E&S
ENGINEERING AND SCIENCE

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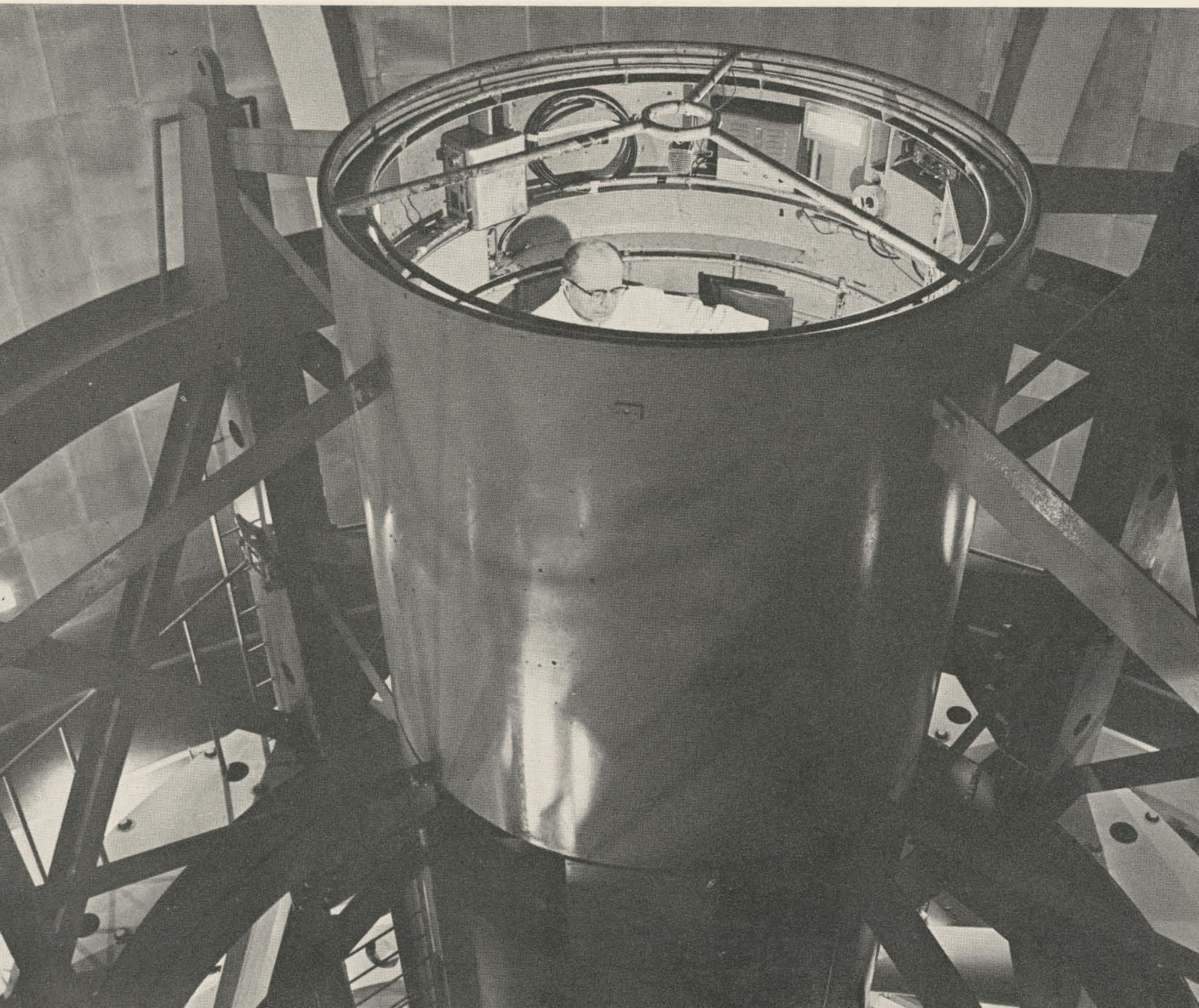

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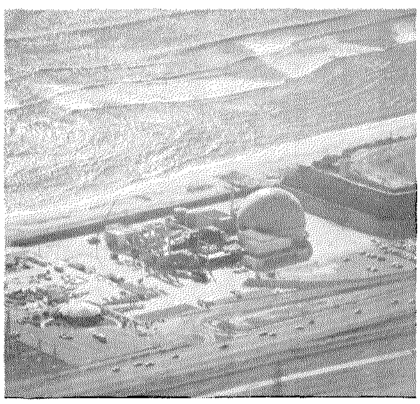

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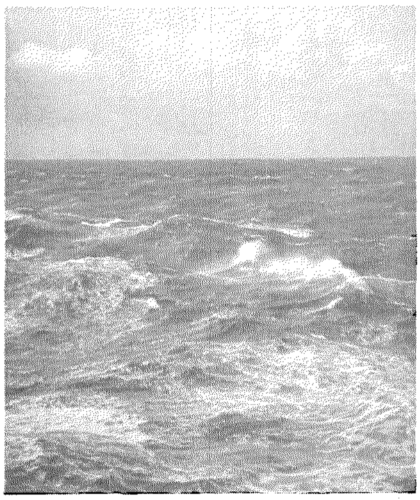

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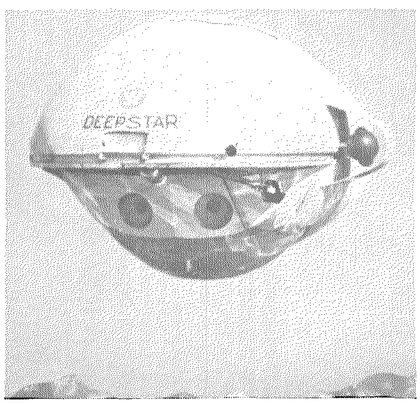

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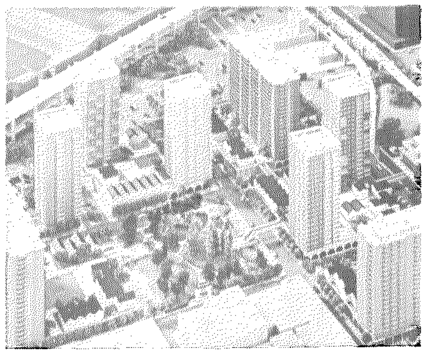

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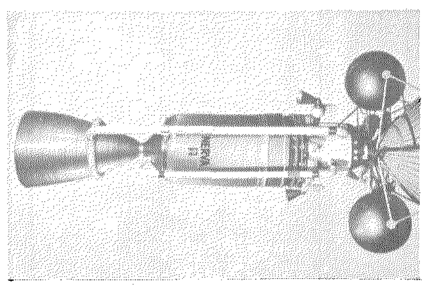

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ENGINEERING AND SCIENCE

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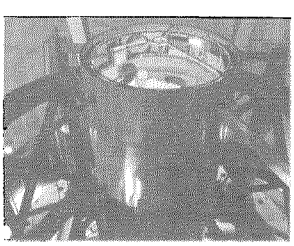

ON THE COVER

Jesse L. Greenstein, professor of astrophysics at Caltech and a staff member of the Mount Wilson and Palomar Observatories, studies quasars from the prime-focus cage of the 200-inch Hale reflector at Palomar. This month marks the 20th anniversary of the Hale reflector (page 13), which was formally dedicated June 3, 1948, and this year marks the 100th anniversary of the birth of the man who designed and built it, George Ellery Hale.

PICTURE CREDITS

Cover, 24-30—James McClanahan; 7, 10, 11—Midge Quenell; 13—Bill Miller; 14, 17—Roy Cameron; 24 (top) Leigh Wiener; 29—Stephen Dashiell.

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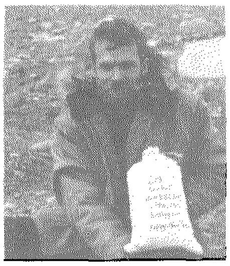
IN THIS ISSUE

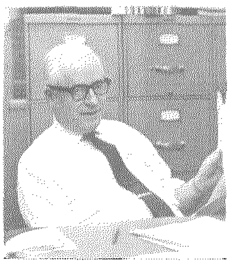
PROVOST, PROTEINS, PROTEST, POT

When Paul Saltman (BS '49, PhD '53) was professor of biochemistry at the University of Southern California, from 1953 to 1967, he developed an increasing concern about the conflict between teaching and research and publishing. At the University of California at San Diego, as provost of Revelle College, he has now also become concerned with the protest and pot problems of students today (page 7). Dr. Saltman's article has been transcribed from the talk he gave at this year's Alumni Seminar on May 4.

SEARCH FOR LIFE IN ANTARCTICA



Charles David (right) and Jonathan King, who received their PhD's this month from Caltech, spent three months in the "dry valleys" of the Antarctic continent as part of a Jet Propulsion Laboratory project to learn more about possible microorganismic life on Mars. An account of their work and experiences in Antarctica appears on page 14.



NUCLEAR POWER & OUR RESOURCES

The rapid growth of nuclear power plants in the U.S. in recent years has raised both private and official concern over the safety factors involved in their operation. As a former member of the Atomic Energy Commission's Advisory Committee on Reactor Safeguards, Jack E. McKee, Caltech professor of environmental health engineering, has been closely following developments in this area. His recent appointment as a member of a new committee, established at the request of the AEC to advise on the disposal of radioactive wastes, insures his continuing collaboration in the attempt to solve such problems as "The Impact of Nuclear Power on Air and Water Resources"–the subject of Dr. McKee's article on page 19.

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LETTERS

Princeton, N. J.

EDITOR:

To one engineer who has worked most of his professional life in civilian industry, the April issue of *E&S* was most stimulating. It appeared that a three-way debate was taking place between Professors Sabersky and Corcoran and Dr. DuBridge.

Professor Sabersky lucidly expounded a problem of great concern to many practicing engineers: How, if at all, will future engineers be trained? Professor Corcoran seemed to provide an answer to kindling the imagination and mobilizing the fervor of the engineering recruit. President DuBridge eloquently pleaded the case of the private institution seeking non-government funds.

Professor Sabersky's question—"Who Will Take the Lead in Engineering Education?"—had been answered for me earlier this year by other members of the engineering faculty—*not* Caltech. During an informal quest for engineering graduates at all degree levels to work in industrial R&D, I was made to understand that the search would be more productive elsewhere. The Institute has trained many brilliant "engineers" in the past several decades. A very large number—possibly a majority—have gone either into teaching or into the aerospace industry. This perhaps because they hoped not to be confronted with urgent, unstructured, technical problems relevant to human needs.

Why then should I respond, or urge my business associates to respond, to President DuBridge's plea? The plain fact is that the largest share of the Institute's recent product has gone onto the federal payroll, directly or indirectly. If we believe Professor Sabersky, this was a tacit choice by the faculty and administration. Why then should they not encourage the government to foot the bill? My interests and those of my associates are centered on civilian economic and social needs as they can be served by a basic mechanical industry. What connection has the Institute's research and educational activities with those interests?

But technologists *are* being trained and some do find their proper place as engineers in civilian industry. The adjustment is traumatic to some. Others come eagerly after learning elsewhere that they are engineers after all, not physicists or mathematicians. In the end most find satisfying and rewarding professional careers. Perhaps a goal of engineering educators should be to help such individuals find their careers sooner and less painfully. Another goal might be to diminish the ranks of those trained in physics and math but who are not able to contribute in those disciplines and who instead spend sterile careers rehashing the work of the Maxwells and Von Kármáns.

Obviously these problems are recognized by Professors Sabersky and Corcoran. Indeed, they have approaches to solutions in mind. But will their colleagues and their administration join and support them in selecting and training young men to respect and assist the practicing engineer in his struggle to find solutions to massive civil problems which face us here on earth?

JOHN T. BOWEN, PHD '49
Director of Research
Ingersoll–Rand Co.

A reply from Frederick Lindvall, chairman of the division of engineering and applied science.

The spectrum of activities in the total engineering function is very broad, and no single pattern of engineering education can be expected to give adequate coverage. Diversity within a given school, if size permits, and diversity among schools reflecting their internal and external environment and resources is an existing, developing pattern. The Engineers' Council for Professional Development recognizes in its accrediting process the concept of differences with certain minimum standards of basic and engineering sciences. Emphasis in most engineering curricula is on the fundamentals which will not be made obsolete by advances in technology.

A second trend is the recognition of the fact that graduate study is an essential part of professional preparation. Caltech was one of the pioneer schools in the development of such education. Research is a necessary ingredient of graduate education, and we have sought to have our research as well as course work compatible with and drawing strength from our resources in the science divisions. Our research and teaching thus tend to focus on fundamental problems in new technology and future trends as we can discern them and on unsolved problems which may exist in established technologies and applications.

Financial support of our engineering research, including facilities and support of the students, is greatly in excess of Caltech's internal resources for *this* purpose. External contract support has made possible the present level of research. With very minor exception, federal agencies have been the source of funding. The research proposals are generated by our faculty for investigations of their choice. However, in engineering particularly, the work undertaken has some relevance to the mission of the granting agency and does not necessarily relate directly to engineering R&D interests of a large part of private industry. A subtle bias may thus have been created which tends to influence students toward those industries which are doing engineering and R&D similar in kind to that of the student's academic research.

We believe that we should have a better balance of research support coming from the private and the public sectors. Yet, over the years, we have found it very difficult to get private industrial research grants under terms compatible with normal academic policies of publication and freedom of discussion. We would welcome greater industrial support for research and fellowships to build a better "image" of engineering in industry generally.

BOOKS

Structural Chemistry and Molecular Biology

Edited by A. Rich and N. Davidson
W. H. Freeman *$15.00*

reviewed by Max Delbrück, professor of biology

Nobody, but nobody, undersells Freeman—907 pages, 60 original papers by 86 associates and students, a classical paper from 1931 by Linus Pauling on the nature of the chemical bond, a bibliography of 375 research papers and nine books by Pauling (omitting about 100 papers on science and world affairs), three portraits of the dedicatee (Pauling)—all this for $15.00! Paper, printing, and editing are excellent. One glaring misprint on the first page of the first paper has been cleverly inserted to put the reader on guard.

The book is as immensely interesting as the man, testifying to the breadth and depth of his impact on vast areas of chemistry, biology, and medicine. Many of the papers are highly sophisticated and speculative; quite a few are review articles; some of the best are retrospective essays; a scattering are purely technical reports. It stands to reason that a book planned to be presented to Linus on his 65th birthday, but delayed in publication for two years by the sweet patience of the editors, will contain only papers which the authors feel they or the world could afford to have in limbo for more than three months. Such a book attracts the contemplative and sometimes the marginal sediments of the mainstream.

Young research students of chemistry, biology, and medicine may well consider this as a bible, not because of its doctrines and dogmata but for its wealth of diversity of content and comment. However, one serious miscalculation appears to have been made—the book weighs over four pounds. The publisher seems to have had in mind a student doing his reading standing in front of a lectern sturdy enough to hold a medieval Bible. Has he not heard that modern man likes to read stretched horizontally? This book would crush him should he fall asleep around page 700. The only practical solution is to Xerox the papers one wants to read closely; this I intend to do and would advise every prospective buyer to do, notwithstanding a scurrilous copyright notice of the publisher's expressly forbidding all forms of copying. Such an attitude strikes me as out of tune with reality as the marijuana laws. Indeed, a "Freedom to Xerox" march on the Supreme Court by 20,000 professors and students would set even Art Buchwald on fire!

Nuclear Astrophysics

by William A. Fowler
Amer. Philosophical Society $3

In 1965 William A. Fowler, Caltech professor of astrophysics, delivered four Jayne Memorial lectures for the American Philosophical Society in Philadelphia on the origin of the elements, nuclear reactions in stars, the age of the elements and of the universe, and some early results and interpretations of galactic explosions and quasars.

The subject matter of these lectures, updated to include information gathered through 1967, now appears in this well-written book.

For the mathematician, the physicist, and the astrophysicist (Dr. Fowler is all three) to have the additional ability to present these understandable accounts of difficult scientific subjects is indeed a lucky break for the enlightened lay reader.

Matrix Theory

by Joel N. Franklin
Prentice-Hall $10.95

reviewed by Richard A. Dean, professor of mathematics

This text is an outgrowth of Joel Franklin's course in Matrix Algebra, which he has given at Caltech since 1957. The text presents a variety of applied problems and emphasizes the role of matrices as combinatorial entities which make possible the solution of these problems. The first half of the book presents determinants and the basic algebraic properties of matrices from the standpoint of solutions of linear equations and differential equations. Two chapters discuss eigenvalues, eigenvectors, and canonical forms, including the Jordan form theorem.

The second half of the book is devoted to two chapters on variational principles and numerical methods. These last chapters are of particular interest to students of engineering and science. Dr. Franklin, who is professor of applied science at the Institute, has taken care to see that his discussions are both mathematically sound and comprehensible to the reader.

Leonardo, International Journal of the Contemporary Artist

Edited by Frank J. Malina, MS '35, AE '36, PhD '40.
Pergamon Press, Oxford ....$6 yr.

reviewed by Robert R. Wark, curator of art collections, Huntington Library and Art Gallery

The founder and editor, Dr. Malina, explains the scope and aims of this new quarterly periodical to be "primarily a channel of communication between artists."

This is a praiseworthy aim. Artists communicate basically (one hopes) through art itself. But the writings of artists about their own work are always of interest both to other artists and to the general public—provided one remembers that there is often a fascinating discrepancy between what an artist says he is doing and what he actually does.

The magazine seems to be primarily for people professionally involved with the contemporary art scene, it would not make light recreational reading for the casually interested layman. It seems probable, given the (Caltech) background of the editor, that there will be a considerable number of articles dealing with the interrelations between science and art.

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June 1968, Vol. XXXI, No. 9

PROVOST, PROTEINS, PROTEST, POT: Higher Education in America Today

by Paul Saltman

Provost, Proteins, Protest, Pot—this has been my life these last eight months. How long it will continue is only in the hands of the student radicals, I guess.

Let me talk about being a provost. Let me talk about the crisis that confronts the administrator of the American university today. And not just the American university but universities throughout the world. I pick up the morning paper now like I used to look for the sports results. Who beat who? I want to see who's ahead at Columbia—the profs or the kids. And then I go to Denver, and just as the plane touches down, Denver University erupts—a nice, quiet private-enterprise college nestled in the Rocky Mountains—and they've got 40 students sitting in. The game continues to be played. The University of Paris is shut down. Northwestern has finally endured.

What do I see? Why do I feel that this is happening now?

It is very interesting when you sit in a university. When you're a student, you're sure that it is a conspiracy of faculty and administrators to make your life miserable and to alienate you from any love of learning that might have at one time crossed your brow. As a faculty member, you play another game. The game is—how do you *not* teach the students and extract lots of money from the administration and get promoted very quickly? And then, as an administrator, you're sure that there is a plot abroad, and that plot is a cabal of faculty and students seeking to destroy the vestiges of this beautiful place which you have built with your very own hands. Why aren't they thankful to me for what I have done? It's a three-cornered game, baby. It's two on one. And you can never always be on the side that has the manpower.

And then, as the milling and pushing and shoving and fighting and brawling and sprawling goes on, it turns out that looking on and surrounding you are such creatures as members of the board of trustees, powerful alumni, governors, and—the people, whoever they may be. But they're there. Whatever you say, you'll get a telephone call or an assemblyman will write you a letter, as one writes to me, protesting my a) morality, b) lack of courage, c) "comsymp" philosophy, and d) lack of understanding of the role of a university. I get something like that about once a week.

But, the fact of the matter is that where there should be a unity of purpose, a community of scholars, a community of people learning and teaching one another, there tends to be this terribly stratified, terribly non-communicating, terribly anti-intellectual world which is the university.

One of the major problems with universities today—one of the great issues that is facing us now—is the fact that we have not created, in the environment of the microcosm of that institution called the university, that kind of world which indeed we are trying to give everyone else.

A recent development which I think bodes ill for the University of California involves a circumstance in which, where there had been some hope, and some struggle to achieve this kind of idyllic world that I described to you, there is now chaos. The Board of Regents met in April. One of the matters on the agenda was the rally concerning the draft which was to be held on the campus at Berkeley. Berkeley, as you know, has been symbolic of the new student, so to speak, and the turmoil on the campus. As a result of the 1964 Free Speech Movement escapades, President Clark Kerr is no longer with us; Chancellor Strong is no longer with us; lots of deans and professors are no longer with us. But they, the regents, did bring in a man named Roger Heyns to be chancellor at Berkeley—a magnificent man and a fine educator who for the past two or three years has been working assiduously with his faculty and with his students to bring together these torn and bloody pieces of that beautiful tapestry that was once Berkeley. He had finally worked it out so that what was to be a protestation of questionable legality and taste, to be held in the Greek Theatre, was finally resolved to be a real educational teach-in concerning the law of selective service and the laws of dissent and protest. And the regents, in their infinite wisdom, sought to examine the issue at their last meeting. Now it is very curious: The regents are forbidden, *by law,* to be concerned with the content of the educational events taking place on campuses of the University of California. I emphasize the words *by law.* That power is explicitly delegated to the president and his chancellors. But the regents chose to break the law. And they stated that it was not a function of time, place, or manner that was causing their concern; it was the *content,* and on that basis the rally was not held in the Greek Theatre, but rather on the steps of Sproul Hall. How long will Roger Heyns survive? I don't know. How long can the regents sit in their meetings decrying the breaking of the law by the students when they themselves seem to ignore or forget it? True, they don't wear beads and beards, but to violate the spirit and letter of the law nonetheless is really a curious circumstance.

PROTEINS

I use that word to designate *my* hangup. I've got a sweatshirt on underneath the one that says *Provost* which says *Biochemist.* I'm a card-carrying biochemist. I rose through the ranks, not on the basis of the fact that I was a great teacher, or that I was interested in students, or that I was concerned about the society in which I live. I rose because I have 70 —count them—70 publications. My rat bill last year at USC was $6,000. Now I've heard a lot of my colleagues in industry say, "Saltman, you've never had to meet a payroll." I may not have had to meet a payroll as big as theirs, but I've had to raise $150,000 a year, including that six grand worth of rats, to get anywhere in the problems of the chemistry and biochemistry of iron.

What I am trying to point out is that there is a terrible polarization inside the faculty member today in higher education. And this is the conflict—the *apparent* conflict—between the time that he devotes to teaching and the time he relates directly to the creation of some sort of scholarly manifestation which can be weighed, counted, or measured by some dean. It's very interesting, this business of quantitation or counting and weighing—measuring the number of prizes a man has won or the dollar value of the grants that he attracts to the institution.

How do you measure a man's teaching effectiveness? Is there some device you can shove into a student to find out how well he is learning? Try sometime to go to the faculty and say, "Boys, what do you say, let's really have an honest evaluation of the faculty by either an outside group of your peers who are considered fine teachers or, better still, by an outside group plus the students." And oh, you watch a lot of guys tighten down. Walk, as a provost, into a class and have a professor say, "I didn't invite you." Hard to measure teaching effectiveness—easy to count the grants.

And then, whom do you teach? Well, I had a man come in the other day who is a fine economist from a famous midwestern institution. His publications are double mine and six books besides, and he is considered one of the hottest properties in economic show biz. We were talking, and our economists were hot to trot with him, and he was hot to trot with us, and I said, "By the way, what sort of program at the undergraduate level do you think you'd like to be involved with when you come here?" And he said, "I don't teach undergraduates. I only want to work with a small group of graduate students who are really able to work with me on my research problems."

I said, "Well, I hope the surf comes up on the Wabash because it isn't coming up here!"

I think the time has come when we have got to stop this nonsense about looking down on the undergraduate as some sort of cross we must bear in order to go forward in our work.

About a year ago I wrote an article called "The Science Jungle" in which I vented a little of my spleen at Caltech. I had two professors in the first four years I was there that, outside of the humanities faculty, I felt cared and worried about the way that they were approaching me, at least in the learning and loving of science. Both of these men are terrific scientists. The first was Linus Pauling, and Linus turned me on in a freshman class in chemistry. I kept waiting for the next time, and it didn't come until four years later when James Bonner salvaged me from the Harvard Business School by a little course called Plant Biochemistry. Now those are two very outstanding scientists. Later there were others, and in every case the great teachers, for me, were the great scientists as well.

To me, a great teacher is the person who, being sensitive and loving and creative in the discipline in which he is working, and actually right on the cutting edge of that discipline, can bring that excitement to the freshman. I don't know any other way to do it. Maybe the trick is to find a way to create some new biochemical drug that, when swallowed by a reluctant professor, makes him need this sparkling attention, this vision of students coming alive and being turned on in a freshman or a sophomore class, and seeing these students go forth and enjoying vicariously their thrills, their excitement, their creativity.

I don't think there is, then, a conflict between publish and perish. I think that you perish intellectually if you don't publish, but to allow it to become the driving force of higher education in the selection of faculty and their recruitment is to destroy the essence of teaching in the university.

It is interesting and curious, though, to note what has happened because of the involvement of the federal government in basic science and in higher education. Not only are you promoted on the basis of your publication record, but the wealth and well-being of your campus is a function of your publications. Oh, yes, there are a few millions to be doled out to what they call the "emerging" universities. We tried for one at USC and failed; we had not emerged. Who gets the loot? Caltech gets the loot. MIT gets the loot. Harvard gets it. UC Berkeley gets it. And UC San Diego is getting a piece of the action, man. We have 21 National Academy of Science members and 3 Nobel Prizewinners. And don't think we don't raise those numbers up high. And don't think they don't impress. It relates to a phenomenon that a sociologist wrote about recently in *Science*. It was called the Mathews Effect: the rich get richer. And if you think there's a dichotomy between the have-not nations and the haves, think of what it is like between the emerging universities and the emerged. Twenty universities enjoy roughly 80 percent of the major research funding in the sciences.

PROTEST

I was asked by a group of students to have an informal talk the other evening about what I thought universities were about. I talked a bit, and then I opened the meeting for discussion. Up jumps a kid wearing black pants, black boots, leather jacket, a Che Guevara beret, and a beard. Clutched in his hand is a little red book. He opens the little red book and he starts reading: "Chairman Mao says—'Fight, fight, talk, talk.' "

I said, "O.K., you son of a bitch, come on down here! You want to fight down here, or do you want to fight out on the plaza? Where do you want to fight?"

He said, "Don't get excited, don't get excited."

Why is there protest today? Why does a student who is smart enough to be at an institution like ours read and quote from Chairman Mao and insist on confrontation?

I think it is really a pretty ridiculous world in which we live, and I think perhaps I understand why the protests and rebellion. Look around. We live beset by the threat of a nuclear holocaust which could destroy us immediately. Peripheral to this are the slow deaths of the population explosion and famine that face two-thirds of the world with an immediacy that few of us are sensitive to and realize. And look around you in terms of the environment—the geosphere and hydrosphere, polluted and despoiled, and the biosphere in a state of incipient ruin and destruction, and a psychosphere of our own minds, warped and wrought and twisted by an urban environment that leaves little to admire or love as beautiful. Couple this with a war of dubious value and dubious cause; and relate this to the threat that is held over every male student who is not blind or pregnant that he might have to go and serve. And you ask the students to go to pep rallies and sing of old Alma Mater? No thank you! But I don't want that alienation and that sense of anomie and that anarchy which seems to prevail everywhere, to burn down and destroy the most potent source of social change that I know of, and that *is* the university.

It is curious about this business of protest. When I was at SC, I was considered the leader of the faculty-student Mau-Mau organization —a constant threat to the president and to the board of trustees and an irritation to many of the faculty who were content with their two-days-on-campus and three-days-in-consultation world. I came to the university at La Jolla thinking, "Well, I may have a tough time with the faculty and administrators down there, but me and the kids will straighten it out." And the first day I was there the students started passing out illegal leaflets; and the second day they flew the North Vietnamese flag on the plaza; and the sixth day the Marines landed. And on the seventh day, I rested.

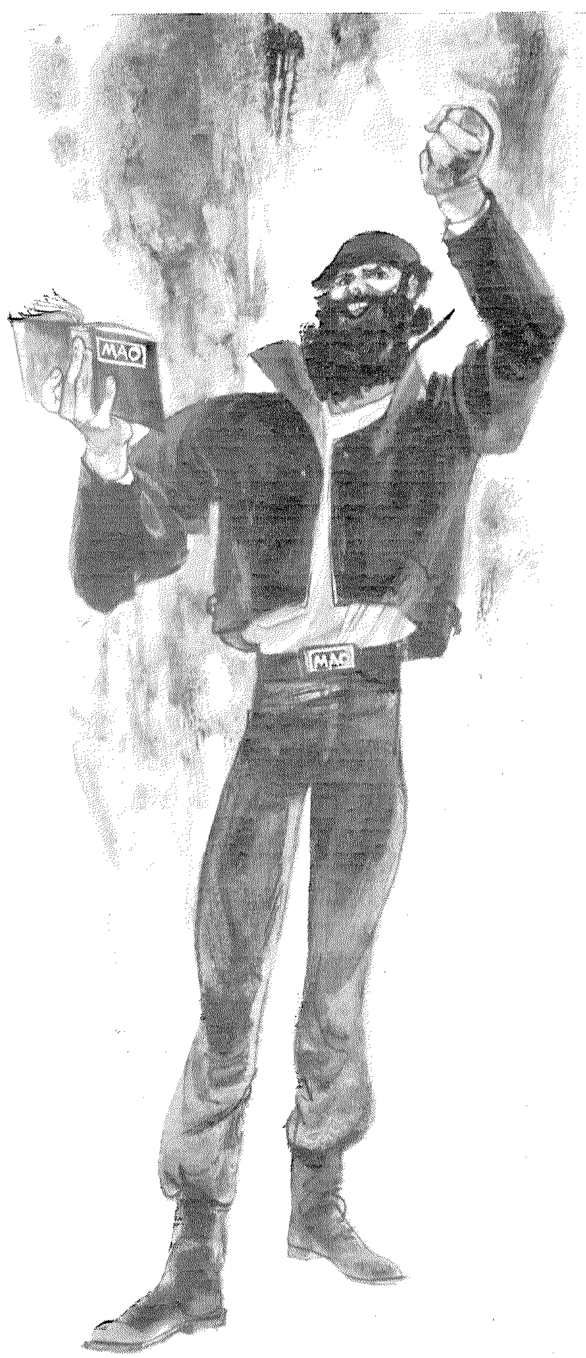
There's a great tendency on the part of the person not involved with campus life these days to say, when a boy walks by with the long hair and beads or a girl unwashed and miniskirted up to her hip, "Why don't you grab those kids and cut their hair and wash 'em up and put a reasonable-sized sailor middy and dickie on them and shape them up and make them be good students?"

Look out, baby; don't touch! If you grab for them—if you grab for their symbols of protest—every student at that university, who has up to this point been totally oblivious to your existence and theirs, rushes to their defense, and they cry, as has been cried to me by a student on the plaza, "We're white niggers, and you're Bull Connor." (I wish I'd had a cattle prod at that time.)

You see, it has come to the point where the student is frustrated and feels helpless to act. After all, he senses more acutely after an education at a university, or during an education at a university, some of the grave consequences of this world in which we live. He finds himself unable to do anything about it. In this loneliness he feels pain and frustration. He lashes out, and he lashes out stupidly and raises the North Vietnamese flag.

Can you imagine anything more pathetic than a scene that was played the other day in the free speech area at UCSD? Some students of the New Left—all six of them—flying proudly the banners of North Vietnam and North Korea, clustered around their booth, while 2,000 students streamed by oblivious to them. Now I think the war in Vietnam ought to be stopped, but *God damn*, it won't be stopped by people putting up North Vietnam flags! It is going to be done through reason, logic, and through the agencies of government and law.

How can we get students to recognize this and be involved and *really* participate in the governance of a university? This is the major problem on most university campuses today. This is the problem that Tom Hull, dean of students at Revelle, and I have addressed ourselves to on our campus. We go before the students and faculty shortly to create what I think will be a true college government, in which the faculty and students and the administrators sit down and begin to work—in which doors are not closed and students dismissed as too immature or unwise, and in which the



faculty agree to come out of their labs, and in which the administrators are no longer fearful of taking it from legislator or citizen and are concerned primarily with giving leadership to the institution that must be. Then perhaps the college will truly become a center for change.

POT

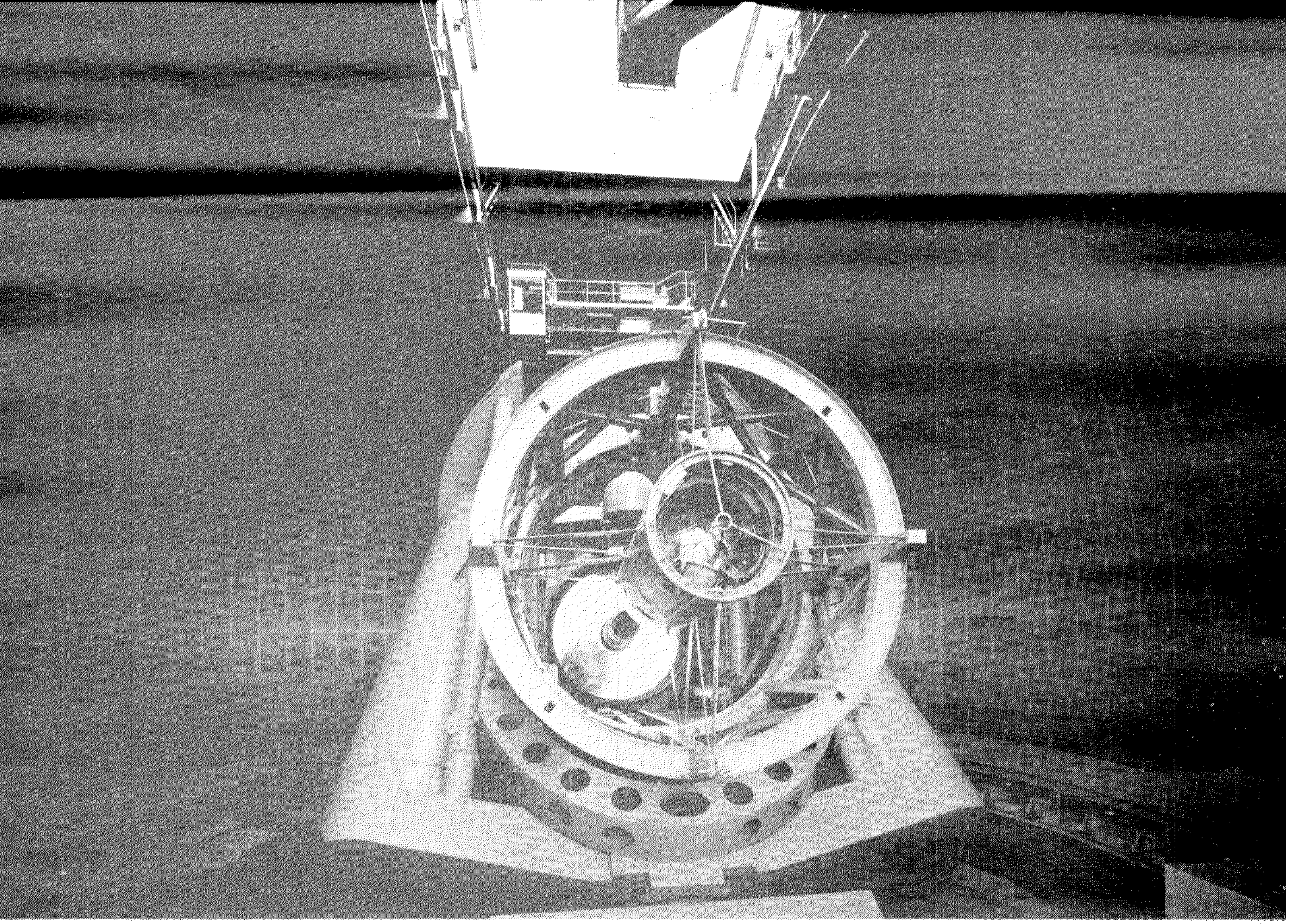
A couple of weeks ago I was on a radio call-in show, and my colleague on the show was the head of the narcotics squad for the San Diego police. Last spring, before I had arrived, the campus made the headlines, because the Narcs hit. They arrested three students at 4 a.m. with no previous warning to the faculty or the administrators or the deans or anyone. They *did* warn the press, because reporters were there in number, as were the television cameras to photograph four kids being led handcuffed out of the dorm.

Now, you see, I have a vested interest in the hallucinogenic drugs. In 1960 I took some LSD as part of an experiment that Dr. Sydney Cohen was doing at UCLA, and we filmed it and did a couple of television shows on drugs and the mind. That was in 1960—before Leary got hip and made a big thing of it. The frightening thing is to see what is happening to the mind expanders, as they are called. (In a true sense they are most contracting, and most destructive.) There is a quality of pathos associated with the students who have turned to drugs as a form of instant Nirvana and escape. I guess I should have been relieved, because on that radio call-in broadcast the lieutenant was pleased to announce that for the past two weeks he had had undercover agents on our campus and had not been able to make a buy. I crossed myself silently over the radio and was delighted, because there is a lot of grass: the grass grows green close to the border, and it is destructive stuff. How is it destructive? Well, it wasn't the grass that got her, but about three weeks ago we had a little gal who tripped out on LSD, and she is still in a mental institution and will probably be there for quite a while. Two fellows made a buy of a kind of peyote, and it turned out to be so toxic that one student was within a half hour of death before we could get him to an emergency ward, have him pumped, and antidotal material put into him. The other was stopped while trying to jump off a fifth-floor rail.

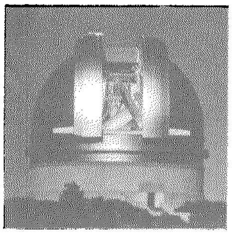
I'm not telling you horror stories just to make you shudder; I'm telling you horror stories because it is horrible to me that within a population of students as we have, there should be this need, this drive to find instant Nirvana. And yet, don't go cluck, cluck, cluck, because it is you and I who drink the booze, who take the tranquilizers, who seek all kinds of hedonistic techniques of "tripping out," but find it somehow not within our understanding to understand their "thing." I'm most concerned about pot not because of the primary pharmacological and physiological effects; I think they are secondary. I am concerned because I think I can understand why a black man in Watts might want to "blow his mind" and find instant tranquility in some form of escape from his ghetto poverty; but I can't understand it with the bright students in the universities, where they can be so turned on by the creative events in which they can participate throughout all ranges of man's human endeavor.

Provost, Proteins, Protest, Pot: Higher Education in America Today. Do we leave it here and walk away? I don't think so. I think it is time for every individual institution of higher education that is worth that name to begin to examine the reason for its being. And in setting up that existence, these institutions must find creative ways of expressing it, living it within their own communities. But even that is not enough. Universities were first built with great walls surrounding them, and the concept of town and gown as two separate entities reigned supreme. We still tend to feel that way on the university campus. I'll never forget that when Watts was burning two years ago, I was on the USC campus in the middle of it doing an experiment. The fires raged *literally* around the walls of the university, but not one scratch was put on one wall during the Watts riots. And we later found out why. Watts didn't even know USC was there.

Reach out; touch; feel; sense. Be a part of this world that must be changed. The talents, the abilities, the minds to change this world are in the university today, but they must be in the community and the world as well. It's time that the fires raged within man's guts and not within the buildings at his universities.



An astronomer at work in the prime-focus observing cage of the 200-inch reflector at Palomar Observatory.



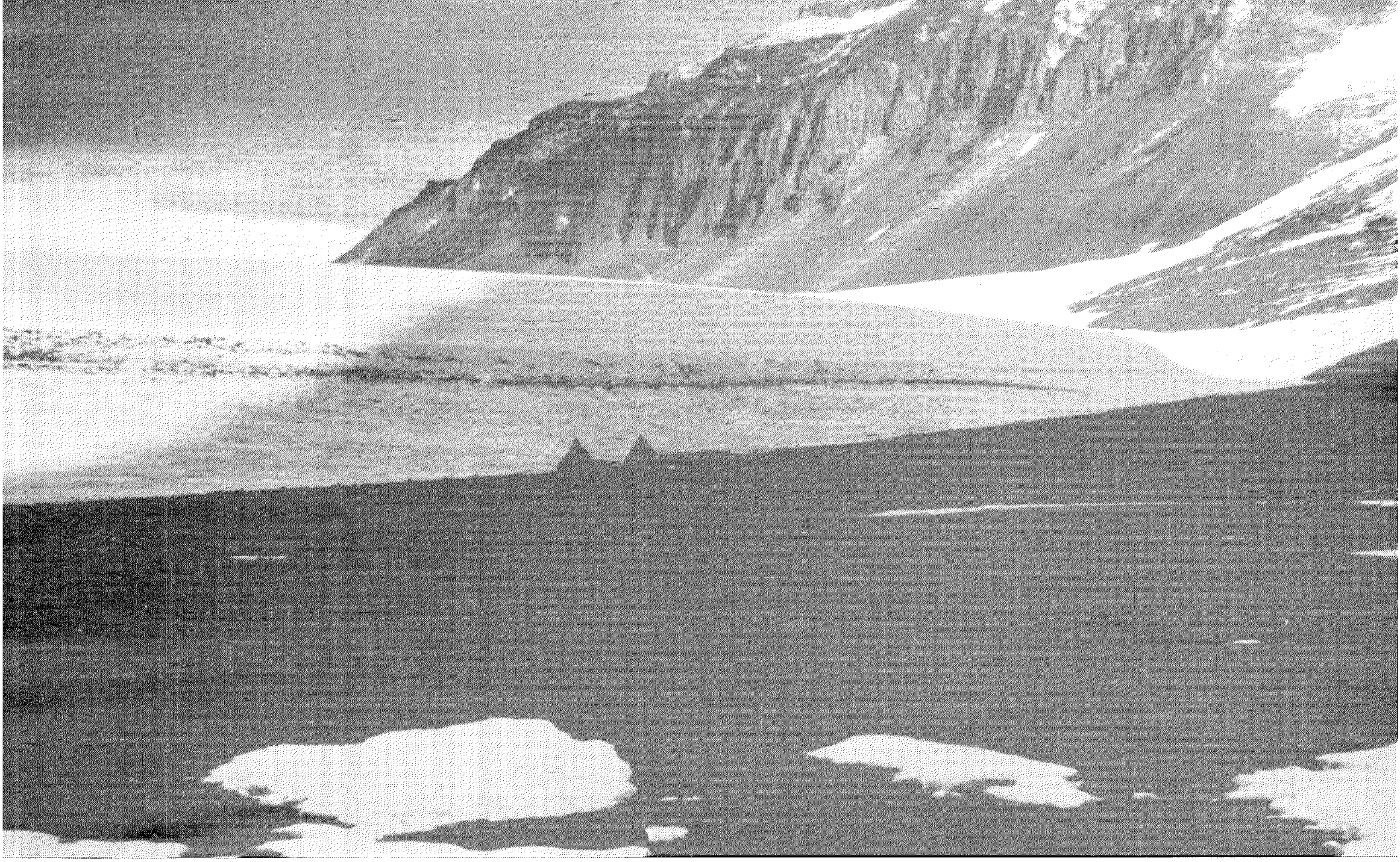
Palomar — Twenty Years After

The world's largest telescope, the 200-inch Hale reflector at Palomar Observatory, celebrates its 20th anniversary this month by greatly increasing its observing powers with the installation of new electronic equipment.

The new equipment not only enables the telescope to measure the intensity of objects that have been recorded at the photographic plate limit but also to make observations much more rapidly than before.

Important astronomical advances made at the Palomar Observatory in its first 20 years include much of the work on the size and geometry of the universe and the research determining the rate at which the universe is expanding. The 200-inch telescope was used in identifying such new cosmic objects as quasars and radio galaxies, and much of the new knowledge of stars and galaxies was obtained through Palomar observations, following the earlier discoveries made with the Mount Wilson 100-inch reflector.

The 200-inch has performed much as George Ellery Hale hoped and predicted. It is a fitting tribute, then, on the 100th anniversary of Hale's birth, to expand even further the great work which Hale had anticipated for the telescope, formally dedicated on June 3, 1948.



Searching For Life in Antarctica

by Charles David and Jonathan King

During the past winter in the northern hemisphere, we were given the opportunity to take a three-month summer vacation in the southern hemisphere—on the Antarctic Continent. As graduate students in Caltech's biology division, we received this invitation from the Desert Microflora Program of Caltech's Jet Propulsion Laboratory. This program, headed by Roy Cameron, is part of the JPL bioscience section's effort to discover microbiological factors relevant to detection of life on other planets—specifically that which may be found on Mars. Since Mars is a cold desert and life there is almost certainly microorganismic and soil-dwelling, JPL is particularly interested in discovering the characteristics and factors that govern the distribution and physiology of desert microorganisms.

The Antarctic may seem a poor place to look for desert microorganisms, since the continent is principally covered with thousands of feet of glacial ice. There are, however, around the periphery of the polar ice cap, a number of small areas where the seaward flow of the ice cap has been stemmed by a mountain chain. Since the annual precipitation of snow is very low, these areas have not accumulated a covering of snow or ice but have remained as large expanses of

The search for life on Mars takes two Caltech biologists, oddly enough, to Antarctica for a summer.

sandy soil and rock. The dry valleys, as they are called, are in effect cold deserts. Although these dry-valley areas are small compared with the size of Antarctica, they are still impressive. The largest, in Victorialand, covers about 1,000 square miles, and it was there that we "summered."

The trip to Antarctica is made in two jumps, first to New Zealand and from there 2,500 miles due south to the main American Antarctic station at McMurdo Sound. This base is on Ross Island, only 80 miles east of the dry valleys in Victorialand. Navy helicopters cover the distance in less than an hour whereas an overland expedition would take several days.

McMurdo is the headquarters for the American effort in the Antarctic. In summer it is accessible by sea to ships accompanied by icebreakers, so it is the principal supply depot from which inland research stations are supplied by air. The Navy provides most of the support facilities for the scientific community, which consists of about 100 men at all stations together. The scientists come from many universities and industries, both in the U.S. and abroad, and are members of the U.S. Antarctic Research Program (USARP). Biology is the principal activity at McMurdo, while atmospheric physics, glaciology, and geology are studied at inland stations on the polar plateau.

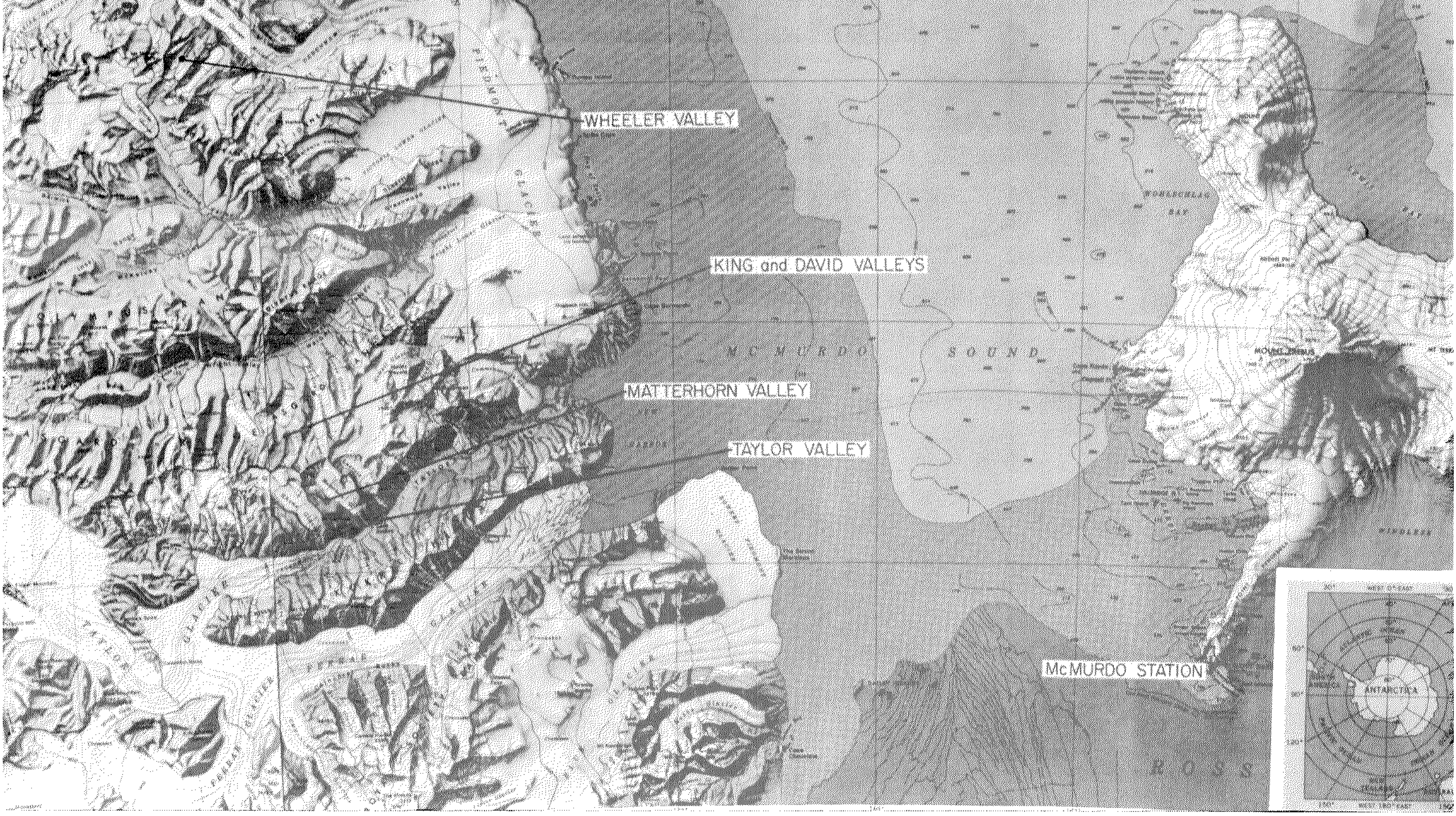
Our own scientific program in the dry valleys was three-pronged. One, we identified and classified the kinds of microflora present in soil samples taken from various locations; two, we examined the physical and chemical properties of these soil samples; and three, we collected meteorological data. The essential effort was to correlate the soil properties and meteorological data with the abundance and variety of the microflora in order to determine what factors critically limit microbial growth in Antarctica.

We established our base camps at three locations in the dry-valley region—Taylor Valley, Wheeler Valley, and King and David Valleys—each picked for specific geographical properties. Helicopters flew us and our equipment from McMurdo to the base camps and deposited us there for five- to ten-day periods. We set up meteorological equipment and recorded data every three hours around the clock. The chief measurements were of the temperature and humidity of the air and soil at various heights from three feet above the soil surface to several feet below it. Total and net solar radiation at the soil surface, evaporation rates, and wind velocity were also measured.

Although the sun never sets in Antarctica during the summer months, it does rise and fall in the sky during the day, providing abundant radiation at noon and dusk-like illumination during the midnight hours. This diurnal radiation cycle is reflected in variations in temperature and humidity in the soil and air. The air temperature fluctuates just below freezing. The soil, by comparison, absorbs solar radiation and is above freezing during the day, often reaching temperatures of 60°F at noon. Deeper in the soil the maximum temperature is just above freezing—cool but certainly adequate to support life. At night the soil cools off and may even go below freezing.

Similarly, while the air frequently has a low relative humidity, the soil has a high relative humidity. The humidity is correlated with the wind velocity and dryness. The floor of Taylor Valley, which is exposed to drying winds, has dry soil compared to areas of Wheeler Valley where there is very little wind and the soils have relative humidities approaching saturation. Since water is essential for life, areas protected from drying winds are likely to be more hospitable. Thus, although the environment in which the scientist lives may indeed be severe, the surface layers of the soil constitute a microenvironment which is *not* hostile to life.

In addition to taking meteorological data at

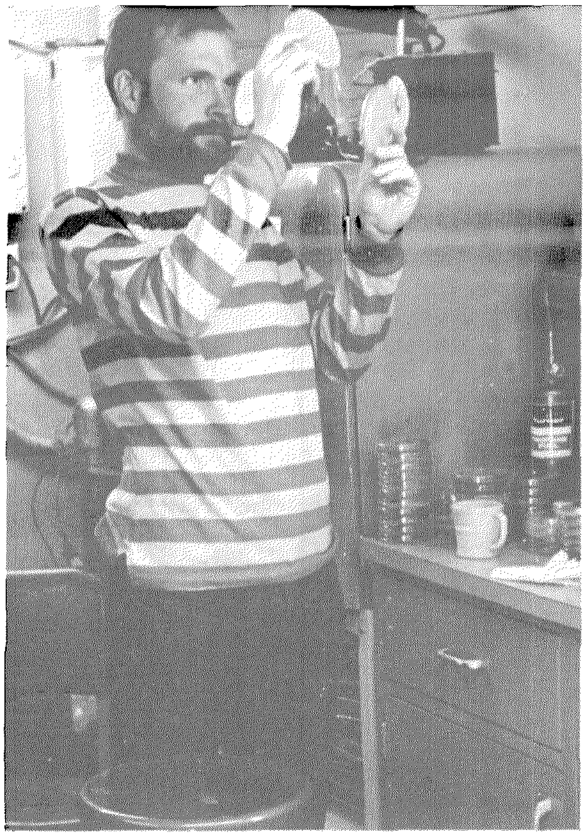


Caltech biologists established camps in four widely separated valleys in Victorialand, Antarctica. The miniscule black dot on the insert map shows the location of Victorialand in relation to the entire Antarctic continent.

the base camps, we took soil samples there and at a number of other sites in the vicinity—up to five miles away. These samples were collected aseptically from the surface and from one inch to four inches below the surface or deeper, depending on the depth of the permafrost. The samples were taken for analysis of microbial life and also for analysis of the physical and chemical properties of the soil. In making the physical and chemical analyses we were concerned principally with the available ions and organic matter in the soil as well as its texture and moisture content—all factors which strongly influence the ability of soil to support the growth of microorganisms.

Back in the biological lab at McMurdo, we ran microbiological analyses on the soil samples. A water suspension was made of soil and used to inoculate a number of different nutrient media which selectively permit the growth of various groups of microorganisms. For instance, an inorganic medium was used to assay for photosynthetic algae. Since it contains no source of organic carbon except the soil itself, this medium does not usually support the growth of bacteria and fungi. With such techniques we assayed the total number of microorganisms per gram of soil and also got an idea of the diversity of groups (algae, fungi, and bacteria) and physiological types (nitrate reducers, anaerobes, and others). A number of these assays were carried out at both high and low temperatures to find organisms especially adapted to live in a cold environment.

Numerically, we found the dominant group of microflora in the dry valleys to be the heterotrophic bacteria. It was the only group present in very poor soils. As sites increased in richness and total abundance of microorganisms, there was also an increase in the diversity of groups and physiological types present. Rich samples contained more than 100,000 organisms per gram of soil, while poor sites contained less than 1,000 and sometimes essentially none. We found that the most conspicuous feature of the distribution of microorganisms



Charles David checks soil samples for microbial life in the biology laboratory at McMurdo Station.

in the dry valleys was the variation between sites geographically close together. Why in the bottom of the main valleys can the population be generally low at many sites, when at 4,000 feet, in the "hanging" valleys on the sides of these main valleys the population is found to be generally rich? We cannot yet offer a complete explanation for all the differences observed, but the results of last summer's work certainly implicate several meteorological factors.

The bottom of Taylor Valley had low abundances of microorganisms. Its soil has very low humidity due to the dry wind that blows through it off the polar plateau to the west. The Matterhorn Valley—a hanging valley 4,000 feet above the floor of Taylor Valley and oriented at right angles to Taylor—has a very high abundance of microorganisms. It is out of the reach of the drying winds. Wheeler Valley has a similar orientation and a high microbial population. We have extensive meteorological data which show that Wheeler Valley is successfully cut off from the dry west wind. The soil in Wheeler is very moist, and, in fact, there were frequently pools of liquid water at noon on sunny days.

In pursuit of the theory that high abundances of microorganisms are found in valleys protected from the dry west wind, we searched the maps for another high valley oriented like Wheeler and Matterhorn. We chose a site in the Asgard Range for which we modestly suggested the names King Valley and David Valley. Once again the mobility provided by the Navy's helicopter support enabled us to get into the selected area for a quick four-day stay just to get the necessary data. Although the area was generally fairly rich in microbial life, the total abundances were not as high as Wheeler and Matterhorn. However, King and David Valleys are not as well isolated from the dry west wind as the maps had led us to hope. Among the sites in the valleys, though, it was clear that those out of the principal wind pattern were richer than sites exposed to the wind.

The analysis of the effects of chemical and physical properties of soil on microbial abundances are not complete. An example, however, will demonstrate the importance of these factors. One site in the Matterhorn, close to several of the rich sites, had virtually no detectable life. This was puzzling at first. Further study, however, showed that this soil was toxic for Antarctic bacteria, and chemical analysis showed that it contained high concentrations of boron, an element known to inhibit microbial growth.

To get aseptic soil samples, Jonathan King and Charles David work downwind from the digging area, using a sterilized trowel and sterile containers.

The results of our work represent only an introduction to the microbiology of the Antarctic deserts. They raise many interesting questions: What are the rates of growth of these bacteria in the natural environment? What do the heterotrophic bacteria use for food? What is the origin of the bacteria present in the permafrost? Are they "ancient" bacteria from an earlier era? How many of the bacteria in poor areas are windblown contaminants from richer areas? How closely related are the Antarctic species to species in the temperate zone? What is the sequence in colonization of initially abiotic areas in the dry valleys—bacteria, then algae, then fungi?

Our results show the need to study all the possible factors that can affect the environment, from the soil properties to the micrometeorology, in order to fully understand the distribution and presence or absence of microbial growth. The results also emphasize the enormous capability of life to find and populate small favorable niches amid a vast hostile area. In terms of extraterrestrial life detection, this fact is very encouraging, since the surface of Mars is without doubt a hostile place. On the other hand, the chance that a space vehicle would land on one of the rare areas favorable for life is small, and it is discouraging to think that a good life detector must be a complicated robot capable of intelligently seeking out such areas.

Although the scientific part of our three-month "vacation" took most of our time and energies, leisure had its challenging, and at times frustrating, aspects. Initially we were attracted to the Antarctic program more for personal adventure than for scientific purposes. Ironically, we came back very much frustrated in the former and very enthusiastic about the latter.

Life at McMurdo is essentially low-grade despite the fact that it is physically very comfortable. We were provided with pleasant private sleeping quarters and four meals a day. Nevertheless, the availability of such amenities does not remove a real sense of malaise among the men. Perhaps boredom is a better word. The environment is monotonous, and there is an extreme lack of imagination on the base. When not working, the men have nothing to do except to go to one of the three movies shown every evening or go to the bar, which serves drinks for almost nothing—a paradise for alcoholics. No effort is made to enrich life with, for example, various sporting possibilities which the Antarctic presents, such as ice hockey or skiing.

In frustration over the dearth of activities, we organized a four-man touch football league by putting up a sign in the mess hall. Overnight we had six Navy teams signed up to play, and we found more scientists to round out a USARP team. The games were played on the only clear level area—the unpaved helicopter landing pad. After a series of playoff games, the Penguin Bowl was held between the two top teams, USARP's Big Kahuana and his Bonzai Pipeliners and the day crew of Seabees, the Saints.

The Kahuanas staged a spectacular comeback in the second half to win 18-12, upholding the honor of the scientific community, to the chagrin of the Navy.

In a more serious vein, we set up a weekly seminar program in the biology lab in order to learn more about the research projects being done by other scientists in Antarctica and to share some of our findings with them. Despite the success of the seminars and the football games in bringing various groups of men together, these activities were insignificant compared to the need. Contacts between the scientists and the Navy and between the scientists themselves were almost nonexistent. Even though it is axiomatic among scientists that contact between persons of divergent interests can be very fruitful, the bureaucracy at McMurdo discourages this contact on the theory that a man is brought there to do a specific job and any time not spent doing that job is "wasted." The weight of bureaucracy at McMurdo is perhaps no heavier than in any other big organization, but it is tragic there since it stifles the imagination so badly needed at an isolated station.

To a great degree it was the prospect of seeing a large part of the continent and learning about the other research projects that initally enticed us to go to Antarctica. In this we were thwarted. What kept us sane and happy was the fact that the scientific project we were attached to proved much more interesting than we anticipated.

The Impact of Nuclear Power on Air and Water Resources

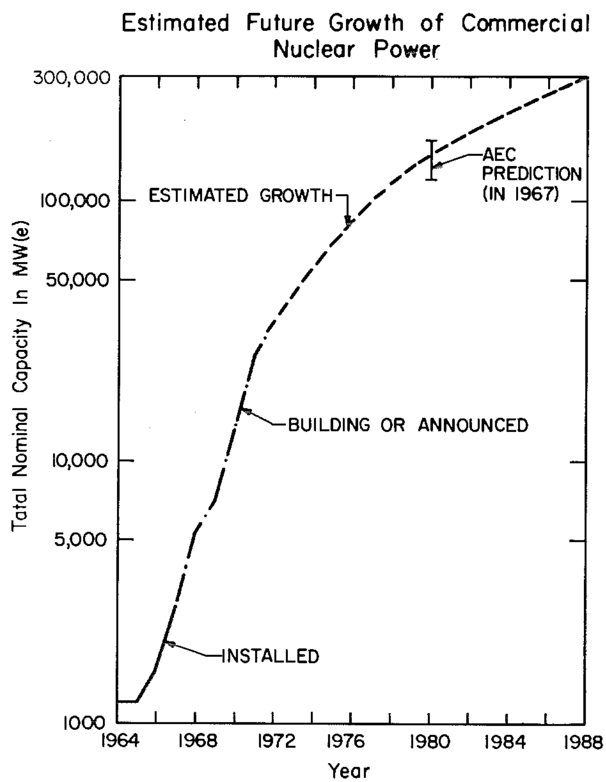
by Jack E. McKee

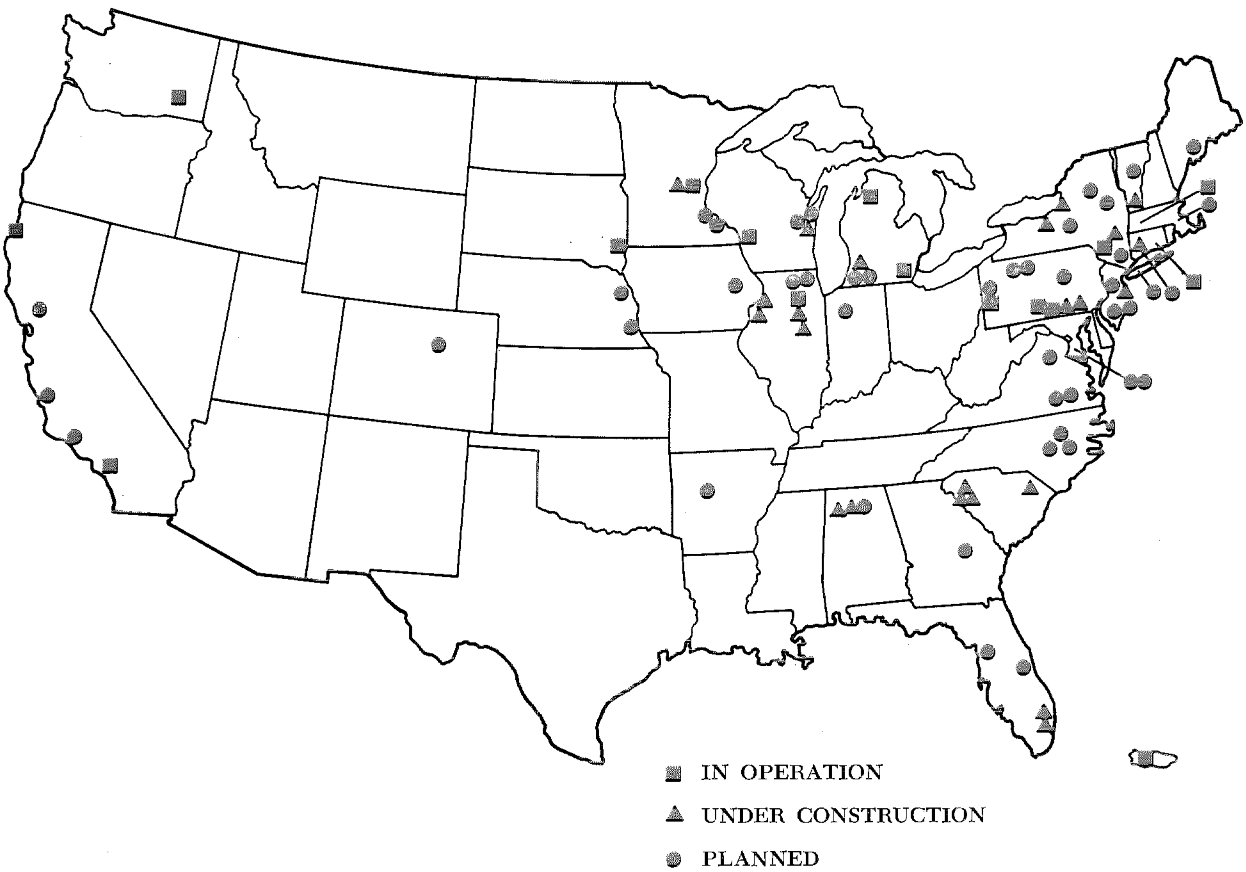
The rapid growth of nuclear power plants in the United States raises serious questions about the environmental factors involved in their operation.

The sudden surge toward nuclear power throughout the world has given rise to some serious questions about its potential effect on many facets of our complex civilization. The social, economic, military, and geopolitical implications are staggering and far beyond the comprehension of most of us. Of immediate and practical concern to all, however, is the impact of nuclear power on our local environment, and specifically on the quality of air and water resources. It is prudent, therefore, to evaluate the probable effects of routine discharges from nuclear power plants on the atmosphere and on natural waters and to assess the possible consequences of a serious accidental discharge of radioactivity.

The past, present, and probable future growth of commercial nuclear power in the U.S. is shown at the right. It is estimated that by 1980 the installed nuclear capacity will be about 100,000 electric megawatts [MW(e)] or about 37 percent of the then total electric capacity. By the turn of the century, more than half of the capacity will probably be nuclear.

In order to weigh the probable and potential impact of commercial nuclear power on the environment, let us consider the major types of nuclear reactors and the nature of their waste products. Almost all large commercial nuclear power reactors in the United States utilize enriched uranium for fuel and ordinary light water for primary cooling and heat transfer. These reactors are categorized into two types, *viz.* pressurized-water reactors (PWR), which account for about 60 percent of the total, and boiling-water reactors (BWR).



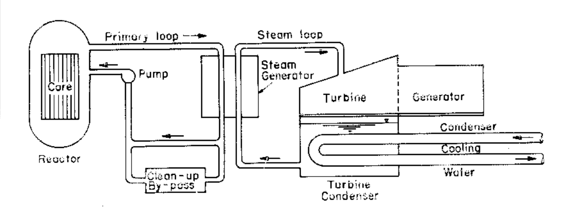


In a PWR (below) the circulating primary coolant water reaches a temperature of about 600°F, but it does not boil because the pressure is held at about 2,000 pounds per square inch (psi). Steam is generated in the secondary loop by means of a heat exchanger or steam generator. The condenser cooling water system is of special note, for this is where one of the major impacts on the environment occurs.

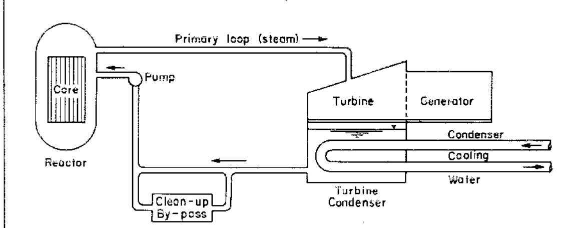
A boiling-water reactor (right) operates at a lower pressure (about 1,000 psi) which allows the water to boil at temperatures of about 500°F. Thus, a secondary loop is not necessary, but there must still be a condenser cooling system. It might appear that boiling-water reactors are much simpler than pressurized-water reactors, but there are many complicating and compensating factors related to safety and waste discharge.

The primary coolant in both PWR and BWR

PRESSURIZED-WATER REACTOR



BOILING-WATER REACTOR



plants is ordinary demineralized water to which may be added small concentrations of boric acid for neutron absorption and phosphates for pH control. The enriched uranium-oxide pellets and their fission products are normally confined in fabricated fuel elements by cladding or coating of stainless steel or Zircaloy. Because of the high temperature and the low mineral content of the primary coolant water, however, corrosion and leakage of the cladding or piping may occur. As a result the primary coolant eventually acquires fission products that leak from the fuel elements and corrosion products (crud) that come from the metal system.

To remove these fission products and circulating crud, part of the primary coolant is diverted through a treatment system utilizing diatomite filters and ion-exchange resins. The used diatomite and spent resins are generally not recovered or regenerated, but are hauled offsite for regulated land disposal.

Liquid wastes. Although the primary loop of a PWR or BWR is normally a "bottled-up" system, overflow of water occurs when the boron concentration must be lowered by dilution. Moreover, small leaks may occur at valves or other fittings, or around pump seals. Radioactive liquids may also originate in the laboratory or washrooms. All such spillage, leakage, and drainage is collected and subjected to treatment before discharge to the environment or prior to controlled offsite disposal. The total volume of such liquid wastes is relatively small, but highly variable. It should seldom exceed 100,000 gallons per day (gpd) for a 500 MW(e) reactor and can be expected to average less than 50,000 gpd. The total radioactivity in the untreated liquid wastes may also be expected to be low, probably not in excess of 10 to 20 curies per year, mostly in the form of activated corrosion products (e.g. Fe-59, Mn-54, Co-58, Cr-51, Mo-99).

Treatment generally comprises detention for the stabilization of isotopes of short half-life, steam stripping of dissolved gases, diatomite filtration, contact with ion-exchange resins, and/or evaporation. The treated liquid is then monitored for radioactivity and, if acceptable, diluted in the condenser cooling water system for discharge to a river, lake, or ocean. Spent resins, contaminated diatomite, and evaporator residues are hauled offsite to regulated land-disposal areas.

Gaseous wastes. Neutron activation of the primary coolant water in PWR's and BWR's will cause a radiolytic production of gaseous radