of stories since he resumed writing them in 1960. A limited signed edition of the book is available. Since the publication of his first novel, *Appointment in Samarra,* in 1934, John O'Hara has been represented on the American literary scene with a variety of books that have drawn both critical praise and popular acclaim. The roster of his works includes 13 novels and 12 volumes of short stories.

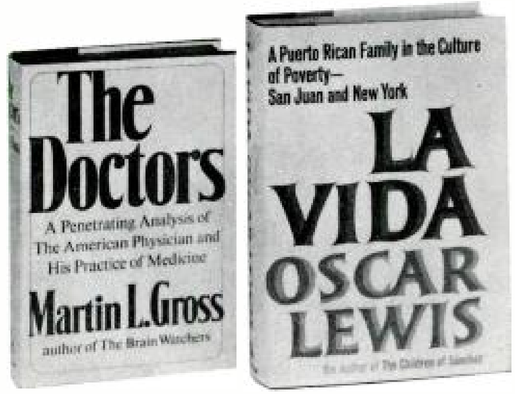
Masada, by Yigael Yadin (Random House). A dramatic and handsomely illustrated account of one of the most significant archaeological excavations of modern times at Masada, in Israel. Masada, King Herod's desert rock fortress, was the scene of the heroic stand of 960 Jews against 15,000 Romans in the years A.D. 70 to 73. In telling the story of the modern archaeological expedition to uncover Masada, Professor Yadin—who is Professor of Archaeology at Hebrew University—gives an exciting account of the courage and heroism displayed by a small band of Jewish defenders nearly 2,000 years ago. The book is illustrated with over 200 photographs, half of them in color.



The Metropolitan Opera, by Irving Kolodin (Knopf). A revised, completely redesigned, and greatly expanded version of Kolodin's earlier books on the Metropolitan Opera, beginning with its opening on October 22, 1883, to its last performance in the old house at Broadway and 39th Street on April 16, 1966. The author of three previous books on the Metropolitan Opera, Kolodin tells the story of the conception and creation of the "new Metropolitan" at Lincoln Center and provides a complete listing of the Met's repertory. Scrupulously researched, the book is not an official history but a free report by a longtime critic and enthusiast of America's foremost lyric theater.

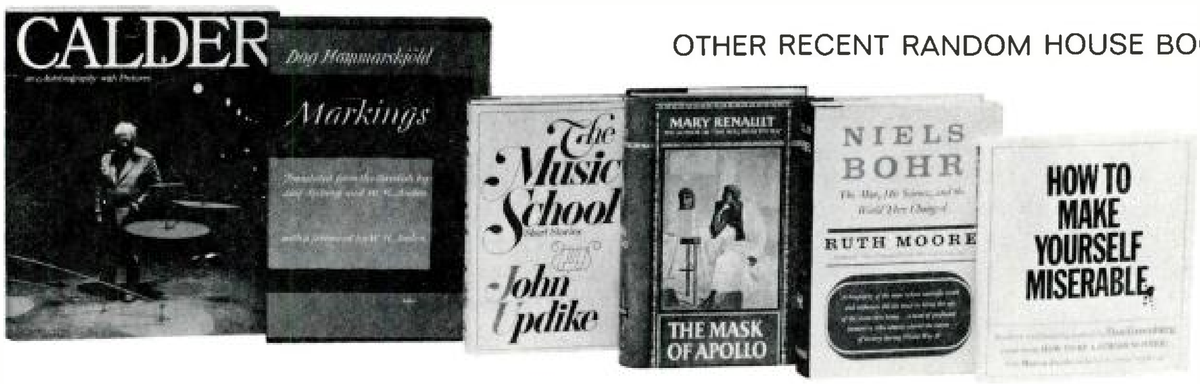
Books at Random...

The Doctors, by Martin L. Gross (Random House). An analysis of the American physician: his practice, his profession, and his patients. A controversial, iconoclastic book that rips aside the "gauze curtain" of medical secrecy and for the first time reveals the true anatomy of one of the most important men in one's life—the American doctor. Gross delves into his competence, his practices, his personality, and his medical education and analyzes his scientific failings in detail. The result is a provocative social document that examines all the components of modern medicine and concludes that the modern physician in general is scientifically and philosophically wanting.



