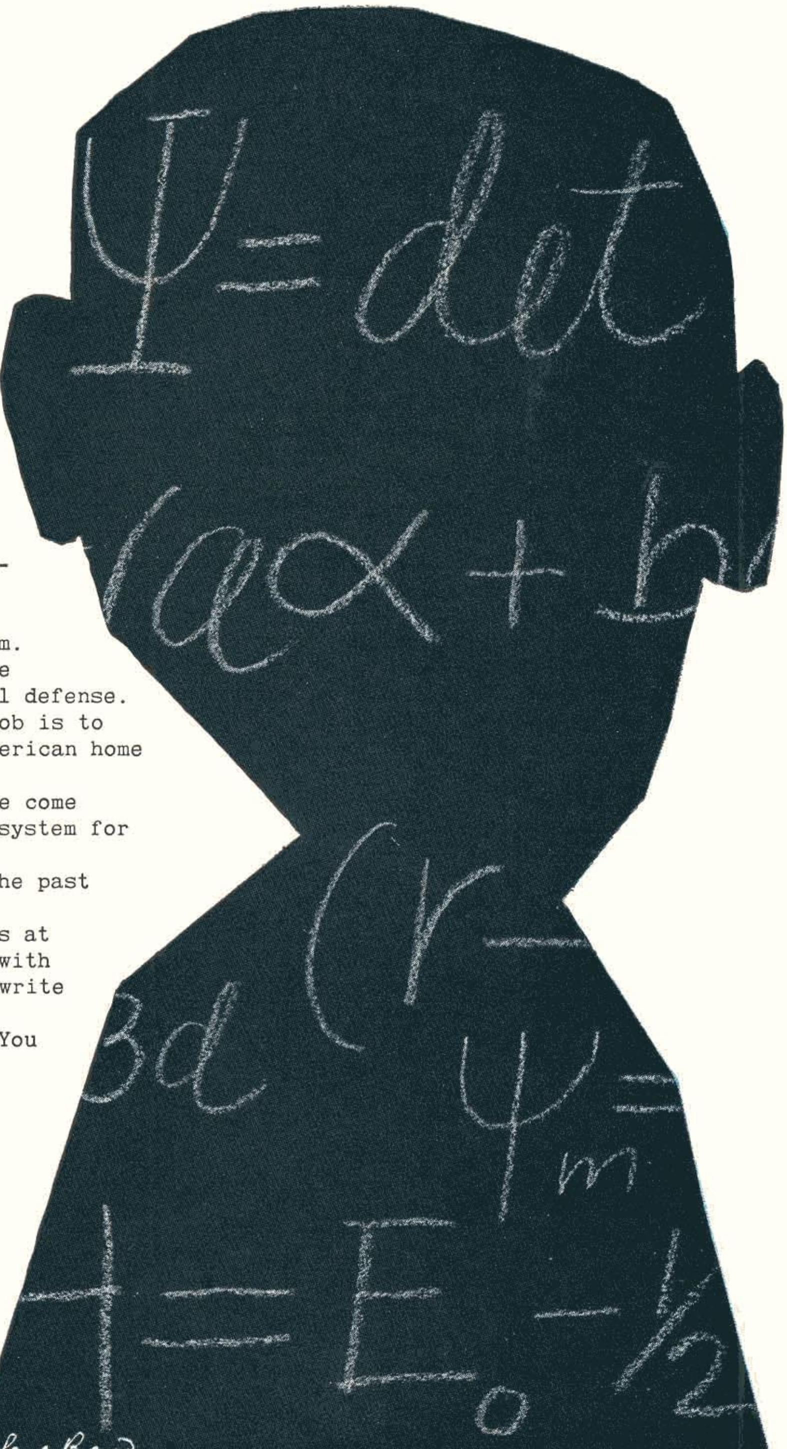
ENGINEERING | AND | SCIENCE

February 1963

Published at the California Institute of Technology

Men who do nothing but Think



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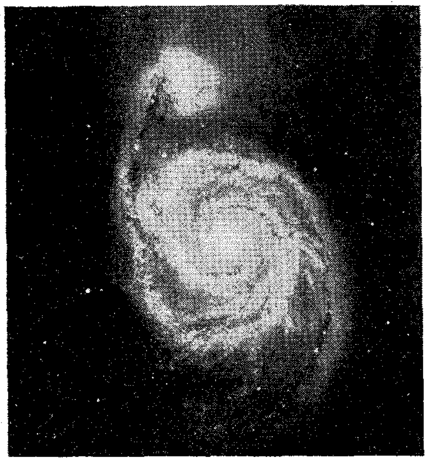
ENGINEERING | AND | SCIENCE

FEBRUARY 1963 VOLUME XXVI NUMBER 5



On Our Cover,

the nearby and famous M 51 or whirlpool nebula serves to introduce a collection of "Strange Galaxies" on pages 11-14. These photographs, taken with the 200-inch telescope on Mount Palomar by Halton Arp, staff member of the Mount Wilson and Palomar Observatories, reveal whole new classes of astronomical objects.

Solomon W. Golomb,

who wrote "When Is Extra-Terrestrial Life Interesting?" on page 15, is assistant section chief of the Communication Systems Research Section at Caltech's Jet Propulsion Laboratory, and associate professor of electrical engineering at USC. His article has been adapted from a talk given at the annual meeting of the American Astronautical Society in Los Angeles on January 17.

Bernice T. Eiduson,

author of "Scientists and Their Psychological World" on page 22, is director of research at the Reiss-Davis Clinic in Los Angeles, and an associate in psychology at USC. Her article is a transcription of a talk given at the Caltech YMCA Luncheon Forum on February 13. The complete account of the study of scientists she describes in her article can be found in Dr. Eiduson's recent book, *Scientists: Their Psychological World,* published by Basic Books.

Illustrations:

Cover, 12 - 14—Mt. Wilson and Palomar Observatories.
19—James McClanahan.

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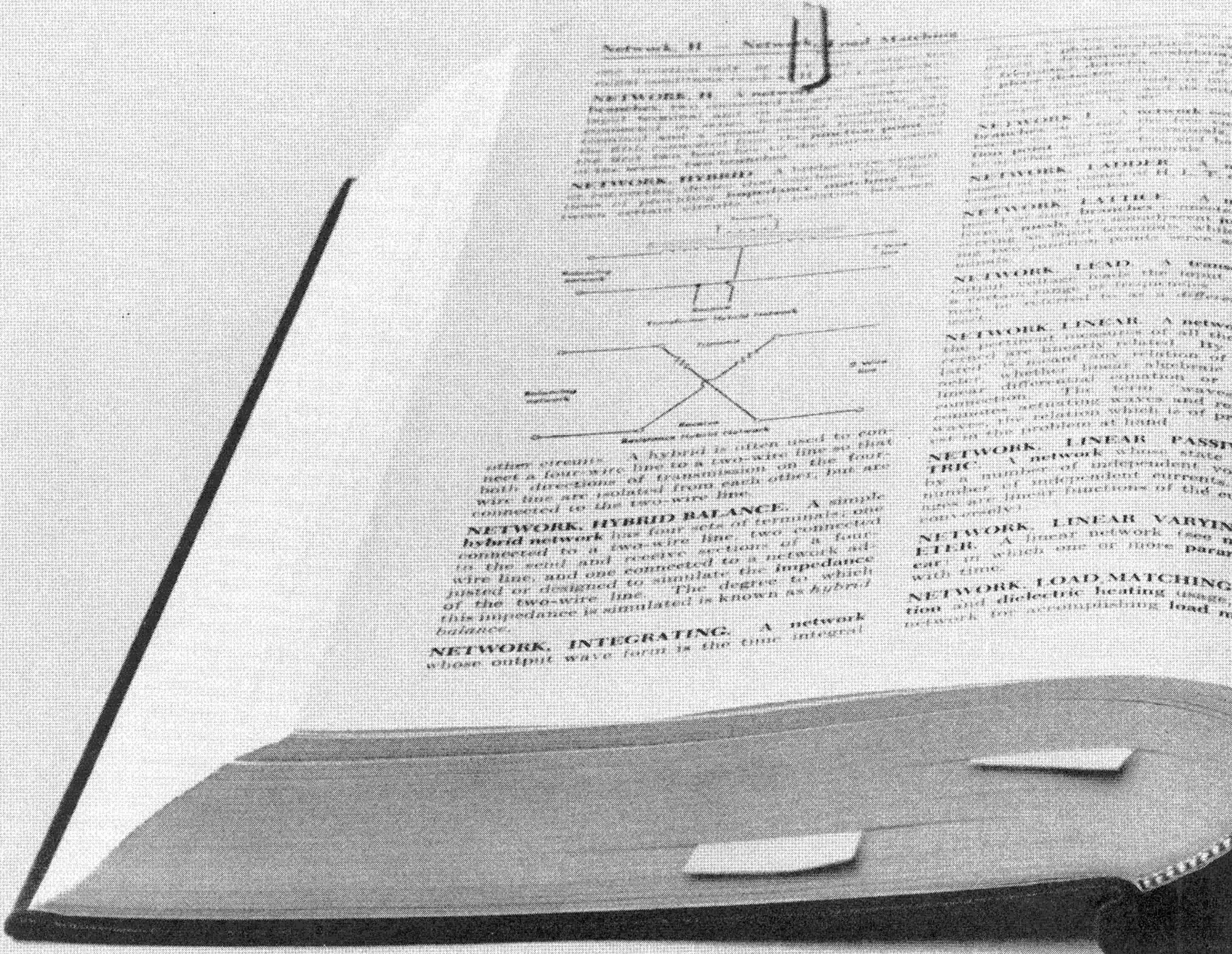

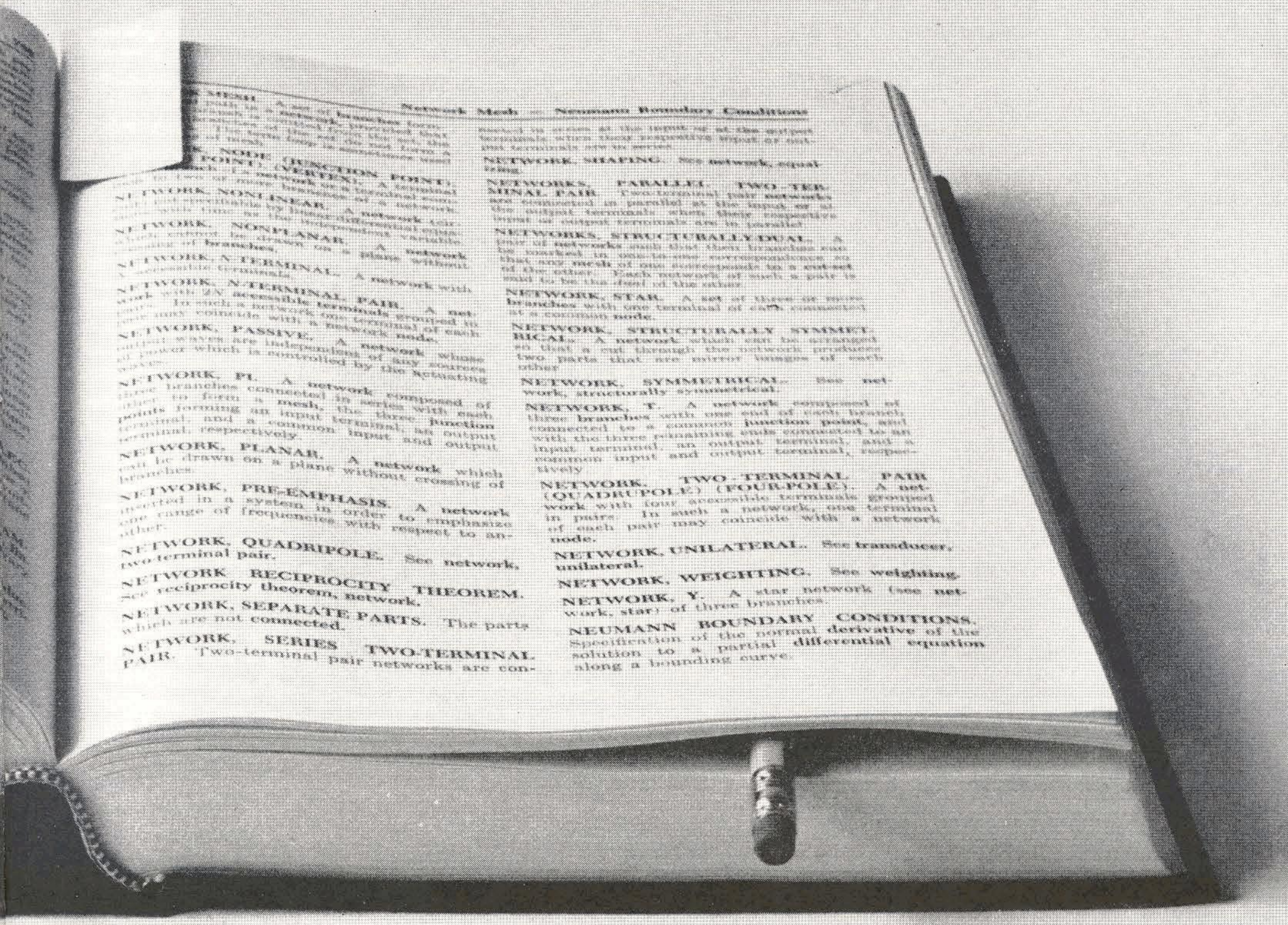

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Books

HIGHER EDUCATION IN ENGINEERING AND SCIENCE
edited by Herman A. Estrin
McGraw-Hill *$7.95*

Reviewed by Richard M. Sutton, Professor of Physics, and Director of Relations with Secondary Schools.

