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ENGINEERING AND SCIENCE

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

March 1968

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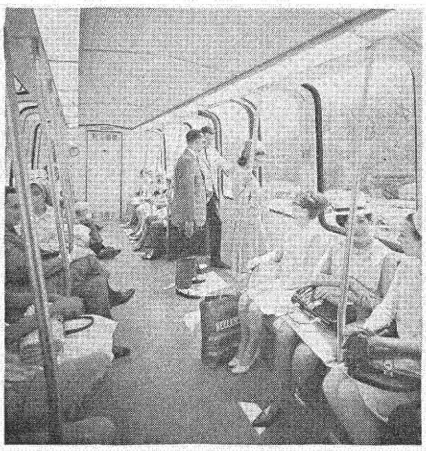

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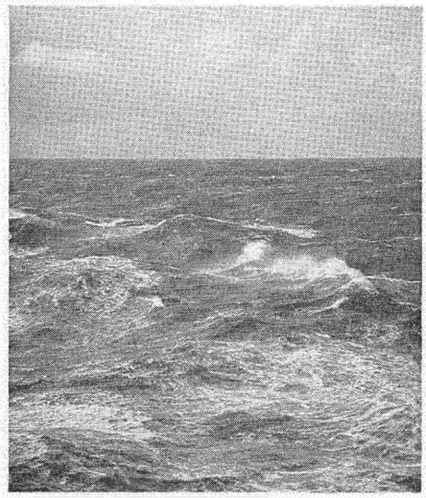

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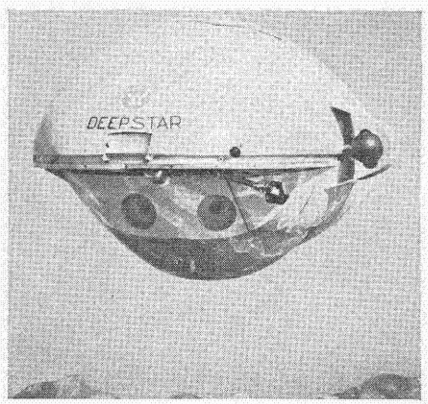

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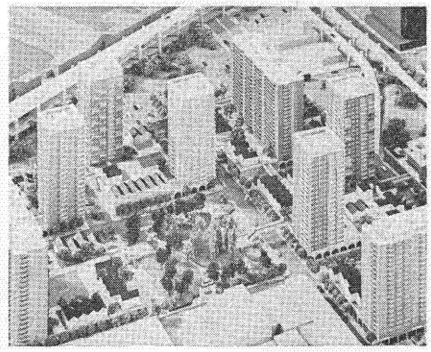

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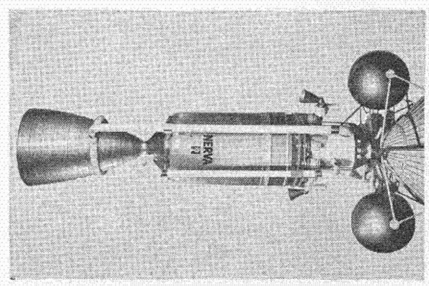

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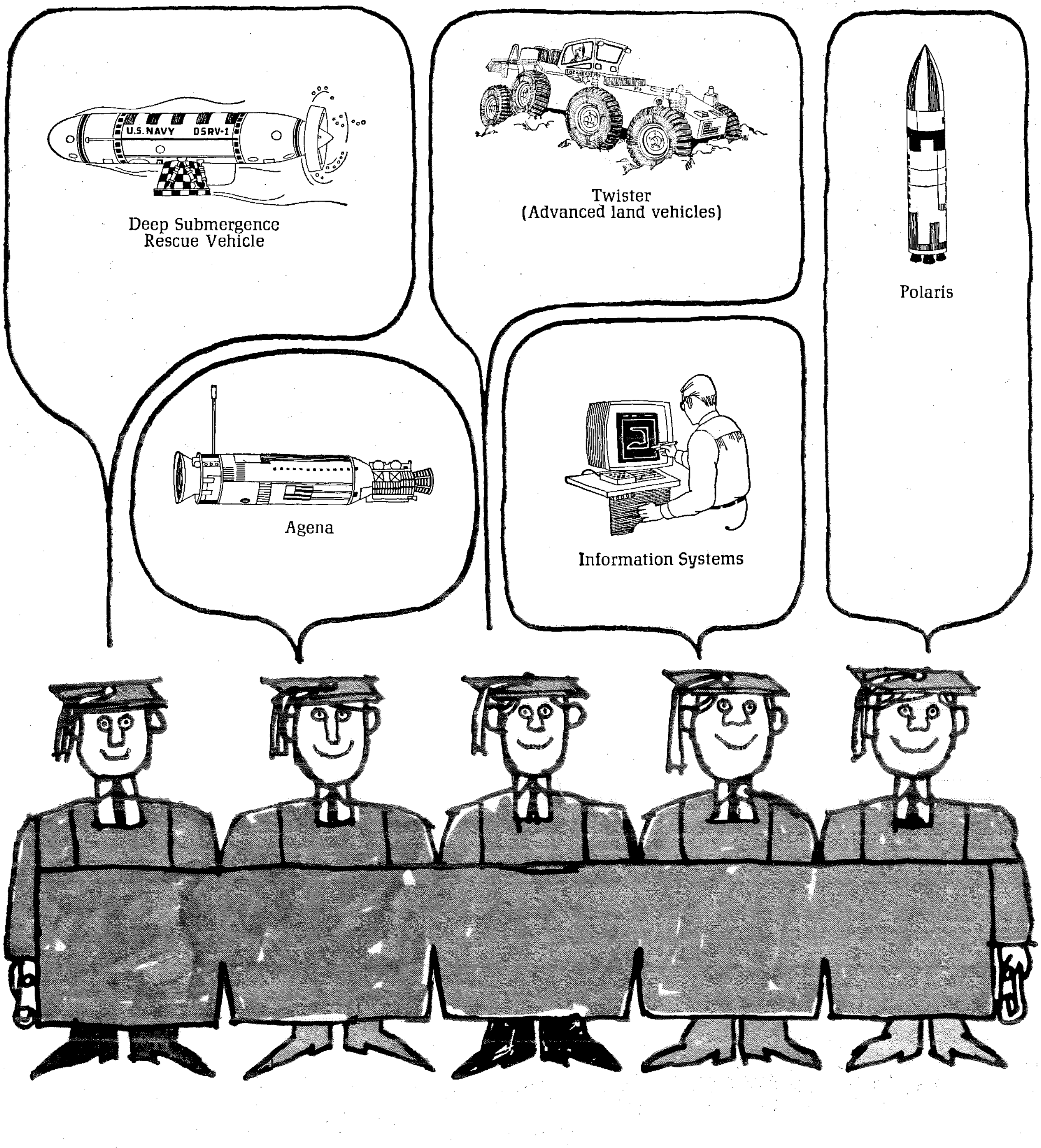

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ENGINEERING AND SCIENCE

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ON THE COVER

A member of the Caltech faculty and a staff associate of the Mount Wilson and Palomar Observatories, Dr. Bruce Murray combines a geological background with recent training in the planetary sciences. Add to this a deep concern about the U.S. space program, and it becomes clear why he was asked to testify on the subject before a congressional subcommittee. His testimony and dialogue with the press—page 9.

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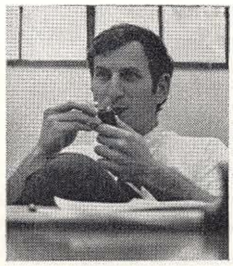
IN THIS ISSUE

PLANETARY EXPLORATION

When Bruce Murray came to Caltech in 1960, he was pure geologist. Within three years he had undergone what he calls his "retread" into a planetary scientist. In the wake of this momentum he was influential in the Institute's establishing, in 1965, an option in planetary science for graduate students in geology. Dr. Murray continued to expand his activities in the field of planetary science, and today he is a much respected critic of the American space program. On pages 9-14 he says what he thinks about that program.

BETA-RAY SPECTROMETER

One of the newest instruments for studying atomic nuclei is the beta-ray spectrometer, designed by Jesse DuMond, professor of physics, emeritus (right). On pages 15-18 is an article on the development and use of this unique instrument, now an important part of the research program headed by Felix Boehm, professor of physics (left).



THE RADICAL RIGHT

Robert Rosenstone is a teacher of history by profession and enthusiasm and a journalist by training and inclination. While getting his BA (in literature) he worked on the UCLA student paper and started a literary magazine "to publish my own short stories." After earning his PhD (in history) he worked for the *Los Angeles Herald Examiner* and the *Los Angeles Times.* Now an assistant professor of history at Caltech, he combines his enthusiasm and inclination to write an account of the Radical Right as he sees it today—on pages 24-28.

A TRIBUTE BY STEWART SMITH

Stewart Smith was a graduate student when he came to Caltech to work with Hugo Benioff in 1957. When Dr. Smith was appointed to the faculty in 1961 the two geophysicists continued to work together, and even after Dr. Benioff retired in 1963 they had a joint assignment—helping to select sites for proposed nuclear reactors on the West Coast. On page 29 Dr. Smith pays tribute to his friend and colleague, who died on February 29.

ANNOUNCING

An Introduction to the Meaning and Structure of Physics

LEON N COOPER,
Brown University

This new text does not require calculus as a prerequisite. Tightly structured, the book first examines all the classical topics—mechanics, heat, light, electricity, magnetism—and then moves to the study of modern physics. This approach integrates the fundamental ideas of physics within their historical setting and is followed by generalization and abstraction to more advanced concepts. The selection of material offers an opportunity to look at physical theories from various points of view: as they are developing; in a classical, formal, or axiomatized stage; and the extent to which they can be developed to provide a picture of the world.

The text develops and displays the structure of physics in a rigorous but not overly technical manner while making the correspondence with experience as immediate as possible. The concepts, rather than the techniques, are emphasized. The text studies, in unusual detail, the development of concepts and the problems to which they were a response. These concepts are expressed in words; mathematical symbols are associated directly with them. Mathematical tools are introduced in simple, explicit form, as they are needed, to motivate the use of mathematical ideas as the expression of a concept. Quotations place the various themes in context and offer the student some answers to questions on why matters developed in one way rather than another.

The discussion begins with an examination of the problem of motion and proceeds to investigations of the development of Newtonian mechanics, electromagnetic theory, relativity, Bohr's theory, quantum theory, quantum electrodynamics, and particle physics. The early development establishes a basis for the discussion of more difficult topics. While employing elementary techniques, the text presents a unique, detailed treatment of the development of quantum theory. The pace of the book varies; some sections are rigorous and quantitative, others, such as the one on quantum electrodynamics, are more expository. The text brings the student through to the heart of modern physics: particle physics.

800 line drawings and graphs and 70 photographs, 5 of which are in color; illustrative solved problems; extensive study questions and problems (with answers for the odd-numbered problems included) for each chapter; mathematical appendix; source notes and index. *April. 748 pp; $13.95*

Introduction to Calculus

DONALD GREENSPAN,
University of Wisconsin

As a first course in calculus, this revolutionary text is designed to reflect the vast impact which modern physics and modern high speed computing have had on all the scientific disciplines. Discrete geometrical and physical concepts are studied with an awareness of high speed computer capabilities. Continuous geometrical and physical concepts are developed by applying limiting procedures to discrete ones. Thus the author not only covers the usual material on limits, derivatives, integrals, series, and first and second order differential equations, but also develops—with equal emphasis—theory, techniques, and applications relating to discrete functions, difference quotients, finite sums, and nonlinear difference equations. Such vital concepts and topics as quantized time and motion, discrete model theory, and interval arithmetic are developed and applied for the first time in any calculus text.

Introduction to Calculus is a mathematics book—calculus is developed with the same rigor accorded to other mathematical subjects. Computer topics, such as systems programming, are not discussed. However, computer related techniques (Newton's method, speeding up convergence of series, etc.) are presented in such a fashion that, if so desired, they can be programmed easily for any digital computer. The ordering of the material is mathematically logical, but reordering for various pedagogical purposes can be accomplished easily and in a variety of ways. More difficult sections, like those relating to the theory of limits are marked with an asterisk and may be treated with care, treated lightly, delayed, or deleted entirely. Applications are made primarily to geometry and to the physical sciences, but applications to the biological and social sciences can be inserted easily and naturally.

Throughout the text, the author has provided numerous illustrative examples. The many exercises at the end of each chapter vary in difficulty and nature; answers to half of them are provided in the text; the balance are given in an answer book. Index. *439 pp; $9.95*

Mariner IV takes off for man's first close-up look at Mars.

In the exploration of space, the U.S. faces an inescapable choice:

TO LEAD OR TO FOLLOW

Bruce C. Murray is associate professor of planetary science at Caltech, a staff associate of the Mount Wilson and Palomar Observatories, and a member of the television team preparing to photograph Mars from the 1969 Mariner flyby. For more than ten years he has been enthusiastically involved in a number of aspects of planetary exploration, both scientific and political. He was co-investigator for the 1965 Mariner IV television experiment; he has been a consultant for the RAND Corporation in the area of earth-orbital space technology; and he has long been engaged in space-related research, which includes making detailed infrared observations of the moon and planets.

Naturally, then, Bruce Murray has strong convictions about America's space programs—convictions most recently expressed before the House Subcommittee on Space Science and Applications in Washington, D.C., on February 20. (The full text of this statement appears on pages 13 and 14.) Back on the Caltech campus the next day, Dr. Murray faced questions from the press. On the following pages—some highlights from this interchange.

Caltech's Bruce Murray states the case for U.S. planetary exploration in an interview with a group of the country's top science writers.

To put it bluntly, the United States is in the process of going out of the business of space exploration, and 1968 is the year in which the patient is becoming terminal. I feel that there is a very real chance that your children and mine will grow up reading about the planets and other discoveries in space from Soviet news reports and Soviet books. And I personally find that a very dissatisfying feeling. I am accustomed to the American view of managing to maintain at least some excellence in areas as challenging as the discovery of new worlds.

Why is it dying? Who is responsible?

You. You, the American people. The space exploration program is not dying due to any Machiavellian plot; it is dying because the American people are fearful; they are turning inward. They are more concerned about the problems of the present than with the hopes of the future, and they are showing it very much in the kind of legislation that is getting passed and in the national priorities that are being set. The blame cannot be placed entirely upon Congress and the Administration because, if popular opinion polls had been followed, we would have gotten out of the space business a little sooner.

Are you more concerned with space exploration in 1978 than a Watts in 1968?

No. However, I am concerned about the image an American has of himself now and will have of himself in 1978. What kind of a person is he and what kind of a country, culture, and society does he represent? I think a country that has the capability of participating in something as exciting as space exploration and chooses not to do so is giving in to an undesirable aspect of its own self.

What evidence is there that the Russians are more concerned with the future in space than the U.S.?