La Vida, by Oscar Lewis (Random House). Oscar Lewis's study of a poor family in Mexico, *The Children of Sanchez,* was hailed as not only a major achievement in sociological studies but a literary landmark as well. In his new book, the poor speak as eloquently for themselves as they did in his prior work. The study is an explosive one, plunging the reader into the lives of American citizens who live on a level of deprivation largely unknown or ignored by our affluent society. With frank, first-person life stories of a Puerto Rican mother and her family, Oscar Lewis depicts the terrible abuse and waste of talent and human resources which is the real tragedy of the culture of poverty.

OTHER RECENT RANDOM HOUSE BOOKS



Phase Alert

by Robert L. Moora

The voice on the public address system was matter-of-fact. "Attention, please. There is a phase alert at J-Site...."

The men seated in the cafeteria went on with their lunch and conversation. To all outward appearances, the words meant nothing to them. But, underneath, every one of them knew the ominous significance of the announcement.

"Phase alert at J-Site" meant that a windstorm was brewing on the Greenland Ice Cap that looms just four miles across the frozen waste from the Ballistic Missile Early Warning System (BMEWS) base—some 600 miles north of the Arctic Circle. J-Site, named for its alphabetical position on the list of locations considered, is a massive radar installation—a vital link in the network of electronic sentinels guarding against missile attack on North America. And most of the men at lunch in the base cafeteria were to go by convoy in mid-afternoon to the radar site to begin the four-to-midnight shift.

Phases at Thule are measured in three classifications: Phase 1, with winds up to 30 knots, when pedestrian movement outside must be by the "buddy system" and travel between Thule Air Force Base and the radar site, 13 miles to the north, must be authorized; Phase 2, with winds up to 50 knots, at which time personnel must remain in buildings except when authorized to travel for emergency purposes; and Phase 3, with winds roaring at perhaps 75 to 125 knots, when no movement is permitted outdoors except for rescue purposes.

Should a phase develop—and one can sweep off the Ice Cap without warning—it could mean winds of 100 miles or more an hour hurling snow and ice crystals across the radar site and the 13-mile road that leads to the air base, where the operating and support crews live. It could mean vehicles stuck in snowdrifts—vehicles ranging from pickup trucks and patrol cars to giant graders and snowplows—and it could mean busloads of men stranded for hours out on the road, with snow drifting around them and only the diesel engines to keep them warm until help arrives. Such storms are an ever-present threat to the civilian and military personnel who man the big electronic warning base at Thule.

In routine language that belies the drama and danger involved, the story of the phases is told in the dispatcher's logs filed away in the office of a man named Max L. Gullette in a big garage at the air base. Max runs the motor pool—more than 100 vehicles of amazing variety—for the RCA Service Company, which is the prime contractor to the Air Force for the operation and maintenance of the Thule warning base. In the dispatcher's logs are the minute-by-minute accounts of all that transpired in the hundreds of phases that have struck Thule during the past eight years of construction and operation.

Max Gullette has been through every one of these phases. In his four-man pickup truck, he has led the bus convoys through snow, driven horizontally by 100-mile-an-hour winds. At times, he has guided the lead bus on foot the last up-hill mile to J-Site.

Hale and robust at the age of 59, Gullette is probably the world's foremost expert on motor transport in the Arctic. He cannot estimate how many thousands of miles he has driven over hazardous Greenland roadways in the last eight years. However, he does remember a one-month period in 1963 when he drove some 3,000 miles seeing only the red reflectors marking the shoulders of the road. Virtually everything else was obscured by the blinding snow and darkness. He was one of the first three RCA men who arrived at Thule back in 1958, and, as an Air Defense Command publication expressed it, "Max took to Thule like a bull-walrus to nearby Wolstenholme Fjord." He has never left the desolate but beautiful Greenland wastes, except for brief vacations with his family in Rockville Centre, Long Island.

Seated behind his desk, in white shirt and business suit, Max looks more like a Wall Street broker than a man who,

ROBERT L. MOORA is a public affairs writer for the RCA Defense Electronic Products group.

at J-Site

The sudden Arctic windstorm, or phase, is a constant threat to the men who service the huge radar warning installation in Greenland.

Max Gullette, who is in charge of the RCA Service Company motor pool at Thule, is probably the world's foremost expert on motor transport in the Arctic.

donning parka and "iron pants," will walk a mile through a hurricane-force snowstorm to find a lost bus. To the Danes who work for him—there are 23 in his force of 37—he is "den gamle ged" or "the old goat." One man who works with him says he is "the most fascinating man I've ever met." Another says, "Next to the power supply, I think Max has been the biggest single factor in keeping the Thule base in operation."

Max knows the snow-packed road between base and site more intimately than his wife's neighbors in Rockville Centre know the block they live on. The road is unique among the world's highways. About the width of a stateside country road, it is just sufficient for two large trucks to pass. It is lined with three-foot steel rods topped by red reflectors, about 50 feet apart on the straightaways, much taller and closer on the curves. These are the only means by which a driver can follow the road during a phase. Their importance is best indicated by this notation in the dispatcher's log—"visibility, one reflector."

Along the road are nine emergency shelters, each capable of providing cozy but cramped refuge for a dozen men—more if the situation is critical. Inside are the essentials for survival—a stove, kept going from September 1 to June 30, food, water, first-aid kit, shovels, rope, a double-bunk bed, and numerous other items, the most important of which is a "hot-line" telephone to J-Site that is answered immediately when the receiver is lifted. Just as important are two items outside each shelter—huge barrels filled with rock, one on each side and linked by cable over the structure to keep it from blowing away in a Phase 3.

There are stringent rules for vehicular traffic at Thule. Speed limit is 20 miles an hour on base, 30 on the road. Seat belts must be buckled. Men leaving the base for the radar site must notify the dispatcher by car radio—"Hilltop, 603, base to site"—and check in upon arrival—"Hilltop, 603, on site." If the driver fails to check in within a reasonable time, a patrol car is sent out.

Parking brakes are never set, for they would freeze in minutes. Wheel blocks are used instead. Motors are always kept running outdoors, or plugged into "hot lines" at many of the buildings. Patrol cars carry "jump cables" to start stalled engines. The vehicles themselves—all standard production models except for the addition of carburetor heaters and the "hot line" plugs—are fed a half-pint of alcohol in every tankful of gasoline as a further carburetor antifreeze.

Through the years, Max and his motor pool force have learned, frequently the hard way, how to conquer the elements along the road to J-Site. One of their "hard way" lessons came in February of 1963. The lesson was—never try to turn a convoy around in a Phase 3.

The year 1963 was the worst phase year in the history of BMEWS. From December 27, 1962, until April 1, 1963, there was almost continuous phase weather. On February 3, with two days of phase already behind, a convoy of seven buses, one of them empty for emergency use, left the Air Base at 4:10 P.M., already 40 minutes late. In it were 147 men due on the four-to-midnight shift at J-Site. The storm had dropped to a Phase 1, but still there were vehicles stuck in the snow on the road ahead, and men were taking refuge in the shelters.

At 4:28, one of the convoy buses stalled near Shelter 5, about halfway to J-Site. Its passengers moved to the empty bus. By now, the winds had risen again to 70 or 80 miles an hour. The temperature was around zero. Three hours later, the winds would reach 100 miles an hour.

The convoy edged forward at five to 10 miles an hour, its progress slowing with every minute. At 4:53, near Shelter 6, the lead car carrying Max Gullette halted. Word had come from base headquarters. "Turn around and return."

Max got out of his pickup. Shielding his face against the driving sandlike snow, he began the arduous task of getting the bus turned around.

By 5:35, only two buses had been turned. At 6:16, a patrol car stalled nearby, and its driver took refuge in a bus. It was obvious now that the convoy could not be turned. With agonizing slowness, the vehicles were moved into a semicircle around the shelter, their windshields facing the fury of the storm. It was 6:35 P.M.

There the men sat through the rest of the night, the diesels running to keep warmth in the buses. At 11:55, one of the diesels stopped, out of fuel because of a leak. At 1:20 A.M., the vehicle's passengers abandoned the bus and moved into Shelter 6.

Just past midnight, Max ordered the bus drivers to maneuver into position for return to base. The snow was drifting badly—in places up to five feet. Meanwhile, down the road, a "trackmaster," specially built for use in snow and ice, had picked up men stranded in a patrol car and bulldozer. They joined the convoy.

At 2:20, the convoy set out slowly toward the base. Ironically, each driver assumed that someone else had picked up Max Gullette. But "the old goat," checking to see that every vehicle got off, found himself alone and afoot on the J-Site road, now swept by winds of 60 miles an hour. Face buried in his parka, Max trudged on after the convoy and caught up with it at the next shelter where it had stopped while a drift was being cleared.

There were further troubles ahead—a brake failure, a bus stuck in a drift, another stalled because of clutch trouble caused by the cold. But at 5 A.M., the dispatcher was able to make this notation in his log, "0500, all vehicles returned to motor pool."

Max Gullette is an affable man who wins the affection of most of his fellow workers. But he is tough when it comes to enforcing his rules for driving in the Arctic. "Let a guy neglect his fuel supply and run out of gas on the road to J-Site and he's on the next plane home," he says.

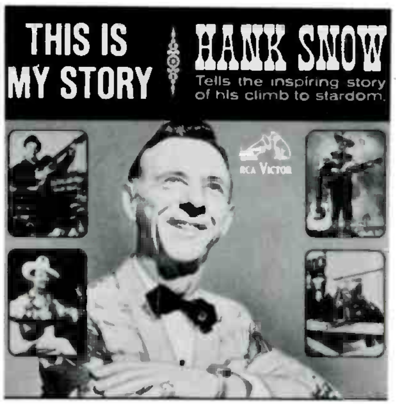
His insistence on minding the book, plus his drivers' awareness of the risk they run if they do not, have paid off. As the long dark nights of the 1966–67 winter approached, the RCA motor pool was brightened by receipt of a citation from the Air Force for having not a single reportable accident in a year. A scratch on the fender is not reportable; a dent is. Actually, the accident-free period now stretches closer to two years, and Max boasts that his buses have driven about 50 million passenger-miles without a mishap.

Max Gullette and his motor pool force are proud of the record. Particularly so, because they are driving motor cars in one of nature's severest environments to support the big electronic watch tower sitting on top of the world. ■

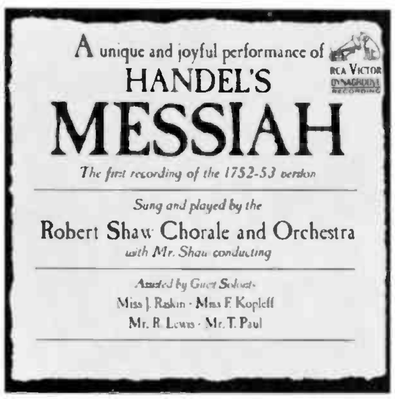
"THIS IS MY STORY"—HANK SNOW *(RCA Victor LPM 6014/LSP 6014[e])*. Veteran country singer Hank Snow is currently celebrating his 30th anniversary as a recording artist with RCA Victor. On the first record of this anniversary album, Hank tells the story of his life from his poverty-stricken childhood in Nova Scotia to his current success as a leading star of "Grand Old Opry" and a prosperous citizen of Tennessee. Hank tells his story in his own easy-going Nashville style, against a musical background of some of his biggest hits.

"SPINOUT"—ELVIS PRESLEY *(RCA Victor LPM/LSP 3702)*. Elvis' newest original soundtrack album is taken from the new movie, "Spinout," in which he plays the part of a band leader and sports-car racer with too-many-girls problems. In addition to the nine songs from the motion picture, there are three bonus hits by Bob Dylan: "Tomorrow Is a Long Time," "Down in the Alley," and "I'll Remember You." The "Spinout" tunes are a balanced blend of heart-throbbing ballads and up-tempo numbers which Elvis puts over with his usual aplomb.

"LOVE FOR LOVE": *The National Theatre of Great Britain production, starring Laurence Olivier (RCA Victor VDM/VDS 112)*. Peter Wood's production of William Congreve's wise and witty 1795 satire on the foibles of fashionable London was the big hit of the last London theatrical season. With a splendid British cast headed by Laurence Olivier, the National Theatre production was recorded by RCA Victor under simulated stage conditions. The result is a highly realistic recording of an enduring masterpiece of the English-speaking stage.



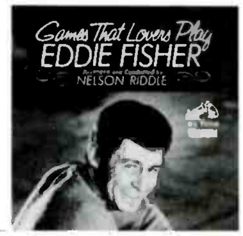
For the Records... NEWS OF RECENT OUTSTANDING RCA VICTOR RECORDINGS

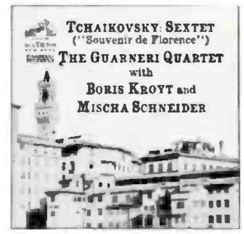


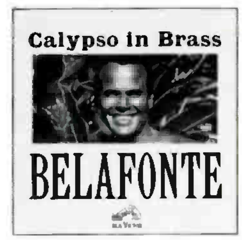
BEETHOVEN: "LES ADIEUX" SONATA; MOZART: SONATA IN C, K. 330: *Van Cliburn, pianist (RCA Victor LM/LSC 2931)*. For his first solo album in five years, Van Cliburn has selected two gems of the piano repertoire. When he played the Mozart Sonata in Moscow in 1958, on the occasion of his winning an award at the International Tchaikovsky Competition, he was compelled to rise four times to acknowledge the applause of his enthusiastic Russian audience. For his playing of this and other outstanding repertoire (Chopin, Schumann, Tchaikovsky, Rachmaninoff) he has been hailed by music critic B. H. Haggin as "one of the most distinguished musicians who have played the piano."

HANDEL: MESSIAH: *Robert Shaw Chorale and Orchestra with Robert Shaw conducting; Judith Raskin, Florence Kopleff, Richard Lewis, Thomas Paul (RCA Victor LM/LSC 6175)*. Surprisingly enough, this is the first recording of the world's most popular major choral work by America's leading choral conductor. For this first recording of the 1752–1753 version, Mr. Shaw used four superb soloists, a small mixed chorus, and orchestra. The performance had been thoroughly rehearsed and practiced during a 30-city tour conducted by the Chorale last winter. One enthusiastic critic wrote in the *Chicago Daily News*, "This was the best over-all performance of 'Messiah' I have ever heard."

"MY FAVORITE HYMNS"—LEONTYNE PRICE *(RCA Victor LM/LSC 2918)*. Brought up as a churchgoer in her native Laurel, Miss., Leontyne Price, now a resident of New York City, enjoys the evening prayer service at St. Thomas Episcopal Church, with its famed Choir of Men and Boys. Fresh from her triumph in the title role of "Antony and Cleopatra" at the opening night of the new Metropolitan Opera House, she joins the superbly trained choir in performances of "Lead, Kindly Light," "Holy, Holy, Holy," "Ave Maria," "The Lord's Prayer," "I Need Thee Every Hour," "Fairest Lord Jesus," "Bless This House," and other hymns that have deeply inspired her through the years.

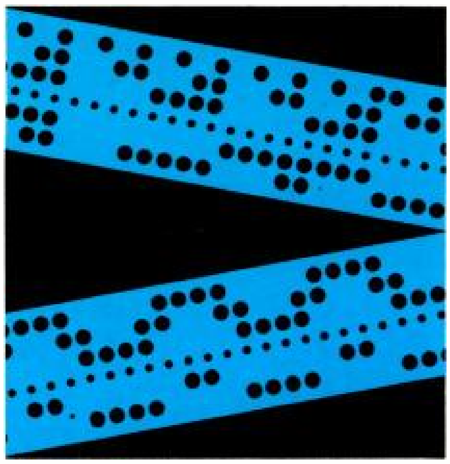






OTHER CURRENT RELEASES

Electronically



Speaking...

VIDEO DATA TERMINAL

A new self-contained video data terminal, when coupled with computers and mass storage memory devices, promises greater convenience for office and other workers in quick need of information. For instance, through use of the device a loan officer in a bank will be able to review a customer's credit history without a time-consuming file search. Similarly, tellers can check account balances instantly, and insurance branch offices can have direct access to home-office files.

The terminal, the newest member of RCA's Spectra 70 family of data processing equipment, can display up to 1,080 letters, numerals, or other symbols on a 12-inch screen of a cathode-ray tube at the rate of 120 characters per second. Resembling a portable television set attached to a typewriter keyboard, the terminal houses the video screen, keyboard, controls, and power supply in a single compact unit. Third-generation integrated circuitry will enable the device to perform with greater reliability, less maintenance, and lower cost.

SUPER POWER

A superconductive magnet capable of generating a magnetic field 250,000 times more powerful than the earth's will soon be available to the nation's research laboratories for experiments in such fields as high-energy physics, plasma phenomena, medicine, and biology.

Superconductive magnets are designed to control hot streams of charged particles employed in hydrogen-fusion research, magnetohydrodynamic generation of electric power, atomic-particle accelerators, and certain space-propulsion systems. Their immensely powerful magnetic fields come from cooling certain man-made superconductors, such as niobium-tin, to the temperature of liquid helium and then applying an electric current.

The industry's first commercial line of these magnets, manufactured by RCA's Electronic Components and Devices organization, will have field strengths ranging from 60 to 125 kilogauss. (A kilogauss is a unit for measuring magnetism.) All the RCA magnets utilize an RCA "VAPODEP" superconductive ribbon, in which niobium-tin is vapor-deposited onto flexible stainless steel and then electroplated with silver.

The new magnets are expected to be particularly useful to small- and medium-sized research laboratories for carrying out high-field magnet experiments that have heretofore been impossible because of the high cost of generating immensely strong magnetic fields.

FULL-COLOR NETWORK

On November 7, the NBC Television Network became the first network to present its entire schedule—daytime, nighttime, weekend—in full color.

The last black-and-white program series in the NBC-TV schedule to switch to color was "Concentration," a daytime game show that has been on since 1958. The program opened in black-and-white, but then host Hugh Downs signaled the transformation to color with a snap of his fingers.

NBC-TV telecast the first publicly announced program in compatible color on August 30, 1953. The color era began the following year when the network broadcast a total of 68 hours. The amount of NBC color hours increased annually, from 216 in 1955 to 4,200 in 1965–66. Earlier this year, NBC-TV became the first television network to present all of its regularly scheduled news programs in color.

FREIGHT-CAR FINDER

Keeping tabs on 150,000 freight cars operating along 11,000 miles of track can be a railroad dispatcher's nightmare. This task will be considerably simplified for the affiliated Chesapeake & Ohio–Baltimore & Ohio systems with a computerized communications network that will not only pinpoint the locations of all their cars but will provide a high-speed teleprinter message-switching system.

The elaborate system consists of four RCA 3301 computers. Two will control the message-switching system at the company's Huntington, W.Va., facilities. They will be linked to another pair of computers, which will handle message switching as well as control an electronic car-tracing file at the C&O–B&O headquarters in Baltimore.

In keeping track of train movements, the new system will work in this way: A "consist"—a report prepared for each train listing all freight cars, their contents, origin, destination, name of shipper, and so forth—is transmitted via teleprinter to the next yard or terminal on a train's schedule. A copy of the teleprinter message is sent automatically to Baltimore where the information is fed into an RCA random access storage unit, which maintains a continual inventory on all cars on C & O–B & O lines. In addition, the information will be stored electronically for immediate recall by one of three RCA Video Data Terminals. Data that are never more than a half-hour old will thus be available upon inquiry on every piece of rolling stock in the two railroad systems.

NEW PACKAGING TECHNIQUE

An advanced process has been developed by RCA Laboratories that not only improves the performance of integrated circuits but also affords a simple, reliable, and inherently low-cost means of packaging them for use.

The need for improved performance of integrated circuits has been recognized for several years. For example, a single silicon transistor is capable of responding to a radio signal oscillating at frequencies up to 1 billion cycles per second or above. In contrast, transistors in integrated form presently respond to maximum frequencies of only about 200 million cycles per second. The difference between the two responses may be ascribed in general to a lack of isolation between devices, which has been a characteristic of integrated circuits.

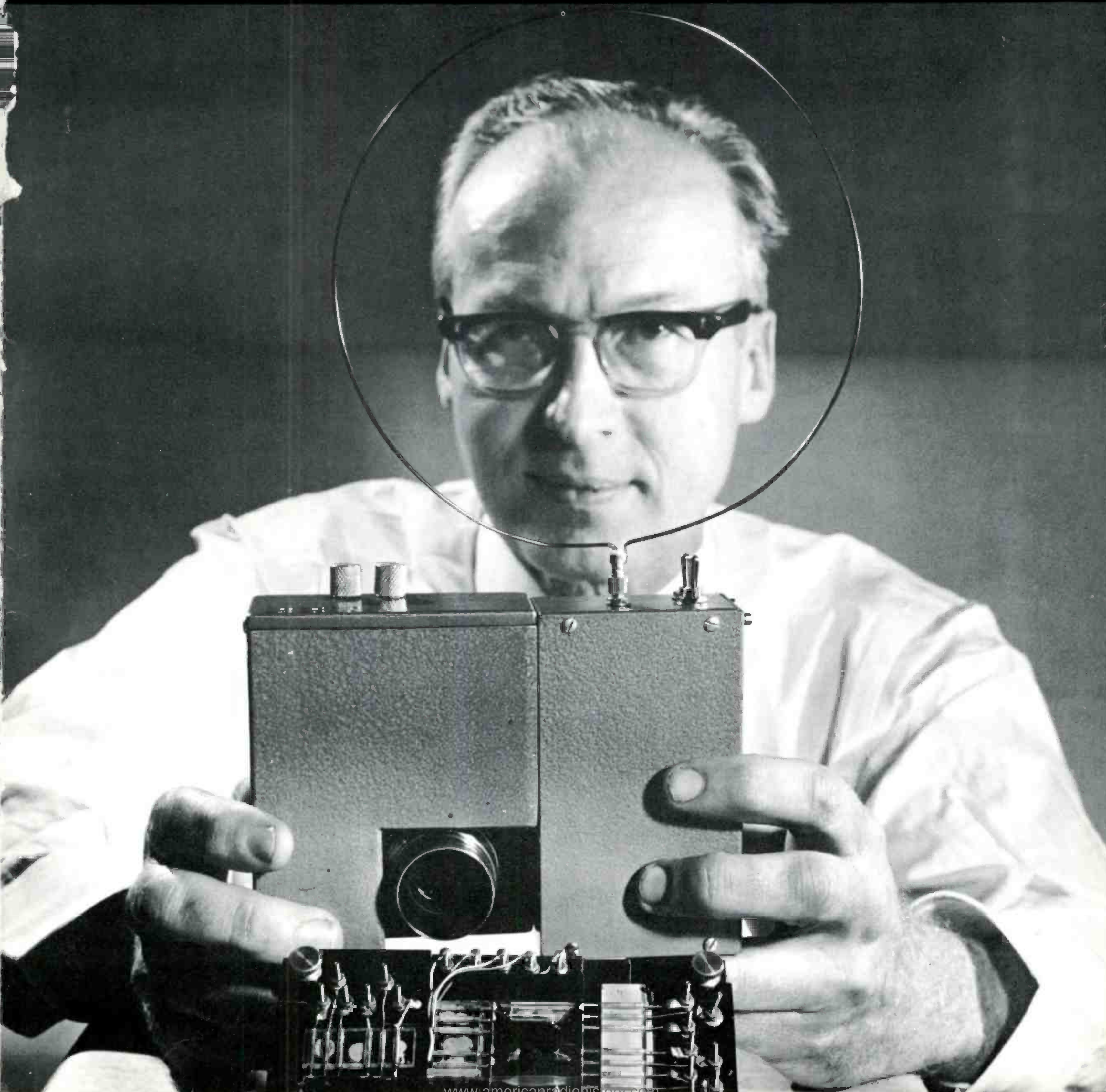
The new packaging technique solves the problem of device isolation and interconnection by grouping arrays of tiny silicon circuit elements on a glass plate and interconnecting them by means of thin tungsten networks. The process results in a half-dollar-size glass disk containing more than 200 microelectronic circuits that can be used in a wide range of standard and new applications, including high-frequency communications equipment such as television, radar, and microwave relay systems.

ASIAN EARTH STATION

Telecommunications capacity linking Thailand and the United States will be substantially increased when the first communications satellite earth station on the Asian continent goes into operation about April 1, 1967.

The transportable station, to be provided by RCA Communications, Inc., under the terms of an agreement with the Thai government, will permit people on the Asian continent to utilize circuits in Intelsat II, the communications satellite to be launched over the Pacific in 1967. Initially, it will have the capacity to handle 24 wide-band satellite channels, which can be used for telegram, telex, leased channel, and alternate voice/data communications. The station will be located on a site outside Bangkok.

A revolutionary, tubeless television camera points to a new era of personal TV communications. The experimental device, displayed here by RCA scientist Dr. Paul Weimer, was developed at RCA Laboratories for the Air Force. It takes pictures by means of networks of 132,000 thin-film devices that take the place of a pickup tube and other picture-processing elements of the standard TV camera. Signals are sent directly to a receiver from a tiny transmitter forming the right-hand portion of the unit as seen in this photo. Such units might one day be used by astronauts on the moon, policemen on their beats, or TV reporters covering news developments.



ELECTRONIC AGE

RCA Winter 1966/1967

Electronic Star-Gazer: the Arecibo Radar Telescope