New engineers must have good teachers, but where are they going to get them? The problem of professorial supply and training is a real one, particularly in a field where the competition for able persons is as great as it is in engineering. No technical institution can afford to rely on the old adage, "Those who can, do; those who can't, teach." But how can an institution cultivate good teaching in its staff while demanding of the same individuals a long technical training and a very high technical competence? There are no places where a teacher can learn his trade at the collegiate level, and much has been left to chance in the past.

Fortunately, our colleges have usually attracted those with high scholarly aims and interests, who found the academic life a satisfying one, and in many cases developed a real love of the classroom and the contact it affords with alert and growing minds. So the situation has not been completely hopeless. However, it seems likely to get worse rather than better, when industry is calling so loudly and forcefully in an economic way for the best output of our technical institutions.

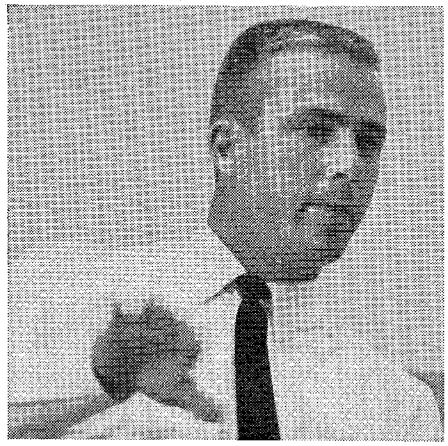
Professor Estrin of the Newark College of Engineering, and his colleagues, have been devoting themselves to the problem of training technically able instructors to make them into proficient teachers as well. As an adjunct to this course, Prof. Estrin has produced one of the first books ever compiled in this field of higher education in engineering and science.

The book consists of 93 essays divided appropriately by subject content to cover the whole gamut of the teacher's job, his relations with his students, his professional development, the place of examinations and grades in the process, the development of good teaching, and many other facets. Most of these essays from 88 authors appeared originally in professional and technical journals.

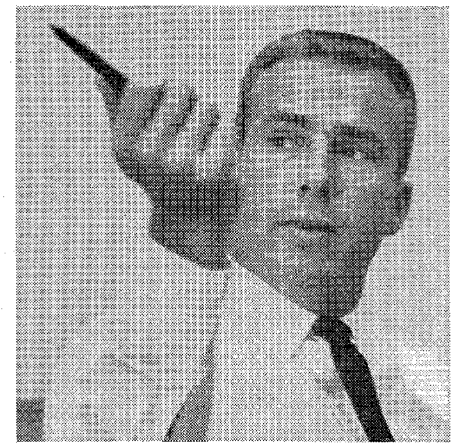
In an anthology as varied as this, it is not possible in a short review to characterize individual contributions. Your reviewer of course started by rereading his own article, then with admirable broadmindedness worked farther afield to a generous sampling of what others had to say. The farther he read, the more delighted he became with the many concrete suggestions and points of view that could conceivably change his own firmly established habits.

Let me close with two brief quotes from Mark Van Doren's article on "Teacher and Student in the Search for Truth." He says, "The teacher who does not love to learn will never cause anybody else to do so." Again, "The college teacher is devoted to the search for truth, and as such he is the envy of all those in our society who are paid to obscure or distort it. He is the only one who is paid to be as honest, as simple, and as serious as he can. Because the value of truth remains unknown he is paid chiefly with gratitude and love, whose value also remains unknown."

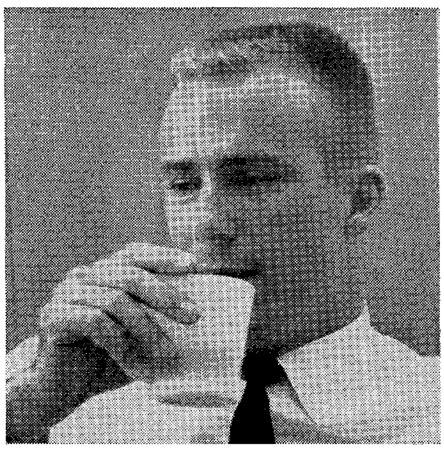
Does your wife mind your doing homework?



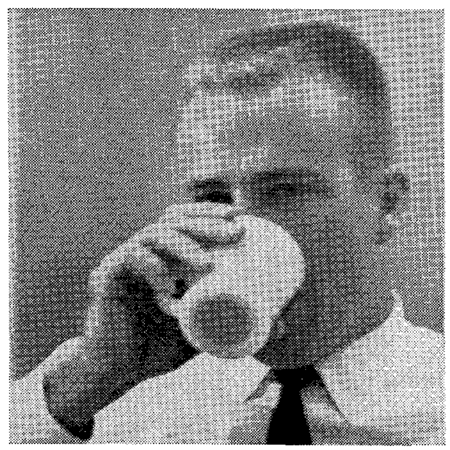
I'm not married. But even if I were, there'd be no problem. After all, my first love is right here.



Sometimes if things are really hot, I come back to the office in the evenings. Then I may take off time here and there. The main thing is to get the job done.

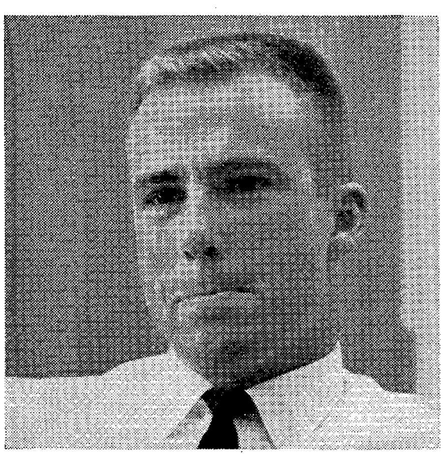


My job? Flight mechanics. I'm working on trajectories for spacecraft JPL hasn't even designed yet. Most of my work is based on advanced propulsion systems. Ion propulsion, for example.



I did my undergraduate work at UCLA. In 1956, I began working at JPL part time, while I was in graduate school. When I got my doctorate, I just naturally stayed on here.

I like it very much. It's a real nice place to work. If I ride my bike, it takes about 15 minutes to get here from home. If I take my car, about 10 minutes.



The people I work with would be pretty hard to beat anywhere. As far as being in the midst of things, you'd have to go some to find a place better than this. The only planetary shots are coming right from here.

As far as technical facilities, again it's hard to beat. Computers, one of the best libraries there is, and Caltech just down the road. I like surfing on off hours. And the Pacific's only an hour away.

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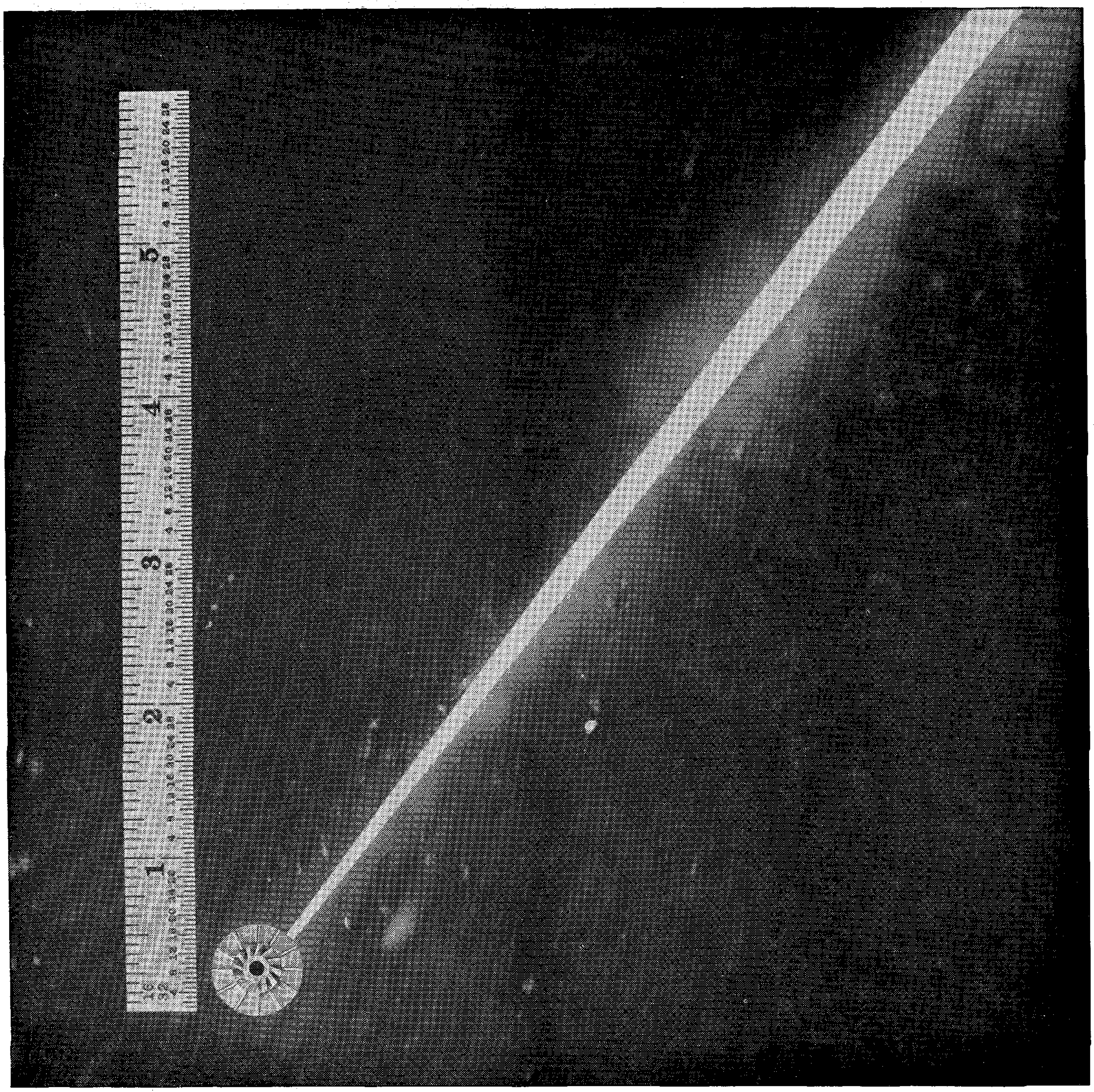

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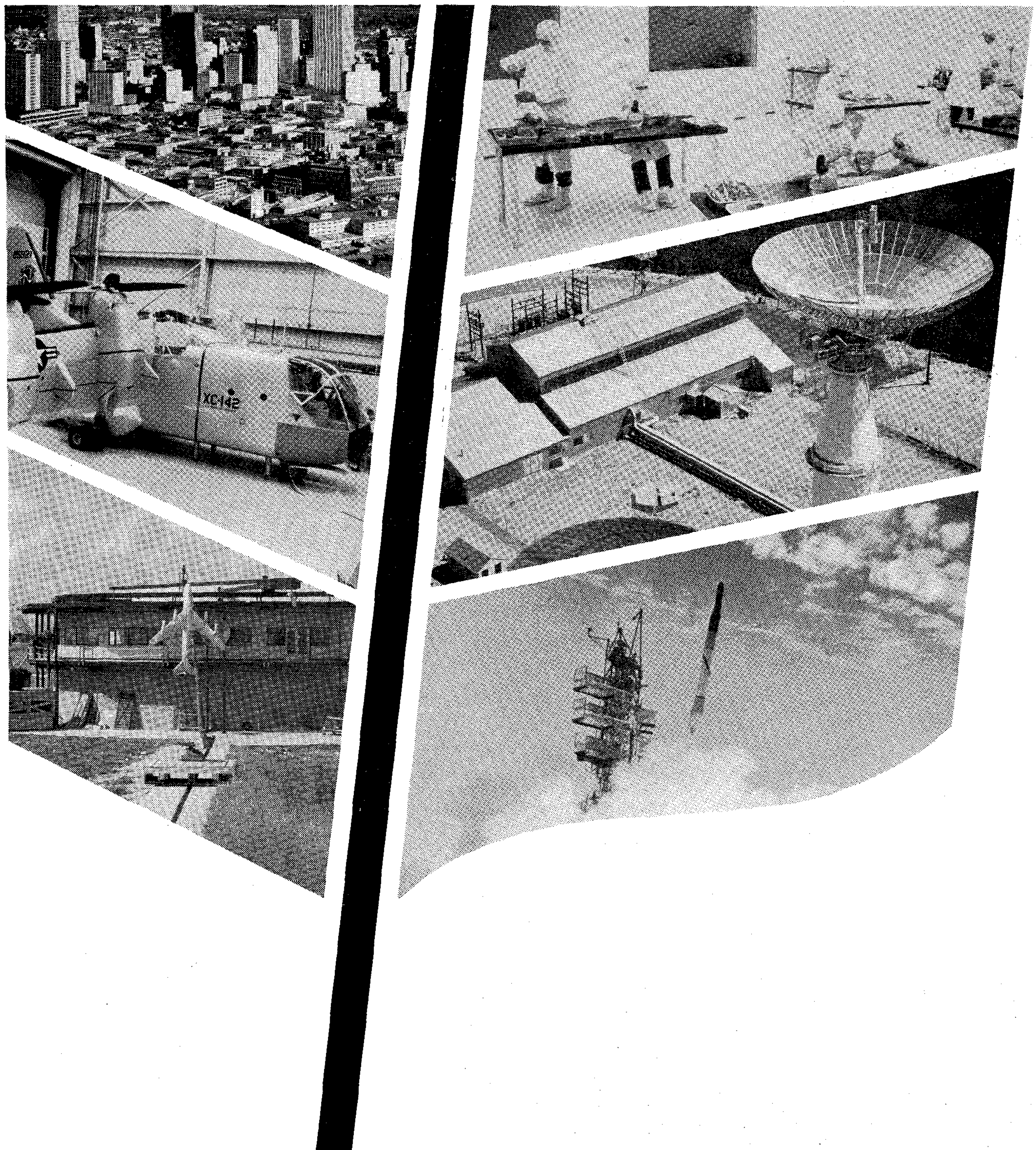


ENGINEERING AND SCIENCE
February 1963, Volume XXVI, No. 5

STRANGE GALAXIES

A sampling of some peculiar and interesting astronomical objects recently photographed by Astronomer Halton Arp with the 200-inch telescope on Mount Palomar.

The National Geographic Society-Palomar Observatory Sky Survey was completed in 1956. For seven years the 48-inch Schmidt telescope had surveyed the sky north of declination —27°. The 1,758 highest-quality plates that were finally accepted penetrated about three times deeper into space than any previous survey had ever reached. Astronomers are still studying and cataloguing the information contained in this survey, and will continue to do so for many years to come.

One of the first astronomers to use the prints of the Sky Survey Atlas for a systematic study was Professor Vorontsov-Velyaminov, a Russian astronomer at the Sternberg Astronomical Institute in Moscow. In 1959 he published a list of 355 peculiar and interesting galaxies. Last year Dr. Halton Arp of the Mount Wilson and Palomar Observatories started to systematically photograph a representative sample of these objects with the 200-inch reflector on Mount Palomar, the most powerful telescope in the world.

This procedure realizes a hope and plan which was originally behind the building of the 48-inch and the 200-inch telescopes on Mount Palomar. The fast-*f*/ratio, wide-field 48-inch Schmidt was designed to survey and find the astronomical objects of most interest. The tremendous light-gathering power and resolution of the 200-inch was to be turned on each worthwhile object individually.

The photographs shown on the following pages attest to the success of this plan. In the catalogue made up from the Schmidt plates, one can usually just barely detect where a peculiar or interesting galaxy is, but cannot tell much about it. Under the photographic gaze of the 200-inch, however, many of these objects resolve into fascinating and provocative subjects. Arp's 200-inch project is only about one-third complete now, but already whole new classes of objects are beginning to appear.

These new classes of objects seem to be pointing at physical-galactic processes which we do not yet understand. Close study of the objects, however, will certainly reveal some of the mechanisms taking place, and cannot fail to illuminate the problems of how galaxies and stars are formed, how thev age, and what their long-term future holds.

Samples of two of the most interesting classes of objects to appear so far are shown on the next three pages.

THE SIX PICTURES on these two pages show galaxies with companions or satellites. The first galaxy shown above (and on the cover of this issue) is the nearby and famous M 51 or whirlpool nebula. This one picture was taken by the 48-inch telescope—not the 200-inch. It has been debated occasionally whether the companion in this case is not just an apparent projection onto the end of one of the spiral arms of the main galaxy. The remaining pictures taken with the 200-inch telescope demonstrate, however, that numbers of similar objects can be found, all with their satellite galaxies at the end of one arm.

Just to the right of M 51 is shown NGC 7753 and NGC 7752.

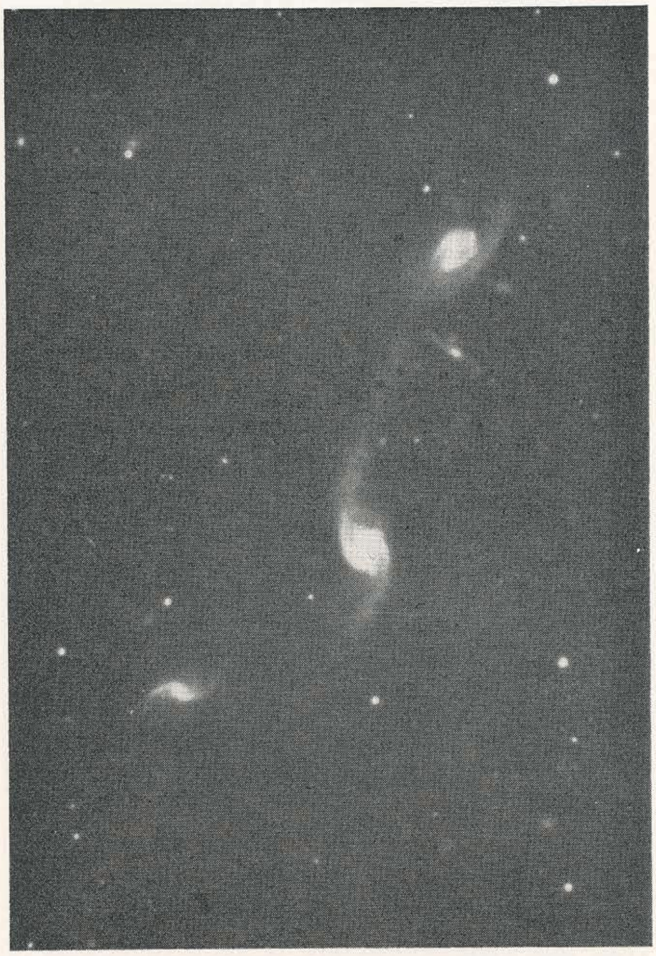
The third picture over shows a more open Sc (S standing for spiral and c for a later stage of development) with long, filamentary arms. This pair is NGC 2535 and 2536 and the companion, apparently itself in rotation, is also showing incipient spiral structure.

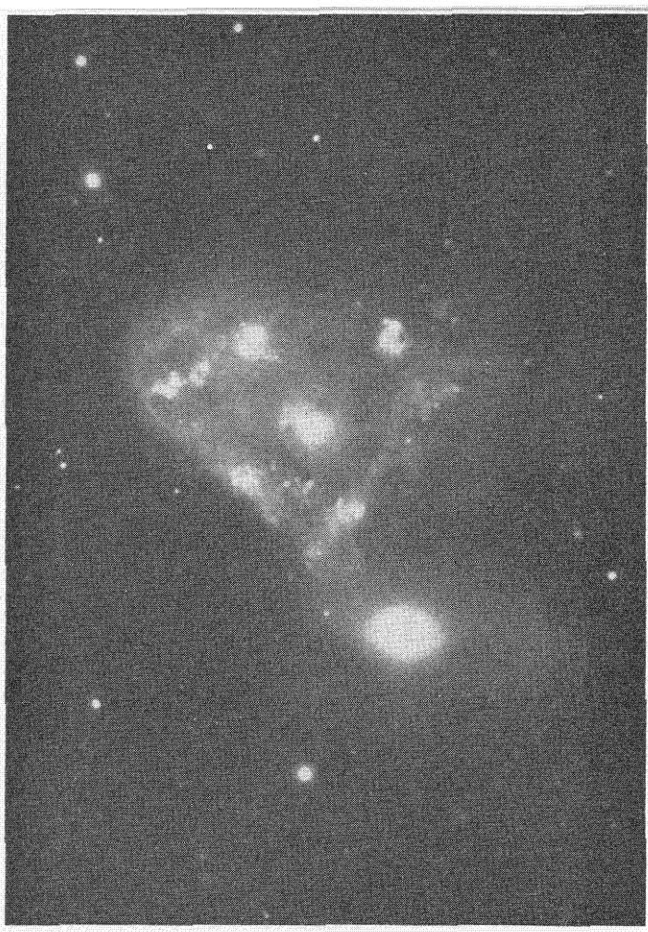
The fourth picture shows a triplet of spirals with linked arms.

The final two pictures show spirals whose companions – still at the end of one arm – are unmistakably elliptical (spheroidal) galaxies which generally do not associate with spirals; and which normally contain faint, cool, old stars, in contrast to the hot, bright, young stars of the spirals.

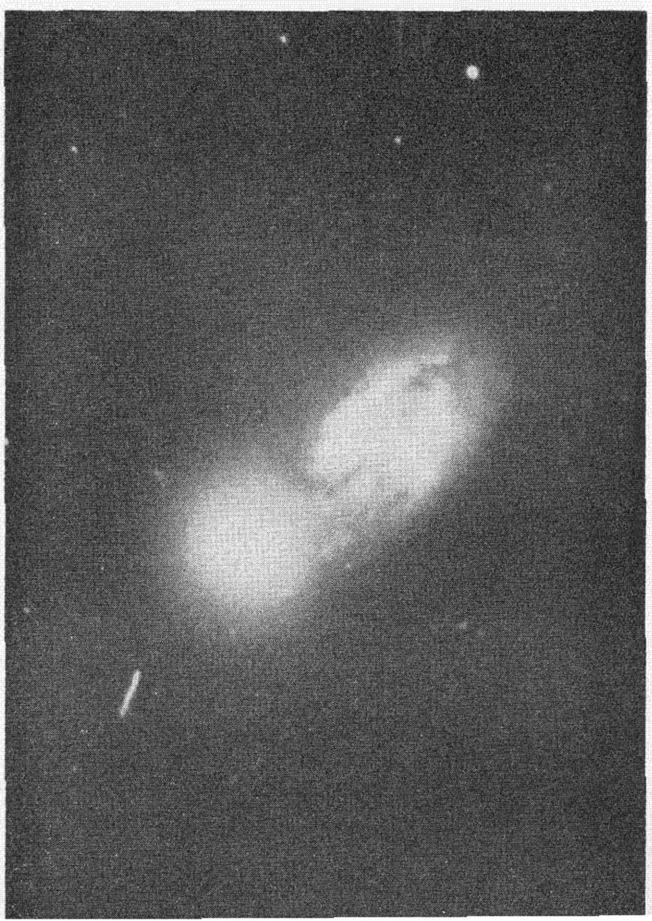
A number of important puzzling questions arise from inspection of this group of galaxies. For example, how long do these filamentary connection, which prevents the gas that is making postulate a magnetic field running along the connection, which prevents the gas which is making (or has made) stars from diffusing very rapidly away into space. Have these galaxies formed at the same time out of the same gaseous nebula? Are they in orbit around each other with gravitational perturbations causing their peculiar connections? Or have they collided and pulled out ionized gases along an ever-stretching magnetic field, like a great taffy pull.

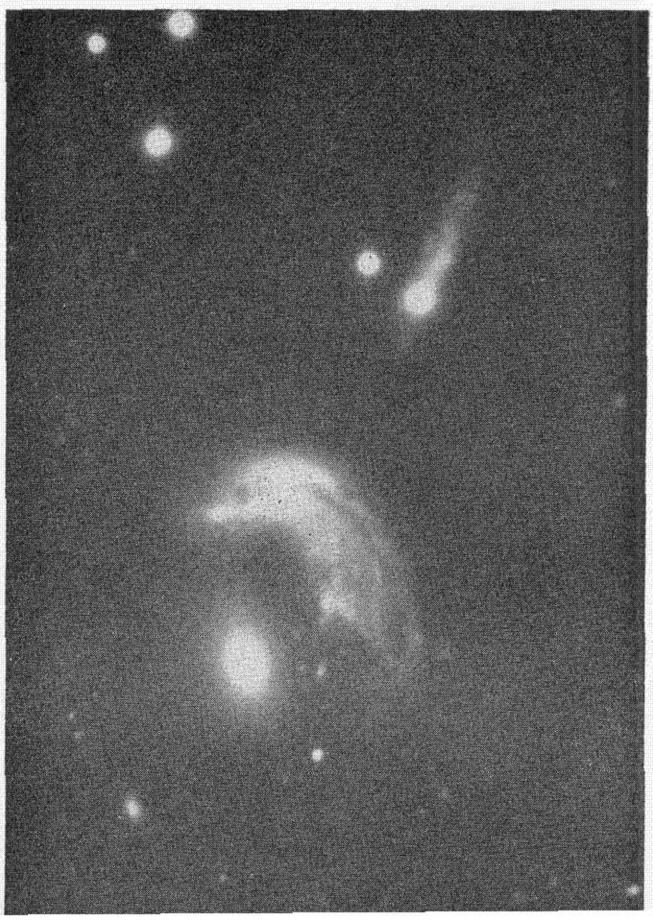
The explanation Arp personally favors as a preliminary working hypothesis is different from all of these. He would suggest that, as rotating, condensing matter twists an internal magnetic field, the disk rigidifies and the object either disrupts (i.e. fissions), or matter starts flowing out at one point to collect again further outside.



THIS SECOND GROUP of four pictures shows elliptical galaxies which may be in some collision process, but their appearance is more suggestive of exploding or ejecting matter. Perhaps it is gas pressure which is responsible for the appearance of the observed material, perhaps radiation pressure. Or perhaps we are only seeing the gravitational effect of the central elliptical galaxy on a surrounding medium. Analysis of the colors, spectra, polarization – and hence the temperatures, velocities, pressures, and magnetic fields – may reveal in the next few years what exactly is taking place in these and other kinds of objects now under observation.





WHEN IS EXTRA-TERRESTRIAL LIFE INTERESTING?

by Solomon W. Golomb

In order to discuss extra-terrestrial life intelligently, we must first have some working concept in our mind of what is *life*. The point of view that I would like to take is that life is basically a *systems* concept, and that the particular *components* used to realize this concept may be quite different from planet to planet. The systems concept itself involves *growth* and *replication*. Of these two, it is the replication aspect which is most characteristic of life. In other words, we are talking about structures, or machines, or devices, or organisms which are capable of making copies of themselves from the raw materials at hand in their environment, and we will regard such structures as *life*.

There is every reason to assume that many different components could be used to embody this systems concept. In fact, a prevalent view among biologists who think about such matters is that the conditions needed for life to evolve are quite simple. First of all we require *soup*, by which is meant any good random mixture of chemical elements or compounds such as the oceans on earth have ideally provided for the origin and evolution of earth life. Next, we need free energy, such as solar radiant energy, to bring about interactions between the ingredients in the soup, plus sufficient time for something to happen. You may recall Thomas Huxley's analogy that if you let the monkeys type on the keyboard long enough, sooner or later they will type out a meaningful word or sentence, or ultimately perhaps even a volume.

Presumably, the richer the soup and the more abundant the free energy in the environment, the less time will be required for the appearance and the subsequent evolution of living forms. Conversely, where the soup is a very thin broth and the free energy is meager, perhaps a much greater length of time would be required for the emergence of living forms. But the basic view here is that ultimately life forms will emerge wherever these conditions are at all present.

Several decades ago, the late mathematician John von Neumann wrote an article about self-replicating machines. This was a mechanistic approach to the problem of devices which will replicate themselves, and it described a method of building a self-replicating machine or of designing one. The device was basically a control computer which had the instructions for making a complete copy of itself, which it did step by step from the raw materials at hand. If anyone tried to realize this model of von Neumann's today, he probably would have to enrich the environment by having some finely-machined parts lying around in the vicinity of the machine, but the hypothetical machine must at least be able to look around for the parts it needs and build a copy of itself. Finally, the instructions for doing all this are on some kind of punched paper tape which contains all the coded instructions for building a duplicate machine, and of course the final step in the replication of the machine is simply to make a copy of this punched paper tape.

Von Neumann didn't really know it at the time, but this is exactly what nature does on earth with all terrestrial organisms. Every earth organism, from the simplest virus to the most complicated animal and plant, has a punched tape consisting of long molecules of nucleic acid. Directly encoded in these molecules of nucleic acid are the complete instructions for making each of the enzymes and other proteins and substances which the organism will need. Thus, the structural parts are the proteins, which are actually built and assembled from the environmental materials on the basis of these instructions. This is the basic growth and replication mechanism of all earth organisms.

It is a very singular fact that earth life always uses nucleic acid for the genetic coding. In some organisms only ribonucleic acid (RNA) is used, while in most earth organisms deoxyribonucleic acid (DNA) is used as a permanent or long-term storage and ribonucleic acid serves the function of short-term working blueprints, from which the actual structures are built. But there is a fantastic amount of fundamental similarity in the basic life process of all earth organisms.

If we find life on another planet, we should ask first of all, "Does it use the von Neumann model of replication?" If it does not, it must replicate by some different or more complicated model that would certainly be quite interesting in itself. If it uses too much of a short cut we might even wonder if it is sufficiently elaborate to be life, even in a very general sense of the word. For example, we don't regard crystal growth as biological replication. But certainly the question of what systems concept is used for replication is, from my point of view, the most basic one we can ask. Beyond that we can start looking for similarities with our own forms of life. For example, we would ask if the chemistry of these organisms is based on carbon, or whether, as various science fiction stories have suggested from time to time, a silicon life, or a boron life, or an iron oxide life is involved.

In terms of the *processes* of life we can certainly expect a great deal of variation. For example, we might ask whether it uses oxygen or fluorine or, as in the case of some earth bacteria, sulfur, as the oxydizing agent in its metabolism. Even here on earth we have more than one chemical element used as the oxydizer. When we start looking for really close similarities to earth life, we can ask if it uses the scheme universally prevalent on earth of nucleic acid for the genetic code and protein as the structural substance. Any nucleic acid-protein life would, of course, look extremely earth-like.

Structure and adaptation to environment

There are other interesting questions which in this context are somewhat less basic. These are questions concerning structure, and adaptation to the environment. Does the planet have animals and plants in a recognizable sense? Are there analogies with terrestrial forms as far as adaptation to particular kinds of environment? These will be very interesting from the point of view of classical biology, whereas the kind of questions I have been asking are the ones the microbiologists, or "modern" biologists, would certainly be more interested in. With these ideas as a basis, we can classify extra-terrestrial life forms according to the following scheme. A major category would be *von Neumann life*. As a subcategory of this, we would have *carbon-based von Neumann life*. A subcategory of that would be *nucleic acid-protein life*, and here we could even have the further subcategory of nucleic acid-protein life using the genetic code universally employed by all earth organisms from nucleic acid to protein.

Crick-Watson life

I would propose to call this narrowest category *Crick-Watson life*, in honor of the 1962 Nobel Prize winners in medicine and physiology, who discovered the structure of DNA; and I would tend to believe that any nearby planet on which we find Crick-Watson life has a physical link with earth life. This would certainly be true if the planet in question were Venus or Mars, where we could invoke the "cosmic spore" theory, which asserts that tiny spores, driven by radiation pressure, or Brownian motion, can effect the transference of life from one planet to another close by.

On the other hand, if the code were different—and, a fortiori, if it were not nucleic acid-protein life, even if it were carbon life—I would certainly suspect that the entire evolutionary system on that planet was quite independent of the system on earth. That is, I would postulate a separate Book of Genesis to account for all the life that we would find on such a planet.

A question which has appealed very much to the Sunday supplement publications on the subject of extra-terrestrial life is whether or not it is intelligent. Here too, my approach would be to look at intelligence as a systems concept in the sense of memory and processing, and then the question that I would ask about extra-terrestrial intelligence, whether it were in a simple organism or a complex organism, would be whether the computer organization of this intelligence was similar to what we have found in earth life. For example, does the alien information processing involve something which is *functionally* similar to neurons, rather than something with elements *structurally* similar to neurons.

I feel it is more likely in the near future to learn interesting things by asking this kind of question than by asking, "Well, what do they know that we don't know?" and, "What have they figured out about nuclear weapons and rocketry, or disease control, or immortality, or some of the other technological topics that we have been interested in?" I suspect it will be a frightfully long time, if ever, before we find a life form that is more advanced than ourselves in worrying about precisely those questions that have been of particular interest to the human race. I would be quite surprised, at the very least, to find such life forms in the solar system.

Considerable attention has been given recently to concern over the possibility that space probes launched from the earth and landing on the moon and other planets might cause biological contamination of those planets, and, of course, this is a legitimate cause for scientific worry. However, there is a much more basic problem that we are faced with when we start talking about the interaction of possibly quite alien life systems. At the extreme of high organization and intelligence, we have the problem of facing the aliens who are smarter than we are, and who are similarly given over to aggressive militaristic passions and would therefore destroy us militarily.

I don't lose any sleep over that one at all. It is not the sort of thing that I am worried about as a possibility within our solar system or within my lifetime. It becomes a possibility when we start fooling around with contacting people in different parts of the galaxy. If they're bright enough to be contactable, they might be formidable opponents. The history of our species has been that whenever human beings have encountered a very similar life form with comparable intelligence—other tribes, other races, or other nations—their instinctive reaction is to have a military showdown first, and compare notes on the niceties of civilization afterwards. But, as I have said, this is not my immediate concern.

An assortment of dangers

The science fiction writers have in fact done a fine job of describing intergalactic warfare, and I couldn't hope to add anything to that. H. G. Wells described another menace which is also reasonably obvious; namely, that the diseases of one planet may be far more severe for the inhabitants of other planets who haven't built up an immunity against them. This was certainly the history of the European explorers in the New World, and has been one of the great problems whenever cultures on earth have interacted. The transfer of disease has been quite violent and virulent. This worries me somewhat in its implications for exploration even within the solar system, but I think that rather routine quarantine procedures could be developed which would handle this problem without too much difficulty, as long as the problem is recognized in advance. I am reasonably hopeful that it would be.

The thing that concerns me most is the competition that could go on, and sometimes inevitably would go on, between truly alien systems of life at the *microscopic*, almost at the *molecular* level, when it comes to competing for the basic raw material out of which they make replicas. This would involve competition as to which is the more efficient energy conversion system. The fact that there is only one mechanism on earth for replication is not necessarily the result of only one system having evolved. In fact, our present system is not likely to be the original form in which a replicating mechanism evolved. Apparently there is a "zero-one-law" of survival among replicating mechanisms leading to the survival of one system and the extinction of all others. After the first one has appeared, and it may have taken it millions of years to emerge, then there is suddenly a strong competition among slight variants of this replicating mechanism as to which one can make replicas faster. That is, the one that is most efficient at it is using up all the raw materials from the environment, and the others are starved out.

The most efficient replicating mechanism

What we have on earth is apparently the result of just such a situation as this, where the nucleic acid-protein mechanism turned out to be more efficient than any of its competitors, and took over. It is certainly conceivable that there is a mechanism on Mars or on Venus that is inherently more efficient than the earth mechanism, and if we were to introduce some spores or some microorganisms of that type on earth, it is just possible that gradually, over a period of decades, or generations, or centuries, these microorganisms might take over the ecology of the oceans or of the soil on earth. Then, at the most basic level of the food cycle, they might make the oceans incapable of supporting the usual kinds of fish and other seafood, or they might make the soil incapable of supporting grass or animal life. At such a point, without anybody ever having fired a shot, we would have lost the entire battle of survival.

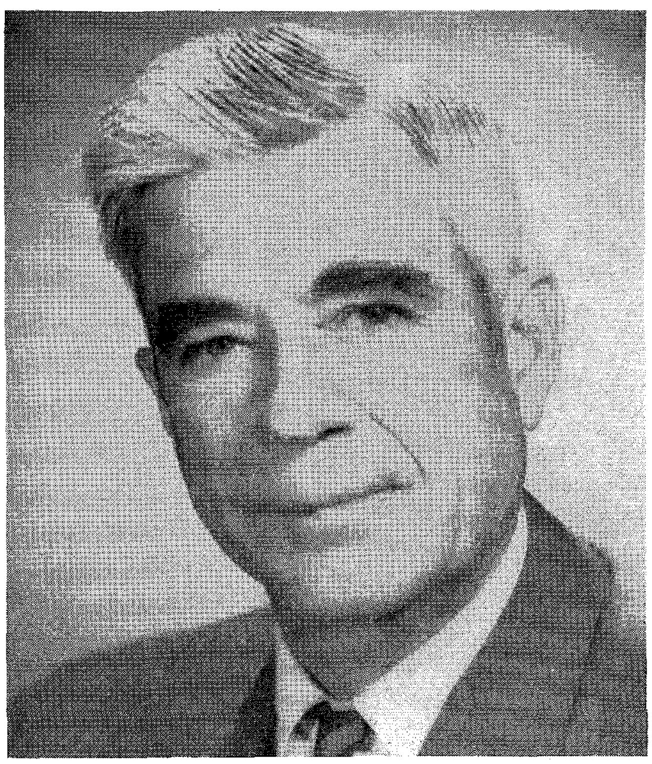
I prefer to believe that life which is very well adapted to Mars, even if we say that Mars is a more hostile and inhospitable environment than earth, would not as a consequence be all the more hearty and successful when it came down to compete with the soft, coddled life on earth, just as desert plants do notoriously poorly when brought into lush tropical regions. However, the consequences of guessing wrong on this point are unspeakably disastrous, and I think we should pay a great deal of attention to this particular danger.

The Month at Caltech

New Trustees

William Clayton, president of the Clayton Manufacturing Company, and Henry Dreyfuss, industrial designer, were elected to the Institute's Board of Trustees this month.

Mr. Clayton was born in Kentucky in 1905. He was in the cotton business until 1929, when he moved to California and founded the Los Angeles company he now heads. He has been a member of the California Institute Associates since 1948 and served as president of the organization from 1959 to 1962. He is a director of the Childrens Hospital in Los Angeles, and a member of the California Club and the Valley Hunt Club.



William Clayton

Henry Dreyfuss

Mr. Dreyfuss was born in New York City in 1904. He was a successful theatrical designer until 1929, when he opened his first industrial design office. His firm now operates in both Los Angeles and New York. He serves as an associate in industrial design on the Caltech faculty and is also a visiting professor in fine arts at UCLA. He is a member of the board of directors of the Ford Foundation's Educational Facilities Laboratories, and serves as chairman of the board of design of the Los Angeles Music Center. He has been a member of the California Institute Associates since 1948.

Gordon A. Alles

Gordon A. Alles, internationally known chemist and pharmacologist who did much research on the isolation and properties of insulin for the treatment of diabetics, died on January 21 of diabetes. Dr. Alles, who was apparently unaware of his illness, collapsed in a diabetic coma.

Gordon Alles received his BS (1922), MS (1924), and PhD (1926) degrees from Caltech. Since 1931 he had been a lecturer in pharmacology at the University of California Medical School in San Francisco, and since 1951 he had been Professor in Residence of pharmacology at

UCLA. From 1934 to 1951 he was a consultant for the Smith, Kline & French Laboratories. He was owner of the Alles Chemical Research Laboratories in Pasadena, and had been a Caltech research associate since 1939. In 1958 he gave Caltech a gift of $350,000 which financed, in large part, the five-story Gordon A. Alles Laboratory for Molecular Biology.

Dr. Alles was primarily interested in natural and synthetic drug chemicals and the relationship between their molecular structures and their biological actions. In 1928 he discovered the physiological properties of benzedrine and he contributed to its development as a drug. This drug and dexedrine, which was developed from the discovery, have had worldwide medical use as general brain stimulants.

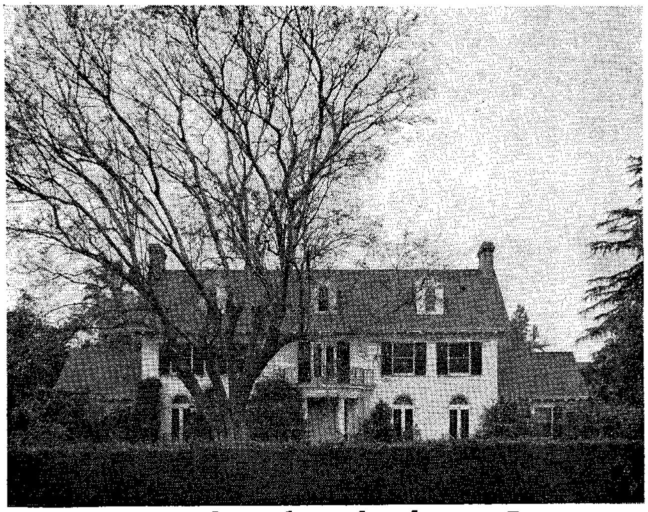
Dr. Alles had just returned from Tahiti, where he was investigating the possibilities of developing tranquilizers from alkaloids in a native drink called kava.

New Officers

Caltech's Board of Trustees has elected Robert T. Baker as comptroller and assistant secretary of the Institute and Ivan F. Betts as assistant to the vice president for business affairs.

Mr. Baker has been assistant comptroller since 1960. In his new appointment, he succeeds Robert B. Gilmore, who was recently made vice president for business affairs. Mr. Baker has been at Caltech since 1952. He is a graduate of UCLA and a native of Syracuse, N. Y.

Mr. Betts has been at Caltech since 1959 and has served as contract administrator for the past three years. He is a graduate of LaVerne College and began his career at Price Waterhouse and



New home for the Industrial Relations Center, next to the President's house on Hill Avenue.

Company. Before coming to Caltech he was studio controller for Universal Pictures.

Industrial Relations Center

Caltech's Industrial Relations Center, which has been housed in the basement of Culbertson Hall since 1941, is now located at 383 South Hill Avenue. The new Center has over 8,000 square feet of floor area on almost an acre of ground, and a private parking space for 41 cars. There are three air-conditioned conference rooms on the second floor, a three-room library on the main floor which can accommodate the huge collection of publications and materials accumulated by the Center, a lobby, several offices, and an annex.

In the new location, meetings and conferences can be scheduled at any time during the year. The first series of evening meetings in the new Center began on January 9 with 127 registrants from 43 companies.

Robert D. Gray, director of Caltech's Industrial Relations Center, conducts a meeting in one of the Center's three new conference rooms.

a
message
to
graduating
engineers
and
scientists

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YOUR EYES CAN BE ON THE STARS

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Scientists and Their Psychological World

A study of the research scientist

by Bernice T. Eiduson

I came to study the research scientist via a study of artists. For many years I have worked as a clinical psychologist in a psychiatric clinic whose patient load was heavily sprinkled with writers, artists, musicians, and actors. These people sought psychiatric help for a number of reasons – marital difficulties, depression, sexual problems, phobias – and, after professional contact, I became familiar with the kind of psychological demands that creative fields make on an individual who goes into them. I became interested in studying these artists as a group.

It seemed to me that it would take persons of a specific type of personality structure to go into the kinds of work that value such characteristics as originality and talent, that insist upon perseverance and inner strength in the face of neglect, disinterest, and misunderstanding. And I therefore undertook a study of the personality structure of persons in the arts.

Obviously, a group of persons in the arts that comes to a psychiatric clinic for help might be labeled a neurotic group, so I couldn't use the patient group as the sole group of subjects on which conclusions about the personalities of artists could be based. I was afraid, too, that using patients as subjects might unwittingly reinforce the old stereotype that neurosis was a necessary ingredient for creative endeavor. So, to overcome this difficulty, I drew upon a second group of artists comparable to the first, except that none of these people had sought psychiatric help, nor did their personal histories or personality pictures show any grossly pathological features.

Then, as a third step, I selected another control group of persons that had selected fields of business such as sales, accounting, or corporate management, and decided to subject these people to the same clinical experimental procedures that had been administered to the artists. I thought this might show which characteristics that defined persons in the arts were different from those that defined persons in other vocational fields.

I chose individuals in business for this third group not because work in business is necessarily uncreative; the growth and development of American industry would certainly attest to the inventiveness and creativity there. But business fields, unlike the creative fields of the arts, do not state first and foremost that originality and creative talent are the most prized and highly valued characteristics, the sine qua non for making any mark at all.

This study turned out to be very successful in being able to differentiate the persons in the arts from the persons in the fields of business. In fact, a significant difference emerged in 32 of the 50 variables that I studied. Incidentally, the study also struck a death blow at the old neurotic-artist theme, for investigation showed that the neurotic features in the group of artists that had sought psychiatric help were not those that were bound up in the characteristics that identified the artist as a creative person.

Now, simply because the variables identifying the artist from the non-artist appeared to be so clear-cut, the next logical question was whether these same characteristics applied only to persons who had gone into the fields of the arts, or whether they cut across single vocational fields and could be said to characterize persons in other creative fields as well – the sciences, for example. If this were borne out, I thought it might be possible to say that such traits identified all persons who go into creative fields, irrespective of the particular work.

So, as the next step, I asked a group of research scientists, all men working in the fields of the natural sciences at university or academic installations, to participate in the same experimental procedures that had been administered to the artists and businessmen. Forty scientists agreed to do this, and thus the present study.

Though I will limit this report to the findings on the research scientists, comparative data on the artists and businessmen is available and has been published.

Selection of subjects

The subject group of scientists was made up of 40 male Caucasians ranging in age from 28 to 65, their average age being 41.7. They were all on the staffs of universities or academic installations on the West Coast. Six were in physics, six in earth and soil sciences, twelve in chemistry, and sixteen in biology and zoology. They averaged fifteen years in science beyond the PhD degree.

The selection of subjects was based exclusively on choice of vocation. I purposely did not use success as the criterion for inclusion in the study because it seemed to me that the motivation and personal dynamics that lead to choice of work in the sciences is very much the same for the person who is successful as for the one who gets little outward recognition for his abilities and efforts. The definition of success in science is extremely difficult to establish, and as dependent on almost as many variables in the sociology of the scientific world as is the establishment of artistic success in the world of music, painting, or the theater. Yet my group was very impressive as far as scientific reputation is concerned; about half had been nominated to the National Academy of Sciences and two were Nobel Prize winners.

Each scientist was administered two psychological tests: the Rorschach test of personality diagnosis and the Murray Thematic Apperception test. And each scientist was interviewed intensively. I studied the men from five different points of view. First, I investigated their developmental histories and their backgrounds, to see what, if any, experiences and relationships in early life were common to the group. Secondly, I investigated their adult personality structure, their emotional behavior patterns and their motivations, particularly around work. A third focus of study was related to the ways they thought and perceived, their styles of thinking. I was interested here in how the intellectual capacities that have identified scientists get expressed, and whether their thinking is marked by the originality, flexibility, and scope it is commonly supposed to have.

The final two areas of study focussed on the socio-psychological aspects, the focus being on the individual scientist in relation to a group. Here I looked at the self-images of research scientists, which reflect their identities as members of the profession and allow outsiders to see them as a single, and in some respects uniform, body of men. I compared the notions they have about themselves as scientists with their ideal pictures of what scientists *should* be like. Finally, I turned to how the fact of being a researcher affects the non-scientific aspects of a man's life, the part he plays as a family member, as a member of the community, and his patterns of work and play.

Biographical data

Of course, I can't hope to give all the results of this study here, so I have singled out a few areas. Let me turn first to the biographical data. Some of my men were European-bred and some raised in America; some were under 40 and some over. I had thought that this would make for a range of difference among the men which would be more notable than the similarities, and this certainly was the case. This was true when men were divided according to geographical area, the occupational backgrounds of their fathers, religious affiliations, socio-economic statuses, and all such factual data.

Furthermore, it came out that, in those instances where certain experiences and background factors were overtly similar among the men, a further look at the implications or meanings to the men, as far as their going into science was concerned, showed surprising variability. Here are descriptions of two of the three scientists' fathers who were in scientific work themselves.

The father of one man, a chemistry professor in a large university in this country, was at home only in his laboratory. His son said of him:

> He was a sort of an American-type man, all mild and beaten down by his wife. The only thing he was independent about was his work. He was mild, good-tempered, and logical and clear — a very good teacher. All my relationships with him were in the laboratory and going to school. I had him as a teacher in two classes, for example, and here he was completely different from relationships at home. That's probably one of the reasons I became a scientist. Looking at it in retrospect, I think when I saw my father in the laboratory, I thought: This is a good way to be independent, to be a scientist.

Another scientist's father scarcely told his son anything about his work. This man says:

> I don't know whether my father kept his work from me deliberately or not, but it must have been deliberate because I knew nothing about it. There were no attempts to interest me in any scientific things. It wasn't that he kept any secrets from us; it was just that he didn't fit very well. He was an embittered man. He had started his career in chemistry, and this had been interrupted by war. He left, became discouraged, and always thereafter remained withdrawn and depressed. He'd sit without talking for long periods of time, and would keep himself apart.

There was only one father in our group who wanted his son to be a scientist above all else, and he devoted himself exclusively to the task of making him one:

> My mother tells me that before I was born, my father told her that if he had a son he would be a scientist, and he did it not by telling me I had to be a scientist, but by showing me all kinds of things: how ants work, what the moon was like, telling me all kinds of stuff — not telling me I ought to be a scientist, but how interesting everything was. And now that I am older and I can look back on the way he understood things, he understood science the way few of us do.
>
> He was not a scientist but he had a feel for it. He knew the insects and what they did, but he didn't know the names of any of them. He didn't know the names of the stars or of this and that constellation, but he did know that stars were great big balls of gas. He would explain them, and he would say: 'What difference does it make what name you give to a star. In Germany it's one name, and the Martians will call it another.' So he would concentrate on the theme and not the way you describe it. In other words, my father had a completely scientific mind.
>
> When I was little, the first game I used to play was after dinner. He had bought a lot of bathroom tiles of different colors. He'd set them up vertically on a highchair, and put them up very patiently. And when he got them all in a line, then I had the fun of pushing them all down—one on top of the other —and down they would go. This is the way it would start, but there was a method in this game. He played the game with me every night and after a while the game changed and became a little more complicated. It had to be a white tile and a blue, a white and a blue — so we had to be more careful. Then two whites and a blue, two whites and a blue. And I would want to put down two blues and there would be some excitement, and my mother would say: 'Look at that poor child putting down two blues.'
>
> What was the idea of the game? Well, the idea was to get me interested in patterns and relationships. And that was the best he could do for a child that couldn't even talk, you see. And that got me quite a mathematical mind, because pretty soon I got quite good at that: two blues and a white, three blues and a white — very complicated things. And the funny thing is that this is the most important feature that I remember about my father: He looked at everything in the same way; it was as rational as possible. He looked at everything in terms of what was real and unreal about it, and I realized what was just talk and what was behind it.

Common denominators

Because the diversity of attitudes and experiences among the men was so great, relatively few common denominators emerged in the background material. However, those that did emerge emphasized some features that seemed to be continuous threads with the personality and cognitive data that emerged independently. The common denominators in backgrounds were these: First of all, the group was one in which excellent intellectual abilities existed. These were often recognized early, and subsequently led to gratifying experiences and relationships. For most men, excellent natural endowment was given encouragement by experiences that tended to place a premium on intellectual activity, and thus helped to crystallize these over-valued activities into later vocational choice and performance.

Secondly, almost all these scientists experienced

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periods of isolation, either stimulated by personal needs or forced by physical and psychological circumstances. The interesting thing about this is not the fact of isolation itself, but that during these times they turned to their own resources for solace and amusement, experimented with their abilities and extended them. They became comfortable about being by themselves, and interested in using these periods to indulge in fantasy, work on problems, read, and so forth.

Another common denominator was that almost half of the men in the group were fatherless, the father dying early or working away from home, or remaining so aloof and non-supportive that the son scarcely knew him.

Mothers were identified more with achievement, but generally relationships with family members were of a fragile and tenuous quality, and not too many scientists look back on their parents and siblings with warm and positive feelings.

Fourth, these men turned away from their families at some time, usually during adolescence and when they started college; some even cut off all but the most superficial ties and then went off on their own.

And fifth, the social histories exploded the myth of the all-important teacher or the absolutely essential chemistry set as crucial for stimulating an early interest in science.

What does this kind of diversity in background mean as to the kind of personality structure that these men developed as adults? The data here show that, despite our stereotypes, the scientist cannot be encased in any neatly drawn personality mold. The study dismissed all those hypotheses that had referred to scientists as falling into one diagnostic category rather than another – as, for example, schizoid or compulsive. It showed that all scientists were not fixated on any particular psychosexual level. They do not use one particular kind of defense mechanism. They do not have certain kinds of conflicts. They are not given to mood swings. They are not ridden by ambivalence, nor are they particularly passive, or bisexual.

The characteristics that emerge

The characteristics that do emerge are these: First of all, there is a strong emotional investment in intellectual activities and interests, and evidence that much of the scientist's feeling about himself as an adult is derived from the fact that he is in work that places a premium on the intellectual. With the scientist's feeling of self tied up so much in work, it is not surprising to see also that intellectual activities become the stage upon which the passions get spent and the gamut of emotions is revealed.

A second major personality characteristic is emotional constriction and control. Constriction refers to the narrowness of emotional response, and is contrasted with what we might call, in psychology, lability or over-reaction. But it is quite different from withdrawal or isolation, and refers more to restriction or channelization of the way most emotions get expressed. An integral part of the stereotype of the scientist has referred to his withdrawal or isolation and loneliness, but from my empirical study this is an incorrect conception, and one derived more from the fact that the scientist is generally in an isolated setting.

Anxieties and fears

A third common characteristic is the way the scientists handle their anxieties and fears. Generally, they are free from free-floating anxiety, so that they show very little symptomatic tension or anxiety. They have anxiety, but this comes out not so much in consciously-felt disturbance or discomfort. Instead, scientists tend to make relatively constant adjustment efforts in the face of problems or conflicts, and these tend to keep his anxieties under control.

Psychological data bring out very clearly the content of the anxieties that scientists have, and the way some of these are displaced onto the work situation; and how, in turn, work activates and reactivates certain anxieties that they have had. Interestingly enough, while scientific work serves to assuage anxiety for some scientists, who perceive science as rational, with built-in controls, others see science as irrational and a hotbed of potential dangers. For some it is the sanctuary, the haven, the retreat from competition, while for others it is a socially-accepted way of being rebellious and aggressive.

A fourth major personality characteristic of scientists is sensitivity. From the tests, it turns out that sensitivity gets expressed in a number of ways. First of all, scientists are responsive to sensory experience data. They seek out subtle and delicate impressions. In relationships, they have a capacity for sensuous gratification, are

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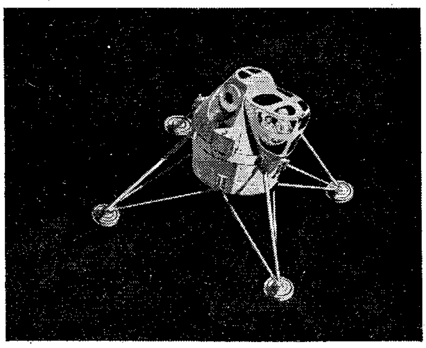

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quite aware of their own motivations and internal environment. They are also aware of the motivations of others, but to a lesser degree.

A fifth common denominator in personality is narcissism. Oliver La Farge has said that the scientific life is shaped by the feeling that the ends must be good not for oneself, but for all mankind, and that the scientist must be able to set aside personal advantage, comfort, and glory in his developing effort to make progress.

But what one sees in these personality pictures is not selflessness on the one hand, nor selfishness on the other. In their overinvolvement in work, in their fantasies about omnipotence, in their anticipated accomplishments, in their minimality of interest in others who cannot further their own ends or goals, the scientists are self-oriented. Yet their gratifications come as much from what they contribute socially, and to the fund of knowledge, as from personal gains. In fact, the latter seem in many ways to be neglected.

Thinking and perceptual styles

While the scientists shared very few personality characteristics in common, there was one way in which they were very similar, and here the degree of similarity turned out to be so striking that it becomes evident that the model of the research scientist is certainly defined in this area. This is the area of cognition, of thinking and perceptual styles, the principles along which they organize and structure their thinking. Here we find a group of men all oriented or set in the same way; towards the new, the different, the unhackneyed; to making new perceptions out of old hat; to new ways of seeing what they have to see, and new ways of describing their experiences. Their interests point to the theoretical and abstract rather than the practical and realistic. They accept reality, but see it in a way different from others. They can tolerate ambiguities in the perceptual area. They can loosen and relax controls in thinking without feeling disorganized.

But there is one finding that I think deserves special mention in this context, and that is that the thinking of the scientists was not particularly flexible or mobile. On the contrary, we find that it tends to be quite patterned and rigid, that scientists work more originally in structured rather than unstructured situations, and that they prefer the bounds and limitations that reality sets.

Of all the data I have accumulated about the creative processes in these men, let me merely say here that none of the scientists leaves discovery completely to chance. They seem to have developed ways of working on problems and thinking about them which for them are potentially fruitful, so that the flying guesses, the original thoughts and the "inspirations" do not come out of soil that has merely lain fallow. I could make a nice little handbook of helpful hints to eager young scientists that some of the more experienced men have passed on to me. Like: "Lucky accidents don't happen to dead cows." Or: "The better intuition a person has, the more you find out he is full of facts." Or "Delbruck's Principle of Limited Sloppiness: You should be sloppy enough so that the unexpected happens, but not so sloppy that you cannot figure out what has happened after it's happened."

I was interested to note, too, that in describing their own creative processes, these men, who are trained in the objective, rational, and logical, showed a high degree of respect for the irrational and the unconscious. They were also insightful into the psychological conditions that seem to stimulate performance in the scientific field and to inhibit it. However, I must also add that when they try to apply these insights to students whose creativity they have to predict in advance, they tend to retreat into looking to attributes that they can point to operationally.

Self-images

To turn very briefly to the self-images: Here I explored what makes a scientist feel like a scientist, where his feelings of identity with other scientists come from. It seems quite surprising to me that scientists as a group seem to be caught up in the same stereotype that the public holds about them, or perhaps put more properly, that scientists seem to have been drawn into science by some of the same fantasies and stereotypes that the public holds. For example, they see themselves as intellectuals, as discoverers of new worlds — worlds which they not only create but which they then proceed to live in. Their work is propelled primarily, they think, by pressing inner drives, so that the majority scorn "impure" motivations, such as the desire for recognition, or exhibitionism, or personal aggrandizement, or pragmatic reward — unless these characteristics are inescapable concomitants of devotion to the

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search for truth. Happiness and fulfillment rest primarily in their satisfactions at work, with routine drudgery and administrative problems played down as interferences. In fact, for these men, rigor, persistence, and discipline have all become institutionalized in their morality code as values in themselves, and therefore the 9-to-5 gentleman scientist is looked down upon as the laggard who is bound to be unproductive.

There is evidence, however, that differences in the way science is being practiced today are being accompanied by certain differences in the identifications that scientists have with other scientists. An example of this changing trend is the researcher's shying away from identification with the "great but maladjusted" or "eccentric" scientist. Reverence for forefathers whose outstanding minds were sometimes housed in very peculiar and odd personalities still exists, and yet the newer scientists seem consciously to be dissociating themselves from peculiar and difficult associates or students, knowing full well that they may be thus shunting themselves off from some very creative workers in their own laboratory. These men nowadays prefer to depend for progress on well-organized, smooth-running, large-scale operations, whose stability demands the minimum of interpersonal relationships, especially disturbed ones.

Sciencemanship

Another change comes in the new interest in "putting breakthroughs across." While many of these men still stress that the motivation behind science is the gaining of understanding and knowledge, without concern for its immediate application, they feel that the fruits of their search can be more readily taken advantage of if they adopt what I call the skills of sciencemanship. Some think that manipulation of success in science is a natural sequence if you realistically acknowledge that the same gamut of motivations that is found in other people is found in scientists too — jealousies, competitions, desires to please superiors. But some scientists feel that such Madison-Avenue manipulation is inappropriate to science, and they blame this development on the new corporate structure of science, which they hold responsible for the invasion of the business ethic.

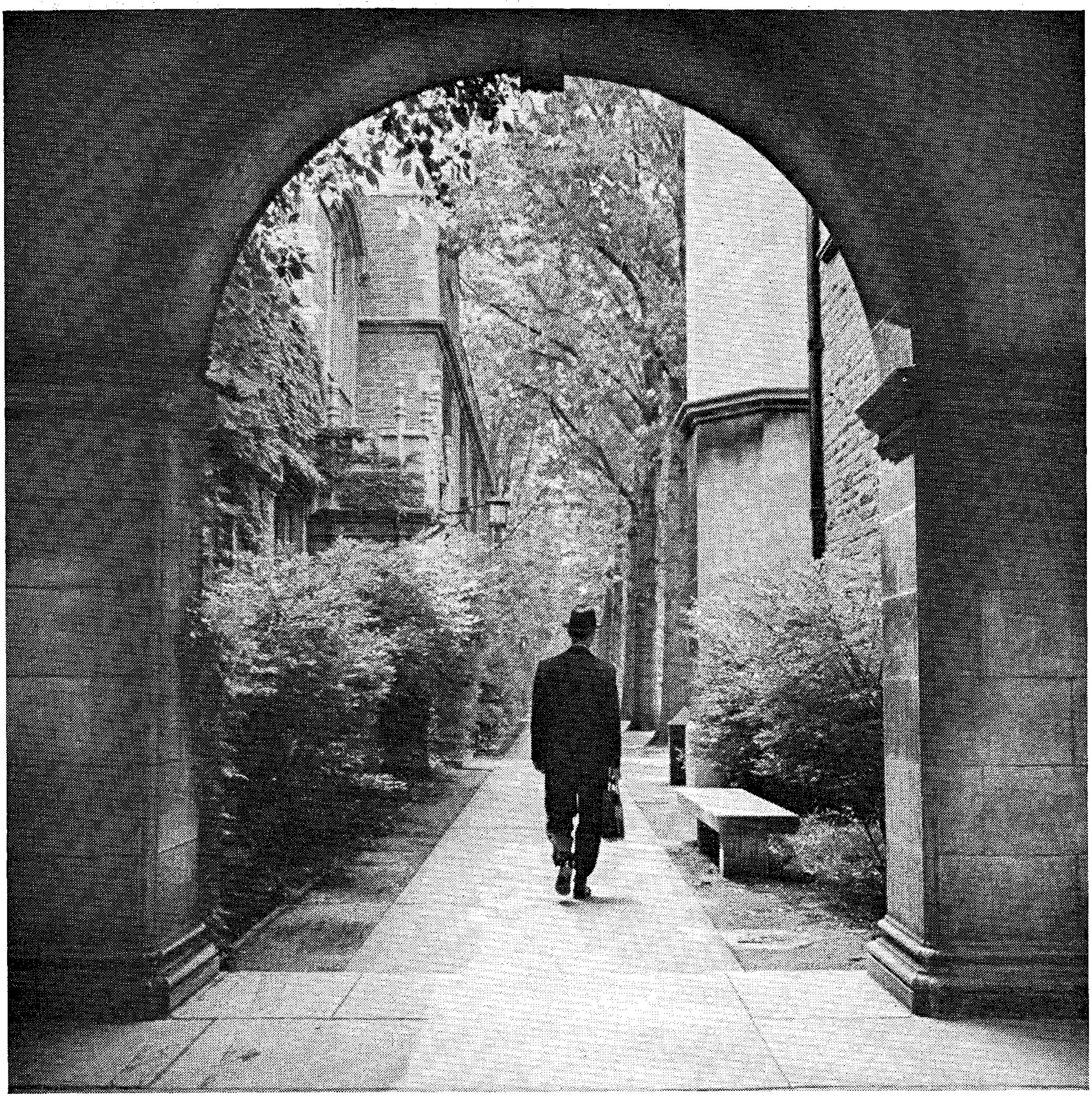
Perhaps it is an inevitable development that, once the notions of success in the business world to some extent invade the scientific, then some of the same tools that promote success in one field are sought after in another. But if the facile and the easily-smoothed-over, and such behavioral techniques as the persuasion by personal manipulation do become acceptable to the scientific community, will they eventually prove compatible to scientific work? Or will the rebellion against the traditional, and the break away from the fixed, and the questioning of the taken-for-granted — all of those aspects which characterize science — really be destroyed?

Taking on a group identity

Of course, all the personality characteristics I have discussed do not play an equal part in the scientists' adjustment. The self-images provide a good example of how certain aspects of personality dominate and even becloud others. A great deal of evidence in these data suggests that the self-images scientists hold deny some of the diversity in background and personality that actually exists among the men, masking these differences and making all scientists appear outwardly more alike than they actually are.

In looking into this further, some evidence in the data suggests that certain individual psychodynamic features in these men encourage group camouflage, and there are also some sociological factors that reinforce and strengthen the tendency to take on the group identity.

Some of the data on the life styles of the men reveal how they let certain patterns, like the university model, become the model for their way of living, salary expectations, and so on, when in some ways this academic model is inappropriate to them. And there are data that point to the fact that the self-identities of the men have even tended to narrow down severely the way scientists function intellectually, so that the growing concern that Snow, Holton, and others have expressed about the dissociation of scientists from the larger intellectual community seems well taken. The most curious phenomenon of all, however, is that by taking on some of the self-images so completely and adapting his life accordingly, the scientist unwillingly perpetuates the very stereotypes about himself which cause so much general concern. This makes for an image of the scientist that is very difficult for today's youngsters to identify with, and contributes to the problem of recruiting young people into science.



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Now zinc can be married to steel and used for vital underbody parts and rocker panels of Ford-built cars. The zinc coating forms a tough barrier to corrosive moisture—and if corrosion attacks, the zinc sacrifices itself through galvanic action, saving the steel.

Other avenues explored in the fight against rust also brought results: special zinc-rich primers to protect key body areas, aluminized and stainless steels to extend muffler life, quality baked-enamel finishes that are more durable (and look better).

Another step forward in total quality—and another example of how Ford Motor Company provides engineering leadership for the American Road.

Salt-water bath is one of tests used to check rust protection built into Ford-built cars.

Ford

MOTOR COMPANY

The American Road, Dearborn, Michigan

WHERE ENGINEERING LEADERSHIP BRINGS YOU BETTER-BUILT CARS

Personals

1926

LAWRENCE G. MAECHTLEN, president of the Square D Company, has been elected a director of the American National Bank and Trust Company of Chicago.

He has been associated with Square D, a manufacturer of electrical distribution and control equipment, since he graduated from Caltech, and has been president since 1960.

1932

WILLIAM H. PICKERING, MS '33, PhD '36, director of Caltech's Jet Propulsion Laboratory, has been named president of the new American Institute of Aeronautics and Astronautics. The AIAA is a merger of the Institute of Aerospace Science and the American Rocket Society. L. EUGENE ROOT, MS '33, MS '34, AE, and MARTIN SUMMERFIELD, MS '37, PhD '41, serve on the new institute's board of directors.

WORRELL F. PRUDEN, MS '33, is director of engineering at the Columbia-Geneva Steel Division of the United States Steel Corporation in San Francisco. He has been with the company since 1933.

1935

WALLACE J. S. JOHNSON, principal owner and president of the Upright Scaffold Company in Berkeley, has put his name in nomination for Mayor of Berkeley for the April 2 election.

BERNARD B. WATSON, PhD, is an Exchange Operations Analyst at the Army Operational Research Establishment in England. He writes that he is enjoying his work as the only American in a British organization. He will be joined shortly by a Canadian under a similar exchange between the British and Canadian armies. The Watsons are living in Surrey, about 20 miles south of London. They expect to be in England until the spring of 1964.

1939

B. L. HAVENS, MS, is now director of engineering of the IBM World Trade Corporation in New York. He has been with IBM since 1946. During World War II, he led a research group in the airborne division of the Radiation Laboratory at MIT, and was awarded the Presidential Certificate of Merit by President Truman in 1948.

1940

A. M. ZAREM, MS, PhD '44, and DUANE D. ERWAY, BS '57, MS '58, are co-authors of a new book, *Introduction to the Utilization of Solar Energy,* to be published in March by McGraw-Hill. Dr. Zarem is president of Electro-Optical Systems in Pasadena, and Mr. Erway is manager of the communications and controls department of EOS.

1947

JERRY DONOHUE, PhD, has been appointed chairman of the department of chemistry at USC. He joined the USC faculty in 1953 after teaching at Dartmouth and Caltech.

RICHARD H. MacNEAL, MS, PhD '49, is director of engineering analysis at Computer Engineering Associates in Pasadena. From 1949 until 1955 he was assistant professor of electrical engineering at Caltech, and then joined Lockheed Aircraft Corporation for a year as a research specialist in structures. He has been associated with CEA since 1952 – first as a director, then as a consultant and as an employee.

IRVING MICHELSON, MS, PhD '51, professor of mechanical engineering and director of the aeronautics laboratory at the Illinois Institute of Technology in Chicago, is on a sabbatical leave this semester and is serving as visiting professor at the Faculté des Sciences, Institut des Specialités Industrielles de Nancy, Université de Nancy, France. He is giving a series of lectures on space dynamics. The Michelsons' five children are with them in France.

1948

JAMES R. DAVIS, MS '49, and Frederick J. Converse, professor emeritus of mechanics at Caltech, have announced the formation of a new corporation, Converse Foundation Engineers, to succeed the Converse Foundation Engineering Co. They will continue their consulting practice in soil mechanics, foundation engineering, and engineering geology under the new name.

JAMES C. FLETCHER, PhD, chairman of the board of Space-General Corporation, has been named vice president of Advanced Systems at Aerojet. He was founder and first president of Space Electronics Corporation, which became Space-General after it was acquired by Aerojet and merged with the company's former Spacecraft Division. He is also a consultant of President Kennedy's Science Advisory Committee, and a member of the Command and Control Planning Board.

JULIUS S. BENDAT, MS, has formed a research engineering and consulting group, the Measurement Analysis Corporation, in West Los Angeles, and is serving as its president. He was formerly a member of the senior staff of Thompson Ramo Wooldridge. The new company will conduct research in fields "involving mathematical and engineering analysis of physical problems."

1950

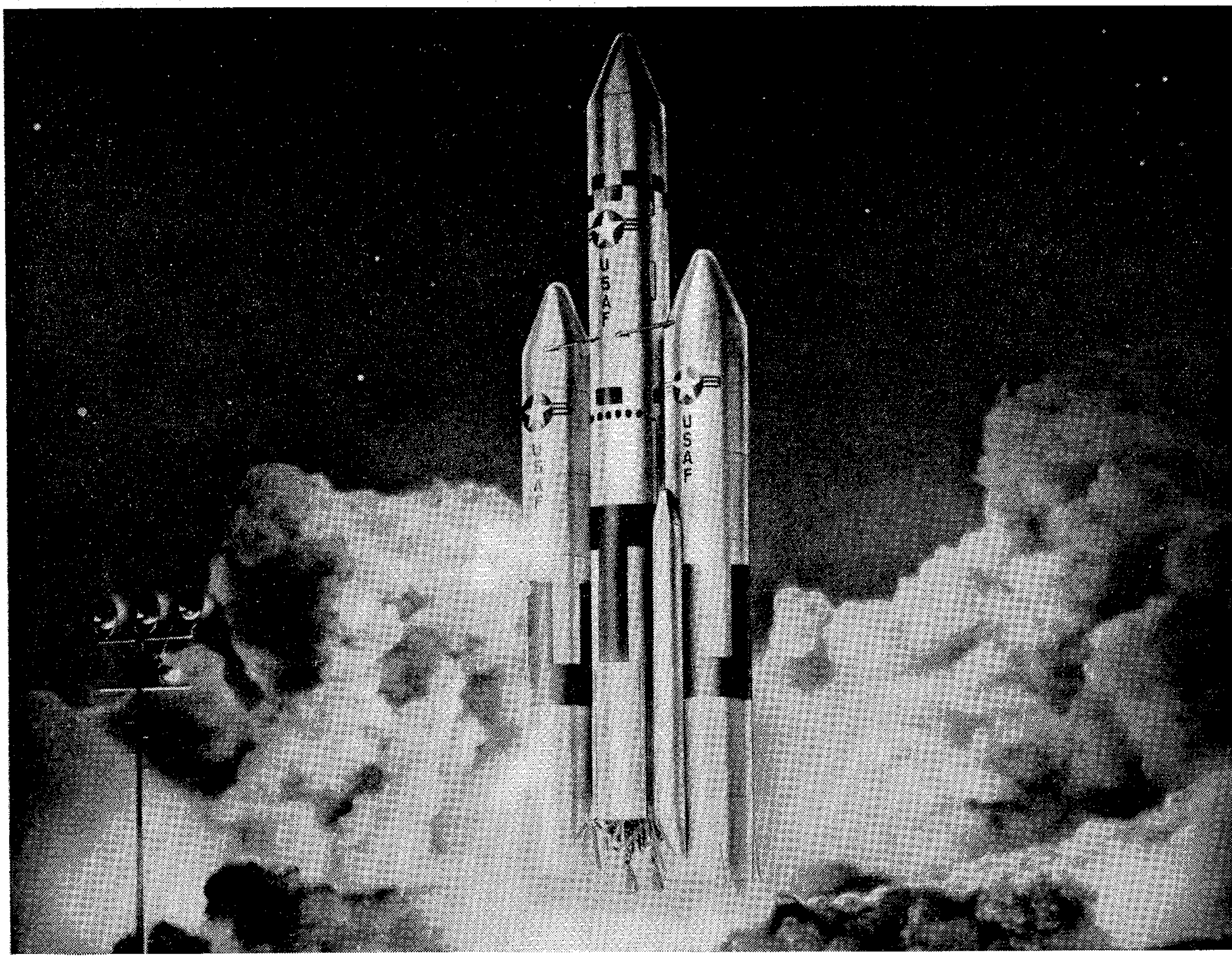
ALFRED J. MONROE, MS, is a member of the technical staff of the Atlas Weapon System Program Office for the Space Technology Laboratories, where he is responsible for the development of weapon systems capability models. After receiving his MS from Caltech he worked as engineering designer for North American Aviation, Inc., and later as research and project engineer at the J. B. Rea Company. From 1955 to 1960 he served as project engineer and research scientist for Litton Industries, Inc., and from 1960 to 1961 as chief of systems analysis for the Hughes Tool Company.

1955

TRUMAN O. WOODRUFF, PhD, is now professor of physics at Michigan State University. From December 1954 to August 1955 he served as a research associate in physics at the University of Illinois, then as a physicist at the General Electric Research Laboratory until May 1962. From June until September 1962 he was an advisory scientist at the Lockheed Research Laboratory.

1956

MAJOR W. HUGH JENKINS, JR., MS, is attending an 18-week course at The Command and General Staff College in Fort Leavenworth, Kansas. The course is designed to prepare selected officers for duty as commanders and general staff officers at division, corps and field army levels. He is assigned to the Geodetic and Space Systems Branch of the Topographic Sciences Division, Directorate of Topography and Military Engineering Office, Chief of Engineers, Washington, D. C.



Alumni News

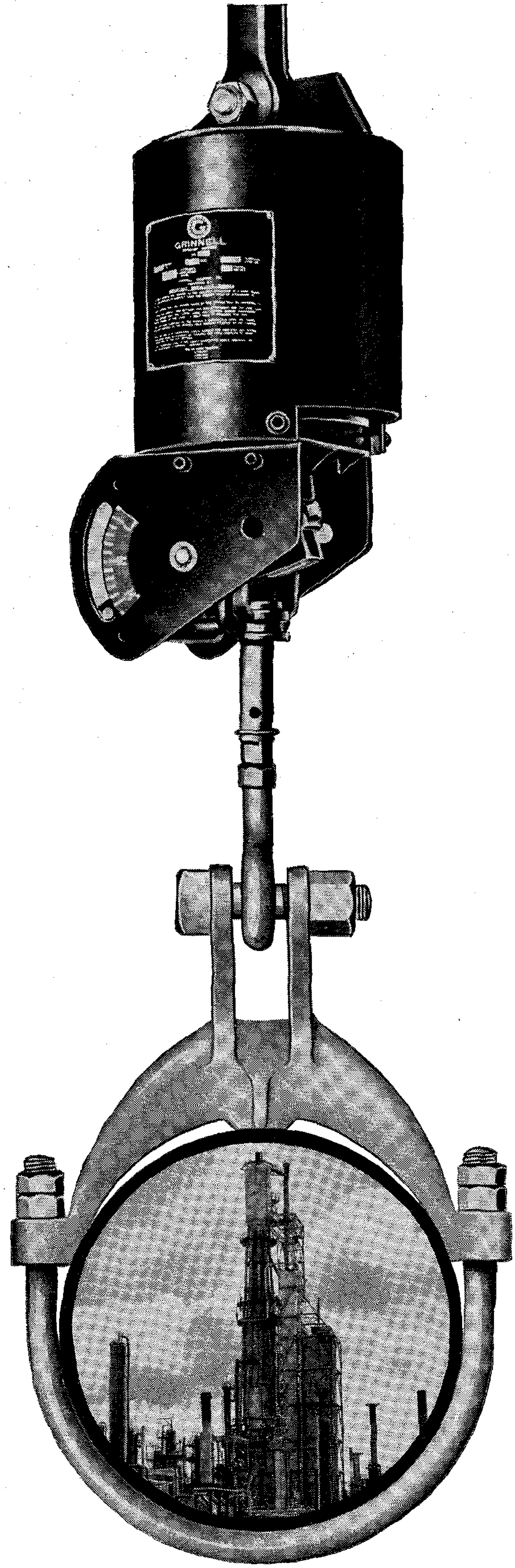
Alumni Dinner Meeting

Albert Ravenholt, of the American Universities Field Staff, spoke on Communist China at the Alumni winter dinner meeting on Thursday, January 10, at the Rodger Young Auditorium.

A correspondent during World War II and a specialist in Southeast Asia affairs, Mr. Ravenholt has been with AUFS for the past 12 years. His discussion recounted the establishment of the Communist regime in China, and told frankly of its efforts to build an industrial nation, of the growth and decline of the communes, of the failure of the "Great Leap Forward," of widespread malnutrition and famine, of the deterioration in the industrial programs. The prepared talk was followed by a lively question-and-answer period. Mr. Ravenholt was introduced by Dr. Edwin S. Munger, Professor of Geography.

The Alumni program includes plans for meeting with other AUFS representatives later this year.

—W. H. Simons '49



PROGRESS REPORT
1962-1963 ALUMNI FUND

Statistics as of January 31, 1963:

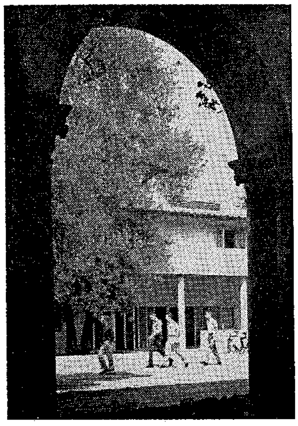
Alumni Gifts Recorded	$52,564.
Number of Alumni Donors	1,050
Alumni Participation	12.0%
Average Gift	$50.07

We are well on our way towards our $75,000 goal, but we can certainly use some help.
Consider this: Eighty-eight alumni out of one hundred are still to be heard from. May we hear from you?

—*G. Russell Nance and William H. Saylor*
Directors of the Caltech Alumni Fund 1962-63


LOOK
WHO'S
TALKING!

CALTECH CALENDAR



ALUMNI EVENTS

May 4 Annual Alumni Seminar

ATHLETIC SCHEDULE

Baseball

March 2
Cal Lutheran at Cal Lutheran
March 6
Cal Lutheran at Caltech

Track

February 28
Claremont-H. Mudd at Caltech
March 2
Long Beach Relays at Long Beach

Swimming

February 28
San Fernando & San Bernardino at Caltech
March 2
Conference Relays at Claremont-H. Mudd

Tennis

March 2
Occidental at Occidental

FRIDAY EVENING DEMONSTRATION LECTURES

Lecture Hall, 201 Bridge, 7:30 p.m.

March 1
Measuring the Heat Earth Receives From the Unlighted Moon and Other Bodies of the Solar System
—Robert L. Wildey

March 8
Nuclear Clues to the Early History of the Solar System
—William A. Fowler

March 15
Rivers and How They Transport Sediment
—Vito A. Vanoni

April 5
Stars in Their Courses
—Olin J. Eggen

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Luncheon first Friday of each month
Visiting alumni cordially invited—no reservation

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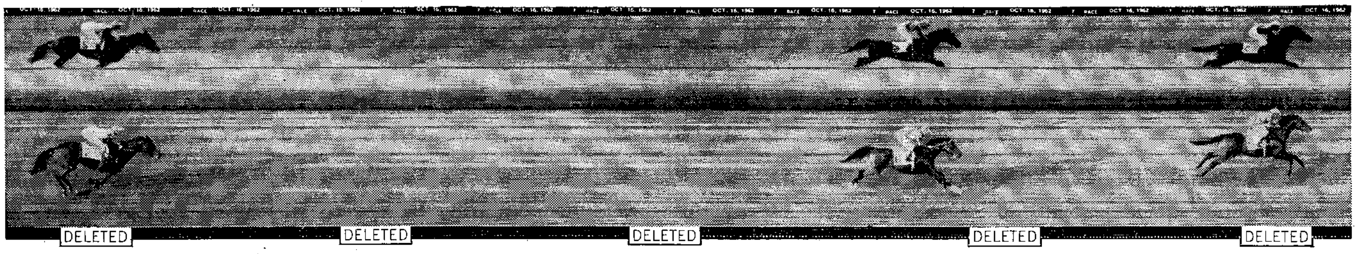
U. S. Navy Electronics Laboratory

Kodak beyond the snapshot...

(random notes)

At long last, the long last horse



The horseplayers of America have made a contribution to engineering. True horseplayers spend their lives contributing. They contribute by a process based on ordinal digits. Determination of the digits often requires instrumentation. A sound technology has developed to support this instrumentation. The horseplayers gladly support the technology by their contributions. The technology is now old enough to have added the expression "photo finish" to common speech.

A photo-finish negative is projected for the judges less than 25 seconds after the last horse crosses the finish line. They nearly always wait for the last horse. If the last horse is quite late, it looks longer than the first horse because there is hardly need for it to hurry any more as it passes the finish line. The finish line is the optical conjugate of a narrow slit at the focal plane of the camera. The film moves past the slit at constant speed.

We have just introduced a new KODAK Timing Negative Film for this work. We don't see why the new film should be denied to off-track use. It is a 35mm film with the perforations omitted and the edge legend KODAK SAFETY FILM reduced in height to .014", all in order to make room for the timing signal and other indicia (some of which have been deleted from the above illustration to protect the privacy of the jockeys). When developed for 10 seconds in the proper hot developer, it yields extraordinary definition at an Exposure Index of about 100. Fixation is extremely rapid. Contrast is readily controlled by the processing parameters. Spectral sensitivity is notably uniform from the ultraviolet to 630mμ.

Electric sugar, $5 per lb.

A mighty industry breaks down the sugar molecule in the interests of conviviality. Use of the sugar molecule as a base for further building is little practiced, except by us. (We do it in the northeast corner of a state which respects the venerable craft that works the other way.)

And what is achieved thereby?

A high dielectric constant, a large increase in the capacitance of an electrical condenser compared with when there is nothing between the plates.

Obviously, the manufacturers of capacitors and of electroluminescent panels have had to be notified. We find them interested and alert.

We divert a little sucrose from coffee breaks and react it with acrylonitrile, forming a clear, viscous liquid designated *Cyanoethyl Sucrose* in which a statistical 7.3 of the 8 available hydroxyls are replaced by OC_2H_4CN groups. At 60 cycles this substance has a dielectric constant of 38 and competes with other cyanoethylated dielectrics at 11-19 and with chlorinated aromatic hydrocarbons at 4-6. (The dielectric constant of water runs around 80, but water is such watery stuff!)

Other invidious comparisons:

	Cyanoethyl Sucrose	other cyanoethylated dielectrics	chlorinated aromatics
cost per lb.	$5 (development)	$12-$27	15c-25c
dissipation factor (25°C, 60 cycles)	0.010	0.17-2.7	< 0.1
volume resistivity (25°C, ohm-cm)	5×10^{11}	$3\text{-}6 \times 10^{9}$	$> 5 \times 10^{12}$

Chemical advice

Virtually every laboratory in this country and many other countries that ever has occasion to work with organic compounds has a green book entitled *Eastman Organic Chemicals List No. 42.* It gives the accepted nomenclature, structural formulas, melting range or boiling range, and prices for convenient quantities of thousands of compounds, many of them in several grades of purity. Perhaps you have a copy.

Get rid of it.

It is out of date. The new one bears the designation *List No. 43,* which seems logical enough. It is BLUE. There is a first-rate chance of acquiring a blue one by asking a division of ours called Distillation Products Industries, Rochester 3, N.Y. If this offer appeals to you at all, we can visualize you in a position some day to do us a favor by buying our chemicals. It is with that same eye to the future that we try to keep you aware of photographic ways of engineering.

Since past endeavors in these directions have made the goods move well, possibility arises also of becoming *one* of us instead of a customer. For example, successful chemical plants need good men to instrument them for process control. Interested?

EASTMAN KODAK COMPANY
Rochester 4, N.Y.