The Soviets have now demonstrated a very impressive interest and a capability for planetary exploration. They have launched or attempted to launch 19 spacecraft to Venus and Mars since 1960. These have included both landers and flybys, and until October 1967 they had not one single success. They've missed only one planetary opportunity, which was the last one to Mars, and I think there were strategic reasons for that. They kept up this effort even though there was a major change in their government. The technical character of their program is the same now as it was in 1960. The objectives have been, starting with Lunik II, to reach—physically reach—the surface of these cosmic bodies. Something in the Russian character is involved here; this is terribly important to them. If you read the Soviet domestic news reports written for Russians by Russians, you will realize this. They were first to get to the Moon, they were first to make a soft landing on the Moon, they were first to get to Venus, and it is obvious that they intend to be the first to get to Mars.

Isn't that just for political reasons?

No. I think their drive reflects a cultural motivation and is not "political" in the propaganda sense. It demonstrates to them the promise of their own society. They have suffered a very great deal. They have put up with a lot of things they don't like. When they are able to do something that they recognize as important and historic, and to be the first, this demonstrates to them that they are the wave of the future. They really feel this way. Our mistake in evaluating it is that we tend to be a little too cynical. We assume it is all a Madison Avenue stunt, and it is not. I think the Soviets would have the same planetary program now even if there were no way of communicating to the West what was going on. I think they would do it for domestic reasons. There is no other explanation for the magnitude of the planetary program. It represents an effort something like five or ten times as large as ours, on a much smaller industrial base. There is no national justification for such an investment except that it is a very important program for domestic reasons.

It seems to me that what you are offering us is just one more chapter in "the Russians are coming, the Russians are coming." Isn't that just what we've reacted to in the last ten years?

Not in the planetary program we haven't. Not by a long shot. The Soviet effort in space is a much bigger one than ours. If we are so frightened, so fearful, and so unsure of ourselves in 1968 that we don't want to respond, I am very worried about us. The reason this is the kind of challenge we should respond to and take seriously is that it is a challenge to our culture's self image. It is not a challenge to national security. That's the point. If a nation only responds to external things that are security threats or only responds when there are riots in the streets, then it is a sad thing, and perhaps such a society won't last long unless it has something more redeeming and more enduring in its image of itself and as its purpose. This is why I say exploration in space is a cultural challenge—and a profound one.

How can our money be best used to give us a viable planetary space program?

The amount of money requested this year for the planetary program is, I believe, enough to support a continuing planetary program which will provide a spirit of adventure and discovery for America. Quite honestly. And it doesn't require that we have enormous funds in the future. It isn't just a come-on. But I don't feel this can be done if we also continue the present program aimed at the search for life on Mars. The U.S. has not faced squarely the choice between a good program it can afford and the much more expensive one that it would like to pursue.

Are you then advocating abandoning the search for life on Mars?

No, I'm advocating that Congress declare whether it is willing to fund the search for life on Mars. If Congress continues, as it has in the past, to support only a small effort and to pay verbal homage—saying "Wouldn't it be nice?" and "Shouldn't we have a big one?" and not do it—then we will have nothing.

Has the Administration made a clear decision not to continue the search for life on Mars?

The presently proposed program in front of Congress includes a Mars mission in 1969, a new proposed mission to Mars in 1971, and a new mission in 1973. Yet it still does not include a life-detection experiment on Mars. The principal justification for those missions evidently is to carry out the preliminary steps before life-detection. A more ambitious mission for life-detection could not be entertained before 1975 and then only if we are willing to provide sharply increased funds two years from now. Thus, it is not clear whether the U.S. will actually search for life on Mars in the 1970s at all. I doubt very much if the Soviets will find it necessary to take so many steps over so long a time scale. I expect the Soviets will go much quicker and go directly into a life-detection mission of some kind.

Couldn't the U.S. drop the preliminary missions and make an all-out effort to search for life on Mars?

I think the problem is not the life-detection mission per se but the lifetime of the lander once it has touched down. The proposed 1973-probe will live for only one day, and life-detection experiments are generally those testing some kind of growth. You throw something out and see if something eats it, or in a very sophisticated way find out if it's growing. If technological considerations alone were all that were involved and a realistic appraisal of the sterilization were made in conjunction with what the Soviets have already indicated, there is no question in my mind that we could deploy a life-detection experiment on the surface of Mars in 1973; and that we could deploy an important precurser in 1971. That's not a technological question, and frankly I don't think it ever has been. It's tied in to some ghosts that have inhabited some dark regions of our decision making.

If we take the "Grand Tour" as opposed to searching for life on Mars, won't we just have a little bit of information about a number of planets rather than a firm grasp on one?

This is a strategic decision, and I did not say we should do that. I said that we must be rational in our choice, and if we accept the challenge of the search for life on Mars, recognizing Soviet competition in this area, we must be sure that we accept the cost implications for future years. But if the U.S. in its wisdom decided it preferred a less costly alternative strategy, I would suggest this logic: We can know so little about the other planets because of their distance from the earth and because of the limitations of our atmosphere that a flyby can give us significant information about those planets by returning high-resolution photographs and other close-up measurements, such as information about magnetic fields and radiation belts. Such "first looks" represent an enormous intellectual step, and one that must be taken in any discovery program. In this approach, one doesn't make a priori decisions about one planet being the most interesting before preliminary information has been obtained about others. Rather, one should take a first look at as many planets as possible and then decide where to concentrate the obviously expensive direct measurement phase.

What do you think are the five or six next planetary programs which the U.S. could consider?

I will give you some possible programs in the order in which we can do them. Our alternatives would be dependent on timing.

In 1970—a first look at Mercury, which up to this time has not been photographed due to its nearness to the sun. In going to Mercury, we could get a free look at Venus and perhaps discover if photographs are a useful way to explore it close up; the continuous cloud cover has prevented us from seeing the surface. We are so ignorant about many of these planets that no matter what we find it can't help but be significant. We can't lose, and this trip would have a big impact on our total view.

Beginning in 1972, we will be able to go to Jupiter every 14 months. We must develop specialized electrical power sources to do this, however—sources that can stand getting that far away from the sun. This is not a big deal, but we've got to get it ready. If it's not ready, we can't go. In a trip to Jupiter we could find out about its radio emissions and how its radiation belts affect them as well as learning about some of the "fine structure" in its clouds.

In 1977-78, we can handle the "Grand Tour." This is a mission where a spacecraft is launched to Jupiter; there it is captured, and then it escapes from Jupiter's gravitational field and is accelerated out into the distant ranges of the solar system where we could never go by chemical or even nuclear rockets, at least not in the near future. This is the same trick that is used to get to Mercury, but with Jupiter being so massive it really provides a zap! The "Grand Tour" would go by Jupiter, Saturn, then by Uranus, and finally on to Neptune, the whole thing taking about ten years. The next time this "Grand Tour" will be possible is 2153 A.D.! For a major power that has the technical capability not to take advantage of this, not to exploit this fantastic opportunity, would be inconceivable. I realize that is a strong statement, but I feel very strongly about this.

Why haven't we heard much about this "Grand Tour"?

This whole set of missions depends upon gravitational acceleration by one planet to another. The so-called swing-by missions were just "invented," if you will, about three or four years ago, and this was a new, imaginative idea that opened up whole new realms of the solar system to exploration. That's one reason those missions weren't in the program before—people didn't even know about them.

Has enough money been appropriated for a significant space program this year?

The issue here is not whether the funds this year are sufficient. The issue is—what are the implications of future costs? If those future costs are not borne, what are the implications of the present program? The U.S. has come to a point in time where we really have some options. We have the chance to really advance. We must think of the cultural significance of what we have before us.

In your address before the subcommittee you stated that one of the compensations for living under the mental and moral stresses that characterize the wealthiest and most powerful country on earth is to be able to harness our wealth and power for the accomplishment of lasting events of which we are proud. What kind of events do you have in mind other than the space program, or is that the only one you would put in this category?

There *are* other events. I think there are very few, however, for which we have the current capability and that are so dramatic as the ones that I have described. You come to a point in time when you have some options. You have the chance to really hit a home run as a country, and I think this is our chance.

Is the space program the only place where we now have the opportunity to hit this home run?

No, but I think it's the only place I know of where it is as clean-cut and simple. I'm sure if we can somehow make a major breakthrough in the problems of helping underdeveloped countries gain scientific competence, that would be very important, but I don't see any simple way of doing that. I'm sure there are ways we can reduce the hostility and dissatisfaction of some of the urban areas, and this would be a great step forward. I don't know how to do that; I *do* know how to get to Mercury.

U.S. PLANETARY DECISIONS IN 1968—A TEST OF NATIONAL JUDGMENT

A personal evaluation of proposed programs for U.S. participation in planetary exploration, prepared at the invitation of the House Subcommittee on Space Science and Applications for presentation on February 20, 1968.

by Bruce Murray

As a nation we seem to be facing an inescapable choice as to whether to lead or to follow in the exploration of the solar system. I would like to clarify why, as a scientist, I think this is so and why, as a citizen, I feel it would be tragic if we were to ignore the challenge and the opportunity when it is within our means to respond.

The process of discovery, geographic and otherwise, is a basic human activity and particularly characteristic of Western civilization. Since the fundamental product of discovery is new knowledge, there is intrinsic significance to the first time an important observation is accomplished and enunciated. Subsequent repetitions of the observation are necessary to confirm and elaborate the basic discovery but do not have the same significance. Consequently, once there is more than one group of people with the technological capability for discovery, a competitive situation automatically exists. And, like competition in business, athletics, and other human endeavors, either a "race" between relatively equal participants results, or one group entirely dominates the situation.

In the area of planetary exploration, the U.S. has not been effectively challenged until last October. True, the Soviets have expended a much greater effort than we as evidenced by the fact they have attempted to launch nearly 20 large planetary spacecraft since 1960, including both landers and photographic flyby's, while the U.S. has only attempted five smaller flyby's involving less than 2 percent of the NASA budget. Yet, the cultural and scientific rewards have, until now, gone entirely to the U.S. The Mariner II flight to Venus in 1962 was man's first direct venture outside of the Earth-Moon system and discovered that our nearest planetary neighbor had no magnetic field. Most important, it pioneered the technological tools necessary to subsequent discovery. Those tools were brilliantly utilized by Mariner IV when it discovered in 1965 that Mars' surface resembled that of the Moon rather than the Earth, that its atmosphere was thinner and more hostile than has been supposed, and that it too did not exhibit magnetism.

Then, last October, the veil of mystery surrounding Venus was pierced directly for the first time by the Soviet capsule mission Venus IV. Suddenly our Mariner V mission lost all chance of being a mission of discovery and was relegated to the role of filling in some of the details. Suddenly, there was another group of people with the technological capability for discovery, and thus a competitive situation came into being. Suddenly, U.S. scientists began to recognize that they might learn about the surface conditions and atmospheric composition of Mars also through Soviet news reports rather than as a result of their own efforts, and further that they might have very little to say about what precautions should be taken to prevent accidental contamination of that planet.

Of course, just because the Soviets have demonstrated a new space capability doesn't necessarily mean they will aggressively utilize it; obviously the U.S. shouldn't attempt to respond to every *possible* Soviet challenge. However, the Soviets have stuck to their original planetary objectives through seven years of disappointing failures and a major change of government even though the U.S. was achieving great success with a much smaller program. And it would be a mistake to attribute such intense and undeviating effort solely to expected propaganda benefits. Venus IV was a very sophisticated scientific endeavor as well as a major technological achievement. Even a casual perusal of the Soviet reporting of Venus IV cannot leave much doubt that being first to the Moon and now to Venus with an unmanned landing constitutes a very meaningful demonstration to the Soviet people of the technological and cultural potential of their own society. There is every reason to expect the Soviets to aggressively exploit their newly demonstrated space capability in an attempt to place a scientific instrument package on the surface of Mars along with the usual Soviet pennant. And there is no evidence they regard the search for life on that planet necessarily as such a complex and difficult task that it must always await second or third generation landers. They might even begin initial experiments with a first landing as early as 1969.

Hence, it seems to me that we must accept the real possibility of Soviet Mars lander attempts as early as 1969 and that we cannot rule out other attempts at planetary firsts either. The real question, then, is what alternatives do we have to participate in the exploration of our planetary companions in this lonely solar system? Most important, do we care enough to make the effort? Is it really very important to us whether or not America plays a key role in what must be regarded as one of the great human endeavors of this century?

1. The recent Soviet Venus success abruptly ended any unilateral U.S. view of planetary exploration objectives and schedules. From now on, we must take into account probable Soviet endeavors when committing our own resources for planetary exploration.

2. Because of our present superiority in communications, in spacecraft reliability, and in photography and other kinds of remote sensing instrumentation, we can maintain a position of unchallenged excellence in some aspects of planetary exploration by pursuing opportunities for a 1970 Mercury flyby, for an early Jupiter flyby (launched no later than 1973), and for a 1971 Mars orbiter. These missions, together with early preparations to exploit the once-in-a-century opportunity in 1977-78 to take the "Grand Tour" of Jupiter, Saturn, Uranus, and Neptune, can be carried out without national commitment to major funding increases in future years.

3. However, the Space Science Board of the National Academy of Sciences has recommended that the search for evidence of simple life on Mars be the principal objective of the U.S. planetary program. A large, urgent, and concentrated effort now will be required if we still wish to participate in this exciting venture. In particular, postponement until 1973 of the first U.S. landing effort on Mars incurs a high risk of obsolescence for that mission as a result of equivalent or superior Soviet landings in 1969 or 1971.

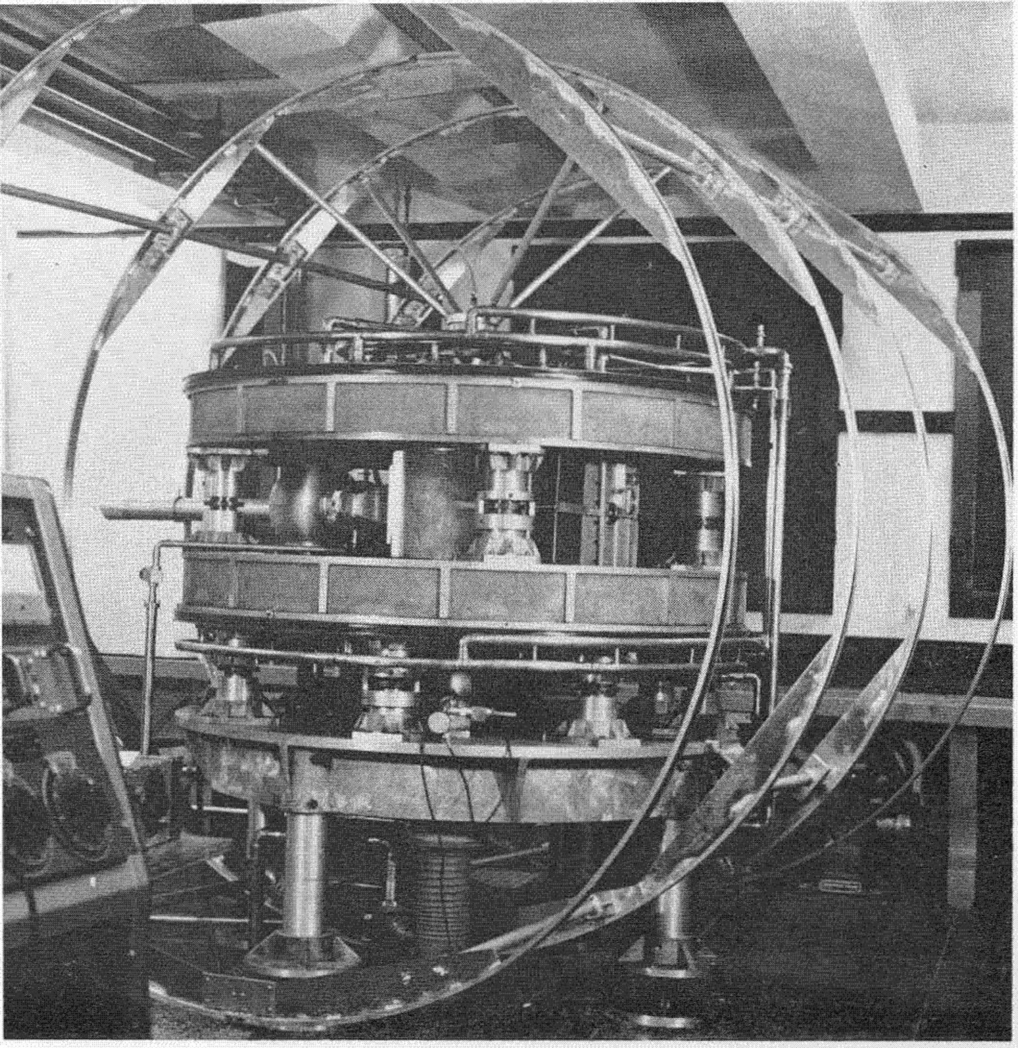
4. On the basis of the foregoing, the currently proposed planetary program may be regarded as an inadequate compromise between the opportunity to exploit our strength in flyby's and orbiters on the one hand, and the need to develop a competitive lander capabiltiy on the other. More satisfactory alternatives might include a single Mars lander mission in 1971, perhaps with an orbiter launched separately also, or a single-launch to Mercury by way of Venus in 1970 at the expense of some of the Mars effort currently proposed.

5. The present compromise is, however, only a symptom of a more basic weakness in our national space effort—the lack of agreement as to its character and magnitude in the post-Apollo period. We can have a program of planetary exploration at modest cost by emphasizing "first looks" at ever more distant planets. We can also participate in the direct exploration of the surface of Mars, if we are willing to substantially increase available funds each year for the next three to four years. But the sure road to mediocrity and to a conspicuous second place, now that the Soviets are in the game, is to try to keep both options open within limited resources. Congress, NASA, and other elements of the Government must come to terms on whether or not funds for U.S. planetary exploration can be expected to increase rapidly in the coming years. The enormous disparity between proposed and actual funding must end if we are to effectively pursue *any* planetary program of distinction.

6. If the enthusiasm of the American people is judged insufficient to support rapid increase of funds for planetary exploration, then we must realistically reexamine the search for possible microbial life on Mars as our guiding strategy, perhaps to conclude that we had best wait initial Soviet results on that subject while pursuing effectively other very challenging scientific objectives in space. There simply may not be now, nor ever have been, life on Mars, whereas the first close-up looks at Mercury and Jupiter, to say nothing of the more distant planets, will surely be historic milestones in man's search to understand his surroundings. We need not always be first but must not always be second.

The U.S. is faced with many challenges today. Some, like the Soviet nuclear capability, bring into jeopardy our very survival. Others, like the increase in domestic violence and lawlessness, put us on notice that we must more effectively adapt our social attitudes and procedures to the ever increasing pressures of the Industrial Revolution merely to sustain the quality of American life, much less enhance it. But beyond challenge to our security and welfare there is the challenge to excel as a society, to contribute significantly to the history of man. That is the nature of the challenge of planetary exploration. This challenge can't be postponed—the planets are going to be explored only once in this history of man, and that time is close at hand. One of the rewards for living in this chaotic 20th century is to witness such marvelous events. One of the compensations for living under the mental and moral stresses that characterize the wealthiest and most powerful country on earth is to be able to harness our wealth and power for the accomplishment of lasting events of which we are proud. We must not fail to respond, because it is a challenge to our vision, to our optimism for the future, to our image of ourselves.

Congress can and must insure that the next generation of Americans can share with us genuine satisfaction and pride in their country's spirit of adventure and discovery. A national commitment to excel in at least some phases of planetary exploration is necessary in 1968 if this precious part of our heritage and national character is to be sustained.



by Jesse W. M. DuMond
and Edwin C. Seltzer

THE IRON-FREE, MAGNETIC, BETA-RAY SPECTROMETER

Designed and built at Caltech, it is one of the newest instruments for studying atomic nuclei.

The Caltech physics research group known as Physics 34, under the leadership of Felix Boehm, has been engaged for a number of years in nuclear spectroscopic studies in an effort to learn more about what goes on inside the nuclei of atoms, how they are constructed, and what laws they obey.

One of the newest tools used in this work is an instrument known as the high-resolution, iron-free, magnetic, beta-ray spectrometer, designed and built entirely at Caltech. In one of its important applications, the instrument is used to study the spectral distribution of the energies of "internal conversion electrons" by deflecting the electrons in a magnetic field as they escape from radioactive sources prepared in a nuclear reactor.

The spectrometer has been designed, as its name implies, to be free of iron or other ferromagnetic materials, the magnetic field being entirely generated by direct electrical currents flowing in coils of copper ribbon of very accurately constructed geometrical configuration. The magnetic field in the vicinity of such coils can be calculated very accurately from the geometrical dimensions of the coils and from the current. If iron were present, the phenomenon known as hysteresis would interfere seriously with this accuracy and reproducibility.

The instrument is used to obtain information as to the energy levels, spins, parities, and other properties of nuclear "excited states" in the complicated heavy nuclei of such atomic species as hafnium 175 and 177, lutecium 175, tantalum 181, ytterbium 175, tungsten 182 and 183, and thulium 169. These eight nuclidic species have recently been studied by two Caltech graduate students, now postdoctoral fellows—Ralph Hager and Edwin Seltzer.

The number attached to each of these eight nuclear species is known as the mass number of that nuclide. It corresponds to the total number of nucleons (protons and neutrons) of which that nucleus is believed to be composed. Since neutrons are electrically neutral (i.e., they have no electrical charge), the number of protons alone determines the atomic number. The atomic number corresponds to the number of electrons which the nuclear charge requires to form an electrically neutral atom. Most of the chemical and physical properties of each atomic species, including the size of the atom, depend on the outer electronic structure.

The nuclei of atoms, when excited, can assume only well-defined *discrete* energy states, called *energy levels*. The nucleus is said to be quantized, just as are the various modes of excitation of the electrons. The intervals between energy values of these levels may differ markedly from each other, forming a pattern characteristic of each nuclear species. For each nuclear species the lowest rung of the energy stepladder formed by these levels is called the ground state, and the levels above it are called excited states. The pattern of unequally spaced energy levels is called the "level diagram" for that nuclear species.

NUCLEAR ENERGY PHENOMENA

When, as may often happen spontaneously, an excited nucleus goes from a higher to a lower energy level, the difference in nuclear energy thus lost may result in several observable phenomena such as:

(a) the emission of a photon of gamma radiation, or

(b) the ejection, from the atom to which the nucleus belongs, of one of that atom's electrons—a process called internal conversion.

When this process occurs, the ejected electron possesses a very sharply defined kinetic energy—the characteristic energy it received from the nuclear transition, minus the energy required to free the electron from its attachment in the atom. A study of the kinetic energies of such ejected converted electrons, therefore, yields highly accurate information as to the energy level diagram of the nucleus of the atom under study.

ENERGY DISPOSAL METHODS

These two processes are not the only ones through which excited nuclei dispose of their energies. For example, they may also:

(c) capture electrons from the atom in which they are situated, or

(d) give birth to electrons where none existed before (beta decay).

The magnetic spectrometer detects the internally converted electrons ejected by process (b), and it measures the different characteristic *speeds* of these electrons by deflecting them with a magnetic field of precisely designed spatial distribution whose intensity can be progressively varied at will over a wide range. The spatial distribution of this field is purposely designed with great care so that electrons of one, and only one, well-defined kinetic energy issuing from one fixed point in the field where the radioactive source is placed will be refocused. This is done sharply and selectively by the magnetic field at another fixed point, the secondary focus, where a fine slit is placed to receive them. The electrons that find their way through the slit are counted by means of a Geiger-Muller counter placed with its thin window immediately behind the slit.

The magnetic field is produced by a system of six coaxial oil-cooled coils of copper ribbon. The intensity of this entire magnetic field distribution can be controlled and varied over a wide range by controlling the electrical current flowing in the copper coils. The spectrum of conversion-electron energies is explored as the magnetic field intensity is automatically varied in successive small steps, stopping at each step and recording the rate at which the electrons are counted at the secondary focal slit. Whenever a magnetic field intensity is reached of a precisely correct amount to focus electrons having one of the energies characteristic of the nuclear source under examination, the counting rate recorded by the detector rises abruptly. This, together with the field intensity, is automatically recorded, thus giving evidence that there is a characteristic line (energy step in the nuclear energy level ladder) at a sharply determined energy corresponding to the existing magnetic field intensity. The energy is automatically recorded.

The energies thus determined yield important information as to the magnitudes of the energy intervals between pairs of levels on the diagram of the nuclear species under study.

The relative *intensities* of these conversion lines also furnish equally important information of another kind. Not all transitions between pairs of levels in the diagram are expected to be equally likely to result in the ejection of conversion electrons. Some of them, on the contrary, may be more likely to emit gamma rays instead. Thus the relative intensities of the conversion electron lines give a valuable clue regarding the nuclear level diagram structure and, when combined with other information, help to identify the nuclear spins and parities associated with the various energy states. For any nuclear transition between a specified pair of levels, the ratio of conversion electrons knocked out to gamma rays emitted is called the conversion coefficient for that transition. This is a very important quantity, of great interest for the interpretation of nuclear spectra, and the iron-free, magnetic, beta-ray spectrometer can play an important role in its experimental determination.

TWO KINDS OF NUCLEONS

Nuclei are believed to be clusters of particles called nucleons. These are of two kinds—protons, each of which carries one unit of positive electrical charge; and neutrons, which are electrically neutral. These two varieties are of nearly equal mass, the neutron being just a little more massive. The nucleons are conceived to be in rapid movement in the nuclear cluster, and the entire cluster is presumed to be held together by extremely strong internucleonic forces, of quite different character from either electrical or gravitational forces, whose range of action is very short—the size of the entire nuclear cluster being only of the general order of one ten-thousandth the linear dimensions of the atom in which it resides. Nevertheless, the mass of the nucleus may be from 2,000 to 4,000 times that of the remainder of the atom (i.e., the atomic electron cloud surrounding the nucleus). It is this electron cloud, however, which determines the size of the atom—the volume it occupies in solid matter.

A reasonably successful nuclear model proposed circa 1950 by Mayer and Jensen, called the "Shell Model," pictures the two kinds of nucleons as executing orbits inside the nucleus, a little like planets. They are conceived as belonging to "shells" in close analogy to the shell structure of the *electron* orbitals *outside* the nucleus which also cluster in so-called shells having different energies of attachment to the parent atom, the innermost shells being those most strongly bound.

CLOSED NUCLEAR SHELLS

Quantum theory tells us that, just as in the case of atomic electrons, a given nuclear shell can contain only a limited number of nucleons. A proton or neutron shell with such a limiting number of nucleons is said to be closed and, if one tries to add further nucleons to reach a larger nuclear mass number, a new shell must be started. Many nuclei may thus consist of closed shells forming a stable core plus a *residue* of additional nucleons external to the core and insufficient in number to form another complete closed shell.

In 1953 A. Bohr and B. R. Mottelson, in Copenhagen, devised a theory of "collective motion" of nucleons, which describes certain states of nuclei behaving as if all the nucleons moved together, rotating and executing surface vibrations—a kind of liquid drop motion.

The shell model of Mayer and Jensen and the collective-motion model of the Copenhagen school seem at first to be incompatible and to confront us with a dilemma. In the first model the nucleons seem to execute more or less independent orbital motions; in the second they seem tied together so as to behave like a fluid. This is indeed exciting, for a dilemma of this sort is likely to conceal a gold mine of new information and new viewpoints.

It seems probable that the shell model describes the behavior of the nucleons in the closed shells which together form the core of the nucleus. This core is probably normally of spherical symmetry, relatively inert, and playing a fairly passive role in the nuclear dynamics. The leftover nucleons, those outside the core, if few in number, can be described as moving independently. The low-lying energy levels of many nuclei can be fairly well described in this way. If there is a sufficient number of these extra nucleons, it may be energetically favorable for the nucleus to exist in configurations where these nucleons move in a correlated manner. In fact, the core is disrupted, and nucleons normally associated with the core now have their motion strongly correlated with the extra nucleons. In this manner we understand the stably deformd nuclei, exhibiting rotational states, and vibrational states of many kinds in all nuclei. Even though the collective states are very complicated in that they involve the interplay of many nucleons, the predictions of the "collective model" have been verified in exceptional detail by precision experimental measurements. Considerable success has been obtained in the last decade in efforts to develop these simple models quantitatively. Many of the techniques developed in the study of electron gases and liquid helium have been extensively utilized.

ELECTROSTATIC REPULSION

Astronomers are greatly interested in a better knowledge of the properties of nuclear matter in a hypothetical state in which an unlimited number of nucleons can cluster together. While this state cannot be realized under terrestrial conditions, it might conceivably exist in postulated astronomical objects such as neutron stars. It is thought that unlimited numbers of nucleons cannot cluster together to form stable nuclidic species, because in ordinary nuclei the electrostatic repulsion between the protons renders nuclei with a large excess of protons unstable. If we try to dilute this repulsion by adding to such nuclei a comparably large increment of neutrons, a different sort of instability results. Such heavy neutron-rich nuclei disintegrate radioactively by alpha and beta decay and by spontaneous fission into lighter and more stable nuclei. However, in neutron stars (the dead corpses of once-ordinary stars) the total mass and density of the star may, through gravitational force alone, be sufficiently large to hold it together as a single huge mass of nuclear matter.

These considerations make it plain why there is great fundamental interest in trying to gain a more satisfactory understanding of the precise nature and properties of the forces which bind nuclei together.

SOME ACKNOWLEDGMENTS

Science, and especially physics, becomes ever more and more a cooperative enterprise to which scientists of all nations and races freely contribute. The present instrument furnishes an excellent example.

The first iron-free beta-ray spectrometer utilizing the principle of two-dimensional (so-called double) focusing was designed and built by N. Svartholm and Kai Siegbahm in 1946 in Uppsala, Sweden. They in turn acknowledged their indebtedness to two Americans, D. Kerst, the inventor of the betatron, and theoretician R. Serber, who were the first to derive the conditions for radial and vertical focusing. These concepts were developed from their observation of the electron orbits in the betatron, a device with a quite different purpose than electron spectroscopy.

The principal difference between the Caltech instrument and its Swedish predecessor is in the design of the d.c. current-carrying coils which generate the magnetic field. The design calculations for the geometrical parameters of our present six-coil design were first worked out for a much larger instrument (about three times the linear dimensions of the present Caltech instrument) designed by G. E. Lee-Whiting and E. A. Taylor, at Canada's Chalk River Atomic Energy Establishment. However, for the smaller, less expensive, and more compact Caltech design the Chalk River results had to be considerably modified through an electronic computer program by Thomas Taylor, then at UC, Riverside.

Acknowledgments are also due to Herbert Henrikson, project engineer of Caltech's Physics 34 group, for his design of the heat exchanger for cooling the circulating supply of transformer oil which removes the Joule heat generated in the coils and for many other design contributions. The winding of the six coils to meet the required dimensional accuracy was an extremely demanding job, performed in the Caltech Central Machine Shop with great care by Mr. Henrikson. The excellent resolving power of the instrument is largely due to his effort.

The designs of the d.c. power source and of the automated data-handling system were the responsibility of Peter Alexander, formerly of Physics 34. He also first brought the instrument into successful operation in 1964.

The skill and interest displayed by Norman Huehl, D. Meyers, V. Thune Stephensen, and Ellsworth Kiersey of the Caltech Central Machine Shop contributed greatly to the success of this instrument.

—JESSE W. M. DUMOND

RESEARCH NOTES

Some recent developments in the fields of biology, applied science, and engineering that help explain more about man and his environment

Exchanging Hormones

Three Caltech biologists have discovered that a tree common in southern California converts cholesterol into a hormone that triggers metamorphosis (molting) in insects—transforming caterpillars, for example, into butterflies.

Erich Heftmann, research associate in biology, and research fellows Raymond D. Bennett and Horst H. Sauer have found that this hormone, ecdysterone, is synthesized from cholesterol by the *Podocarpus elata,* an Australian evergreen used in landscaping. Many other plants probably also manufacture the hormone.

Most insects cannot synthesize cholesterol or other sterols although they may be able to convert them to ecdysterone or other molting hormones. It is still not clear whether insects obtain the hormones directly from the plants by eating leaves or whether they convert the plant sterols to hormones themselves.

The Caltech men made their discovery by applying cholesterol tagged with radioactive carbon-14 to the leaves of Podocarpus seedlings. After a month's time, tests showed that the Podocarpus contained ecdysterone carrying the radioactive carbon-14 atom--proof that the plants had converted the administered cholesterol into the molting hormone.

Biologists thought earlier that only animals synthesized cholesterol, which is the basic material from which they make other steroids including certain hormones. However, Heftmann and his Caltech associates have shown that higher plants also synthesize cholesterol and that some contain the same sex hormones as those produced by animals.

The Heftmann group is continuing research to determine if any of these animal hormones also perform functions in the lives of plants. Their work is supported by the Agricultural Research Service of the U.S. Department of Agriculture.

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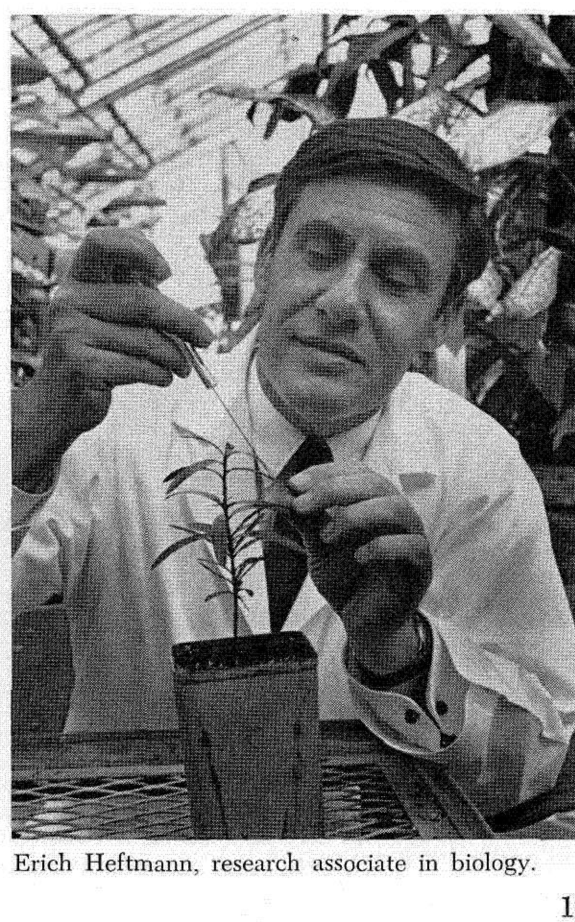


Erich Heftmann, research associate in biology.

Do human beings see in the same way that cats and monkeys do?

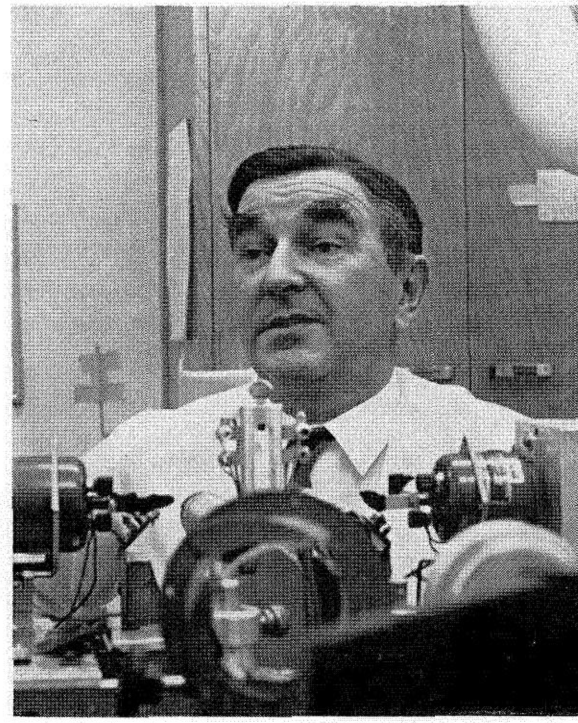
Derek H. Fender, professor of biology and applied science at Caltech, is looking for answers to questions like this in his current studies on how the human brain processes visual signals. Working with him is Dietrich Lehmann, neuropsychiatrist of the Institute of Visual Sciences in San Francisco.

The small part of each hemisphere of the brain that is involved in seeing contains several varieties of specialized neural cells. Tests on cats and monkeys have shown that some of these neurons measure light intensity, some analyze straight lines, others observe dots, and still others, binocular disparity. The current research of Dr. Fender and Dr. Lehmann is one of the first demonstrations that neurons with similar functions exist in human beings.

Twenty-seven women subjects are serving in these experiments which test their reactions to various images flashed on a screen in a dark room. The very small electric signals generated by the optic centers of their brains are recorded by means of electrodes attached to the backs of their heads. Normally, such tiny signals are lost in the general electrical activity of the brain, but in this case computer processing erases the background "noise" and permits the researchers to retrieve only the light-evoked signal. They call this response light-evoked potential (LEP).

The two scientists are trying to get more information about the brain cells that give rise to the LEP. Where are such cells located? Are they classes of cells that respond to specific abstractions of the visual field? How do these classes interact with each other in the complicated process of everyday visual experience?

To do this kind of research in the past, a flashing light was used to project a picture into one or both eyes. Dr. Fender and Dr. Lehmann rejected this method, however, because they felt that the flashing light and the structure of the picture could interact in the retina and thus tell very little about the brain. Instead, the Caltech system is to stimulate each eye simultaneously with a different target. One eye always sees a flash, for example, while the other sees a structured or textured target illuminated by a steady light source. As a result, the flash and the structure can only interact in cells in the brain.



Derek Fender, professor of biology and applied science, studies the mechanics of seeing.

This work has shown that the size of the LEP decreases as the amount of structure increases—a fact which researchers interpret in this way: In monkeys and lower animals it has been shown that there are classes of cells in the brain that respond to elemental processes in the visual field—straight lines, for instance. If a subject views a blank field, none of these cells will be active, and they can be shocked into synchronous activity by a bright flash. But if one eye sees a straight-line grid pattern, some of the straight-line detectors will be "busy" so that fewer of them can be activated into synchronous activity by a flash—and so the LEP is smaller.

LEP's are modified by other mental activity such as involvement with and interest in the experiment, motivation, boredom, vigilance. It is essential that these badly defined and not very well understood attributes of human mental activity remain constant through the experiment—about two hours.

It is interesting to note, then, that women have proved to be exceptionally good subjects for these experiments. Men are hopeless.

Can Fungi Help Purify Water?

More efficient methods for converting waste water into drinking water may result from a Caltech study of the fungi found in the soil.

James V. Harvey, a project scientist conducting research in the environmental health engineering laboratory, has isolated numerous species of fungi found in waste-water spreading grounds and is now trying to determine what role they play in purifying water.

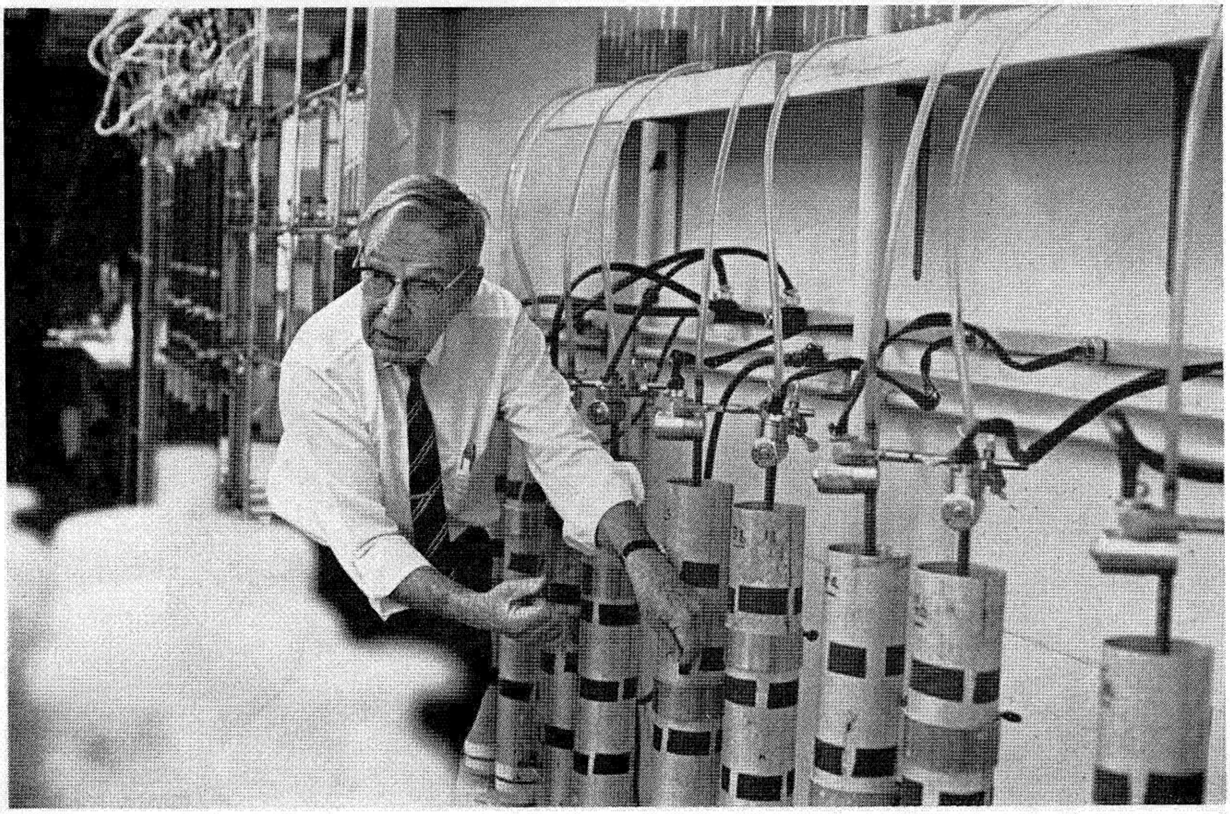
Dr. Harvey is examining the composition and significance of various species of fungi found in a soil area that is being treated daily with two feet of highly oxidized effluent. This effluent, treated sewage, is from the Whittier Narrows area near Los Angeles.

Dr. Harvey, a mycologist involved for years in the study of destructive molds, is conducting the study under Jack McKee, professor of environmental health engineering. His research is supported by the Federal Water Pollution Control Administration.

More than 50 species of fungi have been isolated during the study. Now, Dr. Harvey's goal is to find out what substances are being attacked by the fungi and to determine if fungi act in the same manner as bacteria.

It has long been known that bacteria play a major role in the purification of water as it seeps down from the soil surface. Dr. Harvey hopes to determine if there are any cooperative relationships between bacteria and fungi during water purification. He has constructed a system of 16 aluminum tubes filled with sterilized sand through which measured quantities of sewage water (secondary effluent) from the spreading grounds are dispensed at scheduled intervals. After about six weeks of "ripening," the soils are presently undergoing analysis to determine what fungi are present and which ones are degrading certain substances in the water.

Since the fungi cannot manufacture their own food as do green plants, they are dependent upon existing organic matter. Thus, if fungi survive in the sewage-treated soil, they may have to live on carbon compounds in the effluent and may also make use of nonorganic compounds in the water.



In water purification experiments conducted by James Harvey, sewage dumped into a complex system of aluminum tubes filters through sterilized sand and is then tested for fungi and bacteria.

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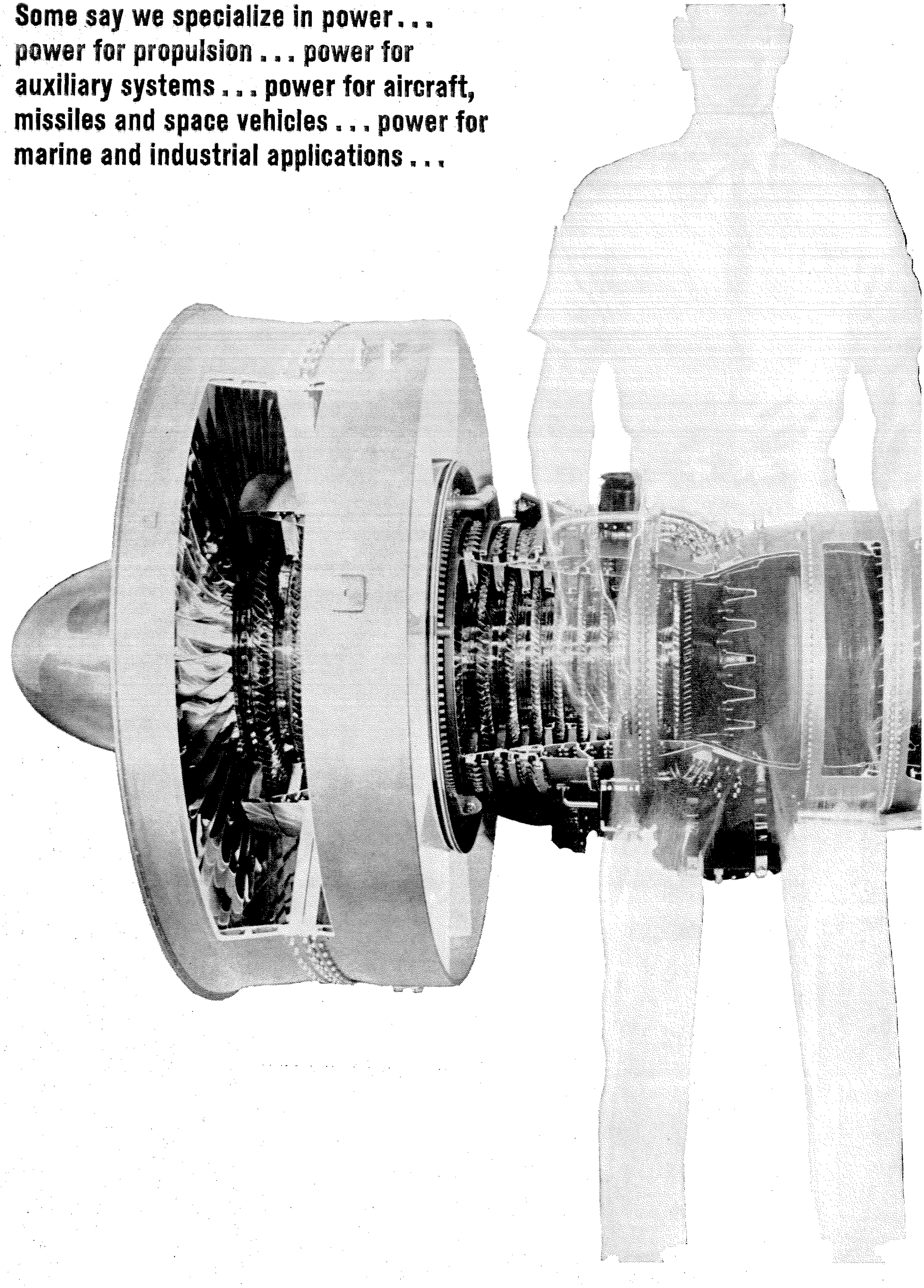
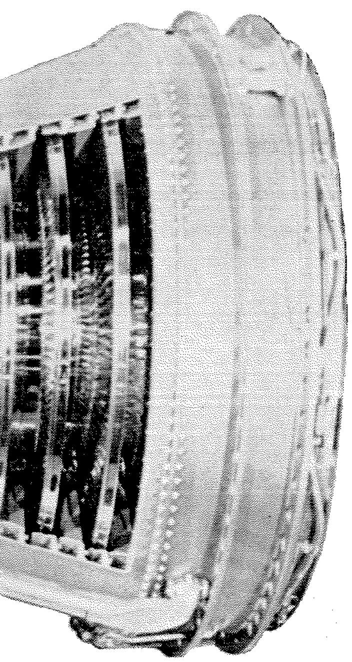


. . . they're right. And wrong.



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THE KINGDOM OF GOOD
A LOOK AT THE RADICAL RIGHT TODAY
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MORE PAY
WARREN COMMISSION
YEAH!
LOVE
NOW!
NOW!
BLACK POWER
FLUORIDATION
NOW!

by ROBERT A. ROSENSTONE

The Radical Right lives in a world divided between a kingdom of good and a kingdom of evil. If one is in the realm of good, there can be no compromise with the surrounding forces of darkness.

Among the many dissident socio-political movements of the 1960's, none is more important and potentially dangerous to the United States than that group of organizations that the press and public have come to know as the Radical Right. Yet because of certain demands of time, space, and newsworthiness, the mass media have not done a very good job of covering such organizations. Or, rather, their coverage has been a sometime thing.

Early in the Kennedy years, when the John Birch Society first surfaced, there was an immense fuss in the press over right wing extremism. Later, interest in the topic died down, only to be revived during the 1964 presidential campaign. After the Johnson victory, concern with the subject waned again, and though it has returned sporadically, there has been little systematic reporting about it. Yet all through the sixties, the Radical Right has continued to grow in terms of membership, finances, circulation of publications, and sponsorship of films, and radio and TV programs. Because it has been increasing in size and scope, and because it is a frightening phenomenon—one that threatens the processes of democracy—the Radical Right should be examined and assessed from time to time.

The term Radical Right obviously covers a host of organizations and people. Included are Robert Welch and the John Birch Society, Billy James Hargis and his Christian Crusade, Fred Schwarz and the Christian Anti-Communist Crusade, Kent and Phoebe Courtney and their Conservative Society of America, the Minutemen, and such individuals as Dan Smoot, Clarence Manion, Edgar Bundy, and Ezra Taft Benson. There are, of course, many more. Indeed, one rightist directory contains more than 1,000 groups and individuals who could be included, though many of its organizations consist of little more than one man and his trusty mimeograph machine.

Listing names, of course, does not define the nature of the Radical Right—a problem which political scientists and sociologists have been struggling with for several years. Anyone who has, in turn, struggled to read the results of their efforts usually gains little enlightenment. For their definitions tend to be terribly specialized and so heavily larded with social-scientific jargon that they cannot easily be translated into English. Rather than getting bogged down trying to define the Radical Right, it seems more profitable to look at some aspects of the way the Right views the world. This approach can give insight into its past, present, and, perhaps, its future development.

A first point is one that may have become obscured because of the Right's apparent interest in politics in 1964 and since. That is the fact that, basically, the Right is anti-political. There is no room in the world of the extremists for the give-and-take of normal, democratic politics. Robert Welch has said that democracy is a perennial fraud, and he and his cohorts have mounted a campaign to prove that the United States is a republic, not a democracy. When you read the works of the Right, however, it becomes obvious that its leaders do not believe in republicanism either—at least not republicanism as we have known it in the U.S.—republicanism in which men of different parties can agree to disagree and can compromise on political issues.

There is a very simple reason why the Right is anti-political. On every issue its leaders believe themselves in possession of the Truth—always with a capital "T." Knowing the Truth, they naturally cannot compromise on programs, for to do so would be to taint themselves with falsehood which they hold to be synonymous with evil.

As it was before 1964, the view of the Radical Right remains today basically Manichaean. It lives in a world divided between a kingdom of light and a kingdom of darkness—a realm of good and one of evil. And if one is in the realm of good as the Right knows it, there can be no compromise with the surrounding forces of darkness.

A good example of this is the experience of Barry Goldwater. Before the 1964 presidential campaign, many rightists urged him to run. Later, because he was willing to accept some of the welfare state programs such as social security and the income tax, he was denounced by them. His views gave evidence that he really did not belong in the kingdom of good.

CRUSADERS NEVER COMPROMISE

This is not to say that men of the Right will not continue to run for office. But if elected, and if they stay true to their principles, such men cannot engage in politics as we know it—that is, the art of compromise. Crusaders (some of their organizational names suggest they think of themselves as such) do not compromise—they annihilate their enemies.

A second important aspect of the Radical Right is its view of historical causation. In the view of the extremist, nothing ever happens gratuitously. Concerned with the great events of history, the Right has a simple explanation for virtually all the things that have happened in the 20th century, or at least since the income tax amendment. Every unfortunate event (and this includes almost everything) has somehow been caused by the dark, menacing, satanic Communist conspiracy, whose ultimate purpose is the enslavement of all mankind—especially Americans. The stock market crash of 1929, the growth of organized labor and of the welfare state, and the election of Eisenhower are all results of the conspiracy.

Recently a new theory has begun to permeate the Right. First enunciated by Robert Welch a little more than a year ago, it claims that an evil conspiracy of men has been manipulating the world since *before the French Revolution*. In this view communism is simply a manifestation of a larger group of "insiders," as Welch calls them.

Not everyone talks in terms of this grand conspiracy. Not every rightist has accepted the idea that the French Revolution, the American Civil War, the institution of the Federal Reserve system, World War I, the Russian Revolution, the Depression, the rise of Hitler, the New Deal, World War II, the assassination of Kennedy, and the election of Sam Yorty were all due to this immense conspiracy. But since so many can believe that every President since FDR has been consciously serving Communism, there is little to keep them from accepting this newer theory.

While some people on the Right have been pushing the world conspiracy backward in time, others recently have been casting their nets wider. All sorts of social change have come to be seen as manifestations of the same conspiracy. Recently rightist publications have labeled all of the following as part of the Communist attempts to soften up the U.S. for a Red takeover: public health programs, fluoridation of water, civil rights demonstrations, police review boards, student movements, hippies, flower children, marijuana, LSD, the death of Marilyn Monroe, underground newspapers, teenage disturbances on the Sunset Strip, and rock-and-roll music. Indeed, the latter is thought to be the most fiendishly clever scheme the Communists have yet devised for conquering America. The Right has proved to its own satisfaction that such music produces "artificial neuroses" in teenagers, "preparing them for riot and ultimately revolution to destroy our American form of government."

PACK UP YOUR TROUBLES—IN ONE BAG

To say that any specific position taken by the Radical Right is, a priori, absurd is certainly not true. There may be sound reasons for agreeing with some rightist views. One may feel that teenage music is noisy, or that review boards hurt law enforcement, or that the Los Angeles *Free Press* is a badly written, semi-pornographic rag. Similarly one could find good reasons for opposing President Johnson's policies, or for thinking that the whole New Deal was misguided, or even for disliking the income tax. What is different about the mind of the Radical Right is that it insists on associating together the things it does not like. It ties them all up within one bag and proclaims that they are all part of a master conspiracy to undermine America and the world.

The means of proving that these various phenomena are Communist-directed vary, but none of them would stand up in a court of law. Three known radicals in a demonstration of 50,000 can prove to the Right that it is a Communist enterprise. On the other hand, the *absence* of any radicals could be considered as the most devasting proof of all. Only the Communists could have such superb control of events that they could plan a demonstration in which no known radicals took part.

To show you how the mind of the Right works, a prediction is in order. Benjamin Spock has recently been indicted for his anti-draft activities. Some people feel that the trouble with teenagers today is that they were raised according to Dr. Spock's teachings, which, they believe, lead to lack of responsibility. Undoubtedly, someone eventually will put these arguments together and find that Dr. Spock originally wrote his book under the direction of Communists with the express purpose of raising irresponsible teenagers who would be attracted by communism.

A third aspect of the Right's world view is that it is basically apocalyptic. Most rightists foresee a day of Armageddon on which the forces of evil and good will battle to the death. The day for such a showdown is drawing closer. A few years ago Fred Schwarz said that the Communist takeover date for the U.S. is 1973, and so far as is known he hasn't revised his opinion. Robert Welch has predicted that it will happen in "just a few more years." Naturally the rightists are girding themselves to keep the Communists from being successful, though it is only a small minority of fringe groups like the Minutemen who are stockpiling arms to use on this day of reckoning.

VIOLENCE—WHO FIRST?

How the final struggle will be precipitated is not made clear. Extremist leaders usually eschew violence, yet their own publications make it seem unlikely that the Communist conspiracy will precipitate an open battle. For example, the 1967 John Birch Society "scoreboard" showed that of 141 countries, fully 108 were more than 50 percent Communist-controlled, while 54 were 80 to 100 percent Communist-dominated. The United States, rated only 20 to 40 percent Communist on the first Birch scoreboard in 1958, is now listed as 60 to 80 percent. This is a rather puzzling statistic when you consider that the Birch Society (which numbers close to 100,000) has been congratulating itself on the good job it has been doing combating the Communist menace. It would seem that the conspirators are doing so well that violence would be unnecessary, and one is left with the feeling that it could, possibly, come from the Right.

ON THE RIGHT—HOW MANY?

Although the Radical Right has been growing through the sixties, it is hard to be precise about its total number of adherents. Hundreds of radio stations carry the weekly messages of rightist leaders, presumably reaching millions of people. Hundreds of thousands subscribe to various extremist publications, and probably larger numbers affiliate themselves with the positions of the Right. Knowing this, one must ask: How can so many Americans believe that Dwight Eisenhower was a Communist, or that Negroes have no legitimate grievances, or that doctors in favor of fluoridation want to soften the brains of Americans?

There is no easy answer to this question. Psychologically oriented scholars have talked about a paranoid mentality affecting such people, and this explanation seems to have a kind of truth to it. One thing we know for certain is that today there are more people involved in the Right than just the wealthy businessmen, retired military officers, and little old ladies in tennis shoes that were believed to make up early Birch Society membership.

Scholars have identified rightist adherents from all walks of life, including many professional men and white collar workers with college educations. It is also known that there is a high correlation between support of the Right and fundamentalist Protestantism. Certainly this is partly because of the black-white style of thinking common to both groups.

One partial explanation for the success of the Radical Right is that it provides a simple and, in its own terms, coherent explanation for the chaotic conditions affecting the U.S. Once a person accepts this world view, all sorts of disturbing phenomena fall neatly into place.

The Negro revolution, the rebelliousness of youth, the increasing tax burden, the rising crime rate, and the seeming impotence of government in dealing with these problems are simply and neatly explained by the conspiracy theory. The terrible complexities of modern life, which frighten everyone to some extent, vanish from view, and the rightist believer is left with the feeling that he alone knows the real enemy—an enemy that presumably can be combated by men of stern morals if they remain true to eternal principles. And how much better to have a *real* enemy than to have to think about the hundreds of complex causes of Negro dissatisfaction, or chronic unemployment, or changes in sexual morality.

FINDING AN ENEMY

Such simplified thinking is not indulged in only by the Radical Right. Much of America's anti-communist feeling in recent years has sprung from the same mentality. This is *not* to say that no Communist menace has ever existed. But if one considers how often American leaders have labeled any native disturbance in foreign lands as Communist-inspired, how many Southerners have blamed racial discontent on the work of "outside agitators," how many university administrators have found student unrest to be caused by "non-students," how many police chiefs have labeled demonstrations as Communist-led, how many government officials have found dissent from their programs to be unimportant because some "Reds" were present among those dissenting, then it becomes obvious that more Americans than just rightists prefer blaming troubles on a particular enemy to taking a good, hard look at the social, political, and economic causes of such troubles.

It is difficult to tell just why certain people adhere to the Radical Right. Scholars have debated the socio-psychological backgrounds of participants without being able to reach any definitive conclusions. One thing we know is that the rightist mentality is not one peculiar to our time or even to our country. Similar conspiracy theories and apocalyptic visions existed in the U.S. in the 19th century when the Masons and the Catholics had the finger of suspicion pointed at them. During medieval times hundreds of millenial sects flourished, all with much the same feeling of conspiracy and impending apocalypse that we find in the Right today. Such sects appeared in periods and in societies where traditional norms and relationships were disintegrating, leaving many people rootless, desperate, and frightened by the world around them. The parallel to today is striking. It leads to the conclusion that as long as the U.S. continues to have the kind of social change and even chaos it has had recently, the Radical Right will be able to hold onto many of its members and perhaps even to increase its influence.

The ideas and beliefs of the Radical Right may seem farfetched and even humorous, and its members may appear to be deranged. Their attempts to impeach Earl Warren, or repeal the income tax, or to label Martin Luther King a Communist may even seem unworthy of serious consideration. Yet the Right *is* capable of doing much harm. On the national level it can confuse and disrupt election campaigns with its spurious charges and thus keep our attention from focusing on the real and critical problems besieging us. On the local level it can have a detrimental influence on such institutions as school systems and libraries. Already some of these have been purged of books and programs teaching about such "Communist" dangers as the United Nations.

EXTREMISM INTO "NORMALITY"

There is also a larger way in which the Radical Right can be a threat. One does not have to make comparisons between *Mein Kampf* and Robert Welch's *Blue Book*, but neither should anyone ignore the fact that a number of powerful, militant groups in the 20th century were originally considered no more than collections of crackpots. For when socio-economic conditions become disrupted; when war, depression, or other calamities traumatize societies; when man, suffering from a crisis of faith, becomes unable to endure the burdens that an impersonal, corporate society places upon him; the desire to believe that evil forces are responsible for one's anxieties and troubles can become overwhelming. In such a situation, the extremism of a relatively small group like the Radical Right has a chance of becoming the "normality" of a nation.

HUGO BENIOFF

1899-1968

A Tribute by Stewart Smith

Sensitivity, warmth, and generosity are foremost in any recollection of Hugo Benioff, a man who was at the same time a master at the art of telling stories and a creative scientist of truly great stature. His ideas pointed the way for fundamental advances in the understanding of earthquake processes, and his inventive mind engineered a revolution in the design of seismic instrumentation.

Hugo was a true Californian, born in Los Angeles, an undergraduate at Pomona College, graduate student at Caltech, and research worker at the Mount Wilson Observatory, the Carnegie Institution, and eventually at Caltech's Seismological Laboratory. He loved California and often spoke of the special responsibility he felt toward it. The guidance and advice he provided in the initial planning for the California Water Project was one of many expressions of this feeling.

Hugo Benioff had a special sensitivity to the earth around him, not only as a subject of scientific inquiry, but as a source of great beauty. As an expression of this love of unspoiled nature, he sought out unusually beautiful wilderness areas in California and Nevada and lived in them for such periods of time as his professional life permitted. In what he knew would be his last choice of land, the wild and beautiful Mendocino coast, he allowed himself the full-time enjoyment of the natural beauty around him.

I came to know Hugo Benioff only in the later part of his life when I had the good fortune to work with him in the final stages of a project he had been concerned with for more than ten years—the detection of the natural vibrations of the earth. In many ways this project was the culmination of his years of work in the development of long-period, seismic instruments, and it was the last major experiment in a monumental career that spanned more than 40 years of work in fields from astronomy to geophysics and from underwater sound to the design of musical instruments.

For a man with interest in music, it was indeed a fitting climax to his career for him to detect and measure what can be thought of as the music of the earth—its natural tones—and he took great pleasure in this fulfillment.

The breadth of his interests and the joy that he felt in his work seem to have come from his essential scientific curiosity. He asked the question "why" with a real passion, and in pursuit of the answer his performance can only be described as exquisite.

All of this, however, does not add up to Hugo Benioff unless one can recapture his humor. "Perhaps I should, but on the other hand . . ." is the caption on a cartoon, "The Benioff Variable Reluctance," which portrays him as a man of varying degrees of reluctance. He was particularly susceptible to this kind of joke because his name the world is over is synonymous with the instruments he invented, the variable reluctance seismometer being perhaps the most famous. He laughed over these and other caricatures involving the Benioff Horizontal, the Benioff Strain; in fact, his laugh was so characteristic it could be immortalized as the Benioff Chuckle.

A recent newspaper tribute referred to him as one who was completely attuned to the world in which he lived. This he was. Seldom does a man leave so much of himself when he departs this world.

THE MONTH AT CALTECH

SEELEY G. MUDD 1895-1968

Seeley G. Mudd, M.D., Caltech trustee, educator, and humanitarian, died March 11 at the age of 72. Dr. Mudd became a member of The Associates of the California Institute of Technology in 1928. He joined the staff as a research associate in 1931 and did pioneering work on the treatment of cancer with high-energy x-rays. From 1935 to 1945 he was professor of radiation therapy, and in 1960 he was appointed to the Institute board of trustees.

Dr. Mudd practiced medicine in the field of cardiology. He served on the faculty of the University of Southern California's School of Medicine and was dean of the school from 1941 to 1943.

Dr. Mudd made notable contributions to the field of medical research, and his generous gifts over the years made possible many university buildings in California, New York, and Massachusetts. He gave $2 million to Caltech for the Robert A. Millikan Memorial Library, which was formally dedicated in December. He personally approved each phase of the library construction and its furnishing.

HONORS AND AWARDS

An annual lectureship has been established at Caltech to honor William N. Lacey, professor of chemical engineering, emeritus, for his contributions to the Institute and to the chemical engineering profession. Dr. Lacey retired in 1962, after 46 years as a Caltech faculty member. For ten of those years he was dean of graduate studies, and for two years he was dean of the faculty. He now lives in San Diego. The first recipient of the W. N. Lacey Lectureship is Arthur B. Metzner, a chemical engineer from the University of Delaware, who will speak at Caltech on April 2 and 4.

The highest honor of the City of Pasadena, the Arthur Noble Award, was given this month to William H. Pickering, director of Caltech's Jet Propulsion Laboratory, for his part in making the city's name known throughout the world in connection with JPL's space and satellite program successes. Dr. Pickering, who has been at JPL since 1944, became its director in 1954 and has been responsible for the programs involving Explorer I, Pioneer IV, Ranger's lunar photographic mission in 1964-65, the Mariner flights to Venus in 1962 and to Mars in 1964-65, and the Surveyor lunar landings of 1966-68.

The Arthur Noble Award was presented to Dr. Pickering at a banquet in his honor by Mayor Boyd P. Welin on March 14.

Charles C. Lauritsen, Caltech professor of physics, emeritus, has been honored by the Aerospace Corporation with the dedication of a library in his name. The $1 million Charles C. Lauritsen Library, in El Segundo, California, contains over 200,000 books, reports, periodicals, and microfilmed reports. Dr. Lauritsen, who retired from Caltech in 1962, is one of the founders of the Aerospace Corporation and is its first trustee emeritus. The library dedication, on March 8, was attended by Cal-

Charles C. Lauritsen

tech President Lee A. DuBridge and Thomas Lauritsen, Caltech professor of physics and son of the honored scientist.

Arie J. Haagen-Smit, professor of bio-organic chemistry at Caltech, has been appointed to the technical advisory committee of the recently established Air Resources Board of the State of California.

Dr. Haagen-Smit, who has been actively engaged in the study of air pollution for many years, has been a consultant at all levels of government on the problems of air pollution control, and is well known for his sharp appraisals of new attempts at such control. It is worth noting, then, that he believes the new board will play an important part in solving air pollution problems and considers it an improvement over its predecessor, the Motor Vehicle Pollution Control Board, because it has control over stationary as well as moving sources of pollution.

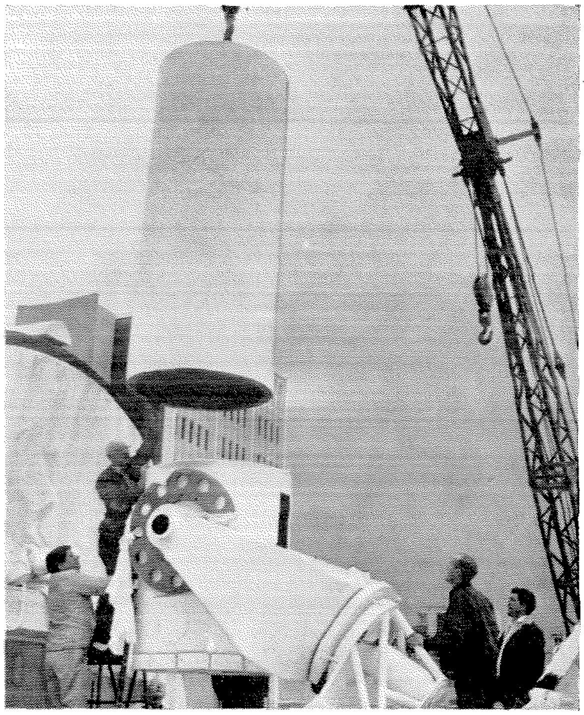
Four Caltech men are among the 73 physical scientists to receive two-year basic research grants from the Alfred P. Sloan Foundation: Jesse L. Beauchamp, Arthur Amos Noyes research instructor in chemistry; Donald S. Burnett, assistant professor of nuclear geochemistry; Peter Goldreich, associate professor of planetary science and astronomy; and Wallace L. W. Sargent, assistant professor of astronomy and staff member of the Mt. Wilson and Palomar Observatories.

E. Richard Cohen, research associate in engineering science at Caltech, is one of five American nuclear scientists selected to receive the Ernest O. Lawrence Memorial Award for 1968, which will be presented in May by the U. S. Atomic Energy Commission. Dr. Cohen was cited by the Commission for his highly original contributions to the neutron transport theory and reactor physics.

A Clear Look At The Sun

The clear mountain air and water which have always attracted tourists and sportsmen to Big Bear Lake in the San Bernardino Mountains will soon be drawing astronomers to the area for a good, clear look at the heavens.

A new $500,000 solar observatory will be



The main tube (42 inches by 10 feet) of a new solar telescope is lowered into its temporary place on top of Caltech's Robinson Laboratory. After it is tested here on campus, the telescope will be moved to the new solar observatory which is scheduled to be constructed this year in the San Bernardino Mountains.

built on a small island near the north shore of the lake. It will be managed by the Mount Wilson and Palomar Observatories and operated by Caltech and the Carnegie Institution of Washington. Construction will be completed by the end of the year.

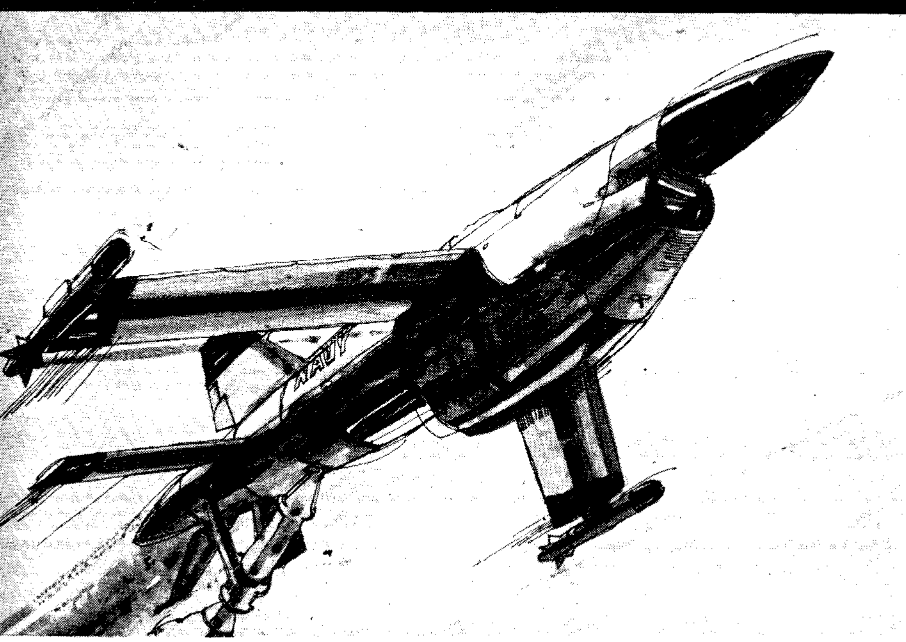
The mountain location, chosen after a long search for just the right site, fulfills the prime requirement necessary for satisfactory solar observations—a minimum of air turbulence. The clean air at the 6,000-foot level and the cooling effect of the water result in the desired still air.

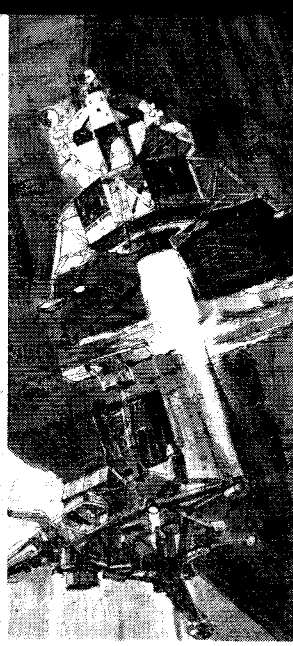
The observatory itself will consist of a concrete tower 30 feet square and 58 feet high, topped by a dome 30 feet in diameter. The telescope, which has been under construction at Caltech for the past two and a half years, has a 42-inch tube that is pointed directly at the sun, and it houses four different telescopes. Two lenses mounted at the top of the tube allow scientists to take moving pictures of the sun simultaneously at different wavelengths of light. Sets of mirrors are mounted to direct light into the spectrograph and coronagraph.

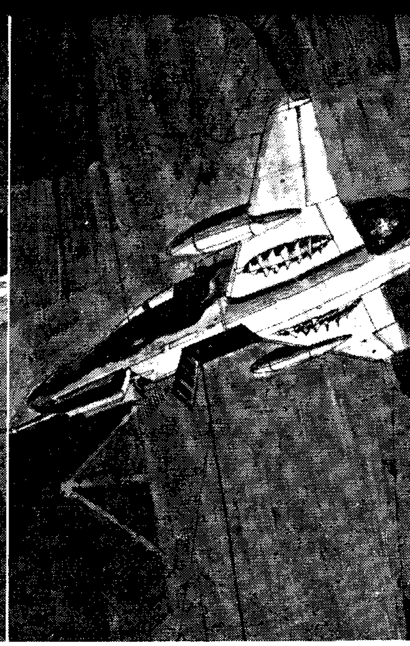
You keep hearing about "advancing the state of the art." But you seldom hear it defined. Simply put, it means adding something to existing knowledge. That's OK, so far as it goes. But we at Ryan believe the "art" in the phrase should stand for "original." In our book, innovation is the key to expanding a technology. It goes beyond just adding to known data. It's talent to see ahead, to anticipate a future need, and determination to do something about it. We live by the philosophy: "Tomorrow's Technology Today." You see evidence of that in the firsts we have racked up in Jet Target Drones, in V/STOL Science, in Space Age Electronics. To keep the firsts coming, we continuously seek believers in the art of innovation. When a Ryan representative visits your campus, ask what we mean, "being first is a Ryan tradition."

RYAN

Speaking of art...







We welcome your inquiry about Ryan opportunities. Write Mr. Harlow McGeath, Ryan Aeronautical Company, Lindbergh Field, San Diego, Calif. 92112

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The day you come to work for us, you are given a job you might think your boss should do. And we'll give you a year to prove, in action, that you're management material.

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Like to be one of the college graduates we challenge this year?

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What's it like to engineer for a giant?

Depends on the giant. Actually, some giants are just regular kinds of guys. Except bigger.

And that can be an advantage.

How? Well, take Ford Motor Company. We're a giant in an exciting and vital business. We tackle big problems. Needing big solutions. Better ideas. And that's where you come in. Because it all adds up to a real opportunity for young engineering graduates like yourself at Ford Motor Company.

Come to work for us and you'll be a member of a select College Graduate Program. As a member of this program, you won't be just another "trainee" playing around with "make work" assignments.

You'll handle important projects that you'll frequently follow from concept to production. Projects vital to Ford. And you'll bear a heavy degree of responsibility for their success.

You may handle as many as 3 different assignments in your first two years. Tackle diverse problems. Like figuring how high a lobe on a cam should be in order to yield a certain compression ratio. How to stop cab vibration in semi-trailer trucks. How to control exhaust emmission.

Soon you'll start thinking like a giant. You'll grow bigger because you've got more going for you.

A network of computers to put confusing facts and figures into perspective.

Complete testing facilities to prove out better ideas.

And at Ford Motor Company, your better ideas won't get axed because of a lack of funds. (A giant doesn't carry a midget's wallet, you know.)

Special programs. Diverse meaningful assignments. Full responsibility. The opportunity to follow through. The best facilities. The funds to do a job right. No wonder 87% of the engineers who start with Ford are here 10 years later.

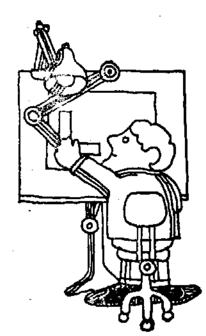
If you're an engineer with better ideas, and you'd like to do your engineering with the top men in the field, see the man from Ford when he visits your campus. Or send your resume to Ford Motor Company, College Recruiting Department.

You and Ford can grow bigger together.

Ford

THE AMERICAN ROAD, DEARBORN, MICHIGAN
AN EQUAL OPPORTUNITY EMPLOYER.

Rather enlarging!



Thirty-first Annual Alumni Seminar

Saturday, May 4, 1968

Dinner and Evening Program

Huntington-Sheraton Hotel, Pasadena

THE CRUCIAL TIME FOR TECHNOLOGY

T. A. Wilson

Executive Vice President, The Boeing Company

The dinner speaker has been in the aeronautical and aerospace fields since he received his bachelor's degree from Iowa State University in 1943. After receiving his MS in aeronautics at Caltech in 1948, he became head of aerodynamics on the B-47 with the Boeing Company. Mr. Wilson has worked in the fields of preliminary design, wind tunnel design, and construction. He has held a variety of managerial positions within the company and has been a member of the Board of Directors since 1966.

General Session

Beckman Auditorium, 2:15 P.M.

PROVOST, PROTEINS, PROTESTS AND POT—
HIGHER EDUCATION IN AMERICA TODAY

Paul Saltman

Provost of Revelle College, University of California, San Diego

These are strange times in higher education. Perhaps they are no different than when universities were first created. But the focus of the ills, the problems, the concerns of our society, and the search for new and creative dimensions for man seems to be located on the campus. The interaction of the student, the professor, and the administrator in the microcosm of the university and their collective interaction with the world in which they live constitute the subject of this talk.

Seminar Lectures

THE BIRTH OF MATTER
9:30 A.M. and 10:45 A.M.

Jesse L. Greenstein, Professor of Astrophysics and Staff Member, Mount Wilson and Palomar Observatories, Owens Valley Radio Observatory; Executive Officer for Astronomy

New evidence strongly suggests that the early phases of our Universe involved a gigantic explosion from a very dense state, in which radiation rather than matter existed. Evolution of the chemical elements followed during the early stages of the expansion and was completed during the brief life of massive stars. Information on the chemical composition of the oldest objects in our Universe illuminates some of the problems in understanding the first billion years.

THE TWO BRAINS OF ADAM
9:30 A.M. and 11:45 A.M.

Jerre L. Agresti, Graduate Student in Biology

The two brains of Adam refer to the twin cerebral hemispheres which distinguish the mammalian brain. Massive fiber connections between these hemispheres allow the brain to function as a unified organ. Recent investigations have revealed that when the fiber connections are surgically divided, each half brain seems to possess a mind of its own, with its own perceptions, memories, and will.

THE FEEL OF THE MOON
9:30 A.M. and 11:45 A.M.

Ronald F. Scott, Professor of Civil Engineering

An important consideration to the landing of the Apollo Lunar Module on the moon's surface is the strength of the surface material. To determine this property, surface sampling devices were flown to the moon on Surveyor III and VII and employed in a variety of tasks, including testing the lunar soil, digging trenches, lifting rocks, and assisting the chemical experiment. Surface sampler operations will be illustrated.

MOLECULAR BIOLOGY, THE NEXT PHASE
9:30 A.M. and 3:15 P.M.

Max Delbrück, Professor of Biology

All organisms employ sensitive devices to process incoming signals (light, touch, smell) to control their behavior. On the molecular level, these transducer mechanisms are not understood and will challenge the next phase of molecular biology. The problems will be illustrated with the microorganism *Phycomyces* whose single-celled fruiting organ responds sensitively to light and to stretch. *Phycomyces* samples will be available to the audience; a film and slides will illustrate the lecture.

MUSIC, MATHEMATICS, AND MEDIEVAL CHURCHES
9:30 A.M. and 4:15 P.M.
John F. Benton, Associate Professor of History

Proportions, geometry, and number series were used in the design of churches by medieval architects, who set out to build into stone the music of the spheres and the divine harmonies. Careful measurements reveal the principles of construction hidden in such great churches as the lost abbey of Cluny. Color slides.

ROBERT A. MILLIKAN: SPOKESMAN FOR SCIENCE IN THE TWENTIES
10:45 A.M. and 11:45 A.M.
Daniel J. Kevles, Assistant Professor of History

America of the 1920's was Ford, Freud, the flappers, and among other things, Millikan. He was a respected and well-known public figure not only because he won the Nobel Prize in 1923, but also because of his social and economic ideas. These contributed to his notoriety as much as his scientific accomplishments. His fame reflected the ascendant prestige and place of science in the business-minded, increasingly urban America of the decade.

OPIUM EATERS AND OPIUM SMOKERS
10:45 A.M. and 4:15 P.M.
Peter W. Fay, Associate Professor of History

Packed 40 to a mango-wood chest, the dark brown balls of raw opium left Calcutta by the shipload in the 19th century, most of it bound for the pipes of China. But in India itself, and in the West, it was eaten or drunk. Why was it taken one way one place, another way another? And why, Mr. Gladstone, was it produced, shipped, and taken at all?

THE AGES OF PLANETARY OBJECTS
11:45 A.M. and 3:15 P.M.
Gerald J. Wasserburg, Professor of Geology and Geophysics

The age of the formation of the earth and the "ages" of meteorites will be discussed. It will be shown that very precise ages of objects with obscure origin have been established. The ability to determine very precisely age relationships of objects left over as fossils from the formation of the solar system will be discussed, and the history of these objects will be presented.

THE MODERN MARINER
11:45 A.M. and 4:15 P.M.
Clarence R. Gates, Manager of Voyager Mission Operations Systems Division

Contemporary spacecraft can now be directed to land at a specified region on the surface of Mars or Venus. Navigation of Mariner-class spacecraft will be described, emphasizing how the oldest of all sciences, celestial mechanics, is combined with the modern developments of molecular resonance and high-speed digital computers to yield extraordinary accuracies.

AN EARTHSHAKING DISCOVERY
3:15 P.M. and 4:15 P.M.
Paul C. Jennings, Assistant Professor of Applied Mechanics

The startling discovery that earth vibrations were detected on Mount Wilson was one result of a series of tests conducted during the construction of Millikan Library. The building was shaken to examine its dynamic properties. This provided information to guide analytical studies of buildings and to interpret their earthquake response. Measurements of the building response and the soil motion in the Pasadena area resulting from the test will be presented.

PLASMA IN CHEMICAL ENGINEERING
10:45 A.M. and 3:15 P.M.
Frederick H. Shair, Assistant Professor of Chemical Engineering

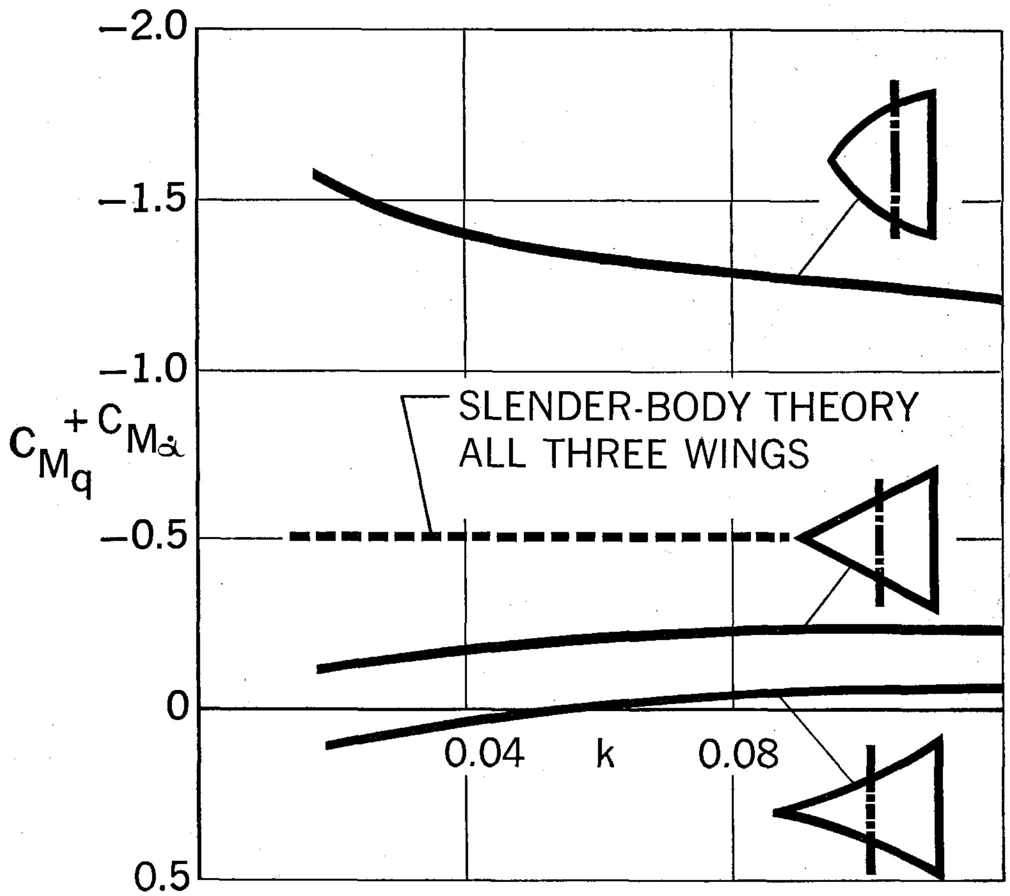
Current investigations will be discussed concerning the use of glow discharges for purifying gases and for providing new paths for chemical synthesis. The basic aspects of electrical discharges are reviewed with the emphasis placed upon future commercial applications. A distinction is made between equilibrium and non-equilibrium plasmas. Most of the discussion will center upon no-equilibrium plasmas. The results of early experiments will be presented along with a short film strip.

HUMANITIES—CALTECH STYLE
10:45 A.M. and 3:15 P.M.
Hallett D. Smith, Professor of English and Chairman of the Division of Humanities and Social Sciences

During the last 20 years, the humanities division has changed its emphasis, introduced humanities options, and has become an integral part of the Caltech curriculum. A look back at the past, coupled with a glance at the alleged conflict between human values and technology, gives meaning to the hopes for the future.

Exhibits: MILLIKAN LIBRARY—Open continuously for inspection; MILLIKAN MEMORABILIA—Millikan Library Lounge; CONTEMPORARY SCULPTURE—Dabney Garden.

Study transonic flow and make good grades.



Like Captain.

Take a look at any campus. Big. Small. Rural. Urban. You see the same thing: guys and gals. Same books. Same looks. Same hopes.

And you are there.

Some students really jam in every bit of opportunity they can grab hold of. Some just drift through.

Which are you?

Here's a good tip: If you join the Air Force ROTC program on your campus you'll know you're grabbing a big opportunity. Financial assistance is available. You'll graduate as an officer—a leader on the Aerospace Team. You have executive responsibility right where it's happening. Where the space-age breakthroughs are. You'll be able to specialize in the forefront of modern science and technology—anything from missile electronics to avionics. You can also be a pilot. You won't get lost in some obscure job with no future.

You'll also enjoy promotions and travel.

So graduate with our blessings.

And a commission.

UNITED STATES AIR FORCE
ROTC (A.U.) BLDG. 500 (ARTOI)
Maxwell AFB, Alabama 36112
Interested in Flying ☐ Yes ☐ No

NAME _______ AGE _______

COLLEGE _______

MAJOR SUBJECTS _______

CAREER INTERESTS _______

HOME ADDRESS _______

CITY _______ STATE _______ ZIP _______

EC-82

ALUMNI NEWS

BOARD NOMINATIONS

The Board of Directors of the Alumni Association met as a Nominating Committee on February 27, 1968, in accordance with Section 5.01 of the Bylaws. Five vacancies on the Board, in addition to the positions of President, Vice President, Secretary, and Treasurer, are to be filled. The present members of the Board, with the years in which their terms expire, are:

Fred C. Anson '54	1970
Horace W. Baker '35	1970
William F. Chapin '41	1970
Donald S. Clark '29	1968
Donald D. Davidson '38	1969
Manfred Eimer '47	1969
Craig T. Elliott '58	1969
John R. Fee '51	1968
Sidney K. Gally '41	1968
Robert C. Perpall '52	1970
Frederic T. Selleck '49	1969
Martin H. Webster '37	1969

The following individuals have been nominated for the terms beginning at the close of the Annual Meeting in June 1968:

President
Donald D. Davidson, BS38ACh (1 year)
Vice President
Craig T. Elliott, BS58ME (1 year)
Secretary
Donald S. Clark,
BS29ME, MS30ME, PhD34ME (1 year)
Treasurer
John R. Fee, BS51CE (1 year)
Director
William A. Freed, BS50ME (3 years)
Director
Robert V. Meghreblian,
MS50Ae, PhD53Ae (3 years)
Director
Charles A. Ray, BS61 Engrng (3 years)
Director
Douglas G. Ritchie, BS57ME (3 years)
Director
Arthur O. Spaulding, BS49Ge, MS58Ge (3 years)

Section 5.01 of the Bylaws provides that the membership may make additional nominations for Directors or Officers by petition signed by at least fifty regular members in good standing, provided that the petition is received by the Secretary not later than April 15. In accordance with Section 5.02 of the Bylaws, if further nominations are not received by April 15, the Secretary casts the unanimous vote of all regular members of the Association for the election of the candidates nominated by the Board. Otherwise, a letter ballot is required.

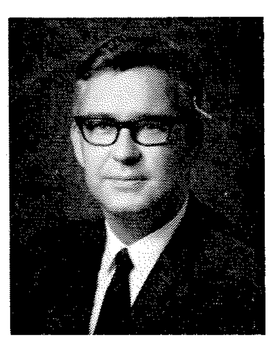
Statements about those nominated for Directors are presented below.

—Donald S. Clark, Secretary

WILLIAM A. FREED received his BS in mechanical engineering in 1950, after which he joined Bell Grove Homes, a residential construction firm. He was later an engineer with Radioplane Co., engineering manager of Coleman Engineering Company, and management consultant for Barry & Company, Los Angeles. He is currently president of A.S.D. Corporation in Pasadena. Freed has been active in several Caltech Alumni Fund drives and in Alumni Seminar programs.

ROBERT V. MEGHREBLIAN received his BS in engineering from the Rensselaer Polytechnic Institute in 1943. He did graduate work at Caltech under a Guggenheim Fellowship, and he received his PhD magna cum laude in aeronautics and mathematics in 1953. He held a variety of positions with the Oak Ridge National Laboratory from 1952 to 1958, when he joined the Jet Propulsion Laboratory as chief of the physics section. He was subsequently associate professor of applied mechanics at Caltech and director of the physical sciences division of JPL. He is currently manager of the space sciences division of JPL and vice chairman of the JPL/Caltech faculty committee.

CHARLES A. RAY received his BS in mechanical engineering in 1961. After graduation he took a job with Stanley Aviation in Denver, Colorado, as a design engineer, working mostly in aerodynamic and mechanical design groups. In April 1963 he began work with Ray Products Inc., in Alhambra, where he is now chief engineer and product manager. He is currently active in Caltech's Alumni Fund campaign.



DOUGLAS G. RITCHIE received his BS in mechanical engineering in 1957. He is now chief engineer of transducer products at Microdot Inc. in South Pasadena. He has previously been employed in engineering and manufacturing supervision positions at Electro-Optical Systems, Wiancko Engineering, Da-

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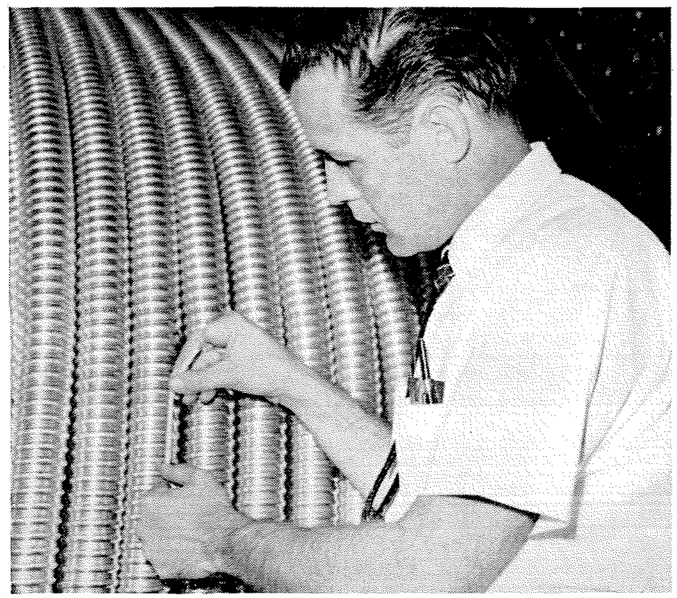
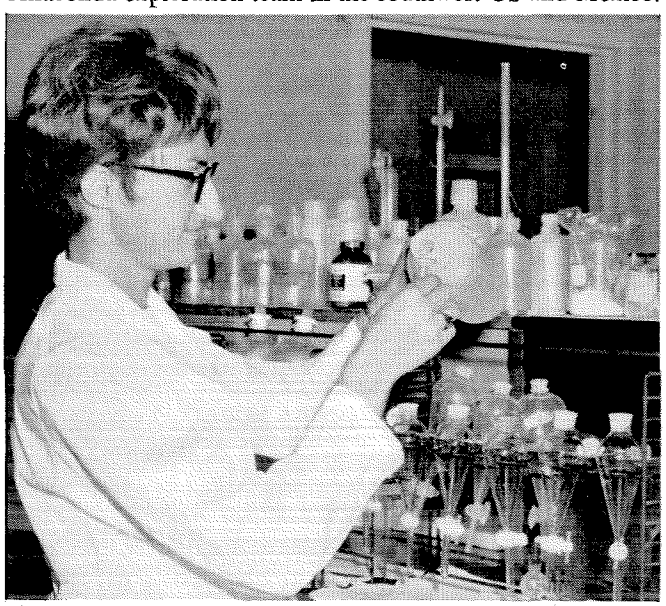
Anaconda is moving.

So are the people who are making it happen.

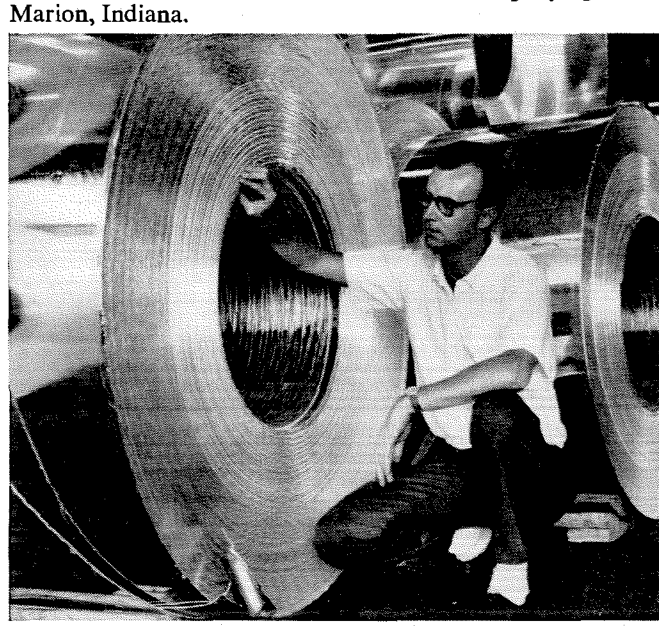
David A. Heatwole (MS Geol., U. of Arizona '66) is a geologist doing geological and geochemical work with an Anaconda exploration team in the southwest US and Mexico.



James F. Lynch (BS Mining E., U. of Missouri, '61) is a general foreman at Anaconda Wire and Cable Company's plant in Marion, Indiana.



Marie C. Vecchione (MS Phys. Chem., Yale '62) is an analytical chemist in Anaconda American Brass Company's research and technical center, Waterbury, Connecticut.



Marlan T. Boultinghouse (BS Geol., Indiana U. '59) is sheet mill superintendent at Anaconda Aluminum Company's plant in Terre Haute, Indiana.

A few years ago these young people were still in school. Today they are specialists in their fields. Growing with Anaconda. To find out about available opportunities in your field, write: Director of Personnel. The Anaconda Company, 25 Broadway, New York, N.Y. 10004.

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10. Provide for stage construction.
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13. Are more economical to build and to maintain.
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FULL-DEPTH Asphalt pavement is an asphalt pavement in which asphalt mixtures are employed for all courses above the subgrade or improved subgrade. FULL-DEPTH Asphalt pavement is laid directly on the prepared subgrade. T_A—a mathematical symbol used in The Asphalt Institute structural design formula to denote FULL-DEPTH.

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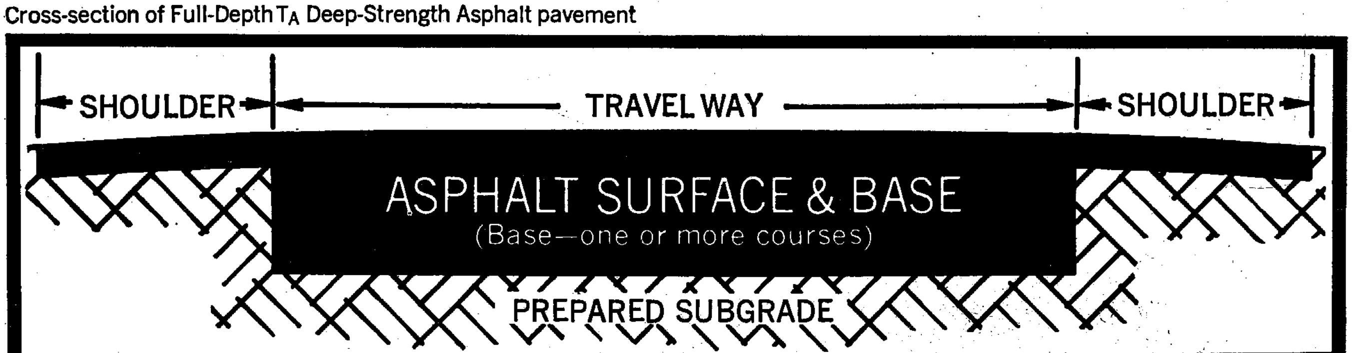
Cross-section of Full-Depth T_A Deep-Strength Asphalt pavement



ALUMNI NEWS *continued from page 39*

tex Corporation, and Consolidated Electrodynamics Corporation. In these positions he has been responsible for various phases of electromechanical instrumentation design, development, and manufacturing. Currently general chairman of the 31st Annual Alumni Seminar, he has served on the committee for the past several years.

ARTHUR O. SPAULDING received his BS in geology in 1949. He was an exploitation engineer with the Shell Oil Company for eight years and then returned to Caltech for graduate work. After receiving his MS in 1958, he went to work for the State of California as an appraiser of mineral rights. In 1962 he assumed his present position as the oil administrator for the City of Los Angeles. Spaulding served on the 1966 Alumni Study Group, which studied ways of improving alumni relations.

Amendments To Articles Of Incorporation And Bylaws Of The Association

All members of the Alumni Association were canvassed in October 1967 for balloting on changes to the Articles of Incorporation. These amendments pertained to the purposes of the Association, the number of Directors, quorum for amending the bylaws, and the disposition of property in the event of dissolution of the Association. On November 30, 1967, the stipulated deadline for the return of ballots, the consents of members to the amendments were as follows: 2,441 consents on Article 2 (Purposes); 2,436 consents on Article 7 (a) (Number of Directors); 2,425 consents on Article 7(b) (Quorum for Amending Bylaws); 2,445 consents on Article 7(c) (Disposition of Property). In accordance with the result of the balloting by the membership, the Board of Directors at the meeting of January 1968 adopted unanimously resolutions for the amendment of the Articles of Incorporation of the Association as presented to the membership. The amendments were certified to the Secretary of State of the State of California, and filing of the amendments was recorded as of January 25, 1968.

The Board of Directors at their meeting of February 27, 1968, amended the Bylaws of the Association to provide for sixteen Directors in accordance with amendment to the Articles of Incorporation. The Directors have also made other amendments to the Bylaws for purposes of clarification and uniformity. The amended Bylaws will be provided to each member of the Association with the notice of the Annual Meeting to be mailed in May.

—*Donald* S. *Clark* '29, *Secretary*

ALUMNI ASSOCIATION OFFICERS AND DIRECTORS

PRESIDENT
Frederic T. Selleck '49

SECRETARY
Donald S. Clark, '29

VICE PRESIDENT
Donald D. Davidson '38

TREASURER
John R. Fee, '51

Fred C. Anson, '54
Horace W. Baker, '35
William F. Chapin, '41
Manfred Eimer, '47
Craig T. Elliott, '58
Sidney K. Gally, '41
Robert C. Perpall, '52
Martin H. Webster, '37

ALUMNI CHAPTER OFFICERS

NEW YORK CHAPTER

President Willis A. Bussard, '44
Appleby Drive, RFD 1, Box 78B, Bedford, N.Y. 10506
Vice-President Frederick E. Wood, Jr., '51
c/o IBM 1000 Westchester Ave., White Plains, N.Y. 10604
Secretary-Treasurer Harry J. Moore, Jr., '48
c/o IBM, Old Orchard Rd., Armonk, New York 10504

BOSTON CHAPTER

President Francis Morse, '40
16 Reservoir Rd., Wayland, Mass. 01778
Vice-President Theodore G. Johnson, '57
Annursnac Hill Rd., Concord, Mass. 01742
Secretary-Treasurer Thomas C. Stockebrand, '53
Depot Rd., Boxborough, Mass. 01720

WASHINGTON, D.C. CHAPTER

President Willard M. Hanger, '43
4720 Sedgwick St.,N.W., Washington, D.C. 20016
Vice-President Bernard B. Watson, '35
Research Analysis Corporation, McLean, Va. 22101
Secretary-Treasurer John T. Cookson, Jr., '66
1225 Noyes Drive, Silver Springs, Md. 20910

CHICAGO CHAPTER

President Laurence H. Nobles, '49
Dept. of Geology, Northwestern Univ., Evanston, Ill. 60201
Vice-President Philip E. Smith, '39
714 Forest Ave., Wilmette, Ill. 60091

SAN FRANCISCO CHAPTER

President G. Neal Huntley, '54
3136 Padre St., Lafayette, Calif. 94549
Vice-President William N. Harris, '49
5 Pembroke Pl., Menlo Park, Calif. 94025
Secretary-Treasurer Harrison W. Sigworth, '44
10 Casa Vieja, Orinda, Calif. 94563
Meetings: Engineers' Club, 16th floor, Hong Kong Bank Bldg., San Francisco
Informal luncheons every Thursday at 11:45 A.M.
Contact Mr. Farrar, EX 9-5277, on Thursday morning for reservations.

SACRAMENTO CHAPTER

President Wayne MacRostie, '42
3840 San Ysidro Way, Sacramento, Calif. 95825
Vice-President Herbert H. Deardorff, '30
3849 Annadale Lane, Apt. 4, Sacramento, Calif. 95821
Secretary-Treasurer Myron W. Black, '56
3364 Sierra Oaks Drive, Sacramento, Calif. 95825
Meetings. University Club 1319 "K" St.
Luncheon first Friday of each month at noon
Visiting alumni cordially invited—no reservation.

"What I like about IBM is the autonomy. I run my department pretty much as though it were my own business."

"Tell some people you work for a big company, and right away they picture rows of gray steel desks with everybody wearing identical neckties.

"Well, that's the stereotype. When you look at the reality, things are a lot different. (This is Gene Hodge, B.S.E.E., an IBM Manager in Development Engineering.)

"IBM has over 300 locations. They believe in decentralization, and they delegate the authority to go with it. To me, it's more like a lot of little companies than one big one.

"Take my own situation, for example. I act as a kind of entrepreneur for my department. I decide if we should bid on certain government contracts for my group and then develop the proposal strategy. Of course, upper management reviews my decisions, but to a great extent I run my own show.

"Another thing that makes this like a small company is the close relationship with your boss. You're almost always hired by the manager you're going to report to. And you work for him on your own or in a small team. It's part of his job to know your long term goals and help you reach them.

"This same interest in the individual also shows up in IBM's educational programs. I'm getting my Master's now, and IBM's paying the entire cost, and some of the class time is on company time."

Gene's comments cover only a small part of the IBM story. For more facts, visit your campus placement office. Or send an outline of your career interests and educational background to E. C. Purtell, Jr., IBM Corporation, Dept. E, 3424 Wilshire Blvd., Los Angeles, California 90005. We're an equal opportunity employer.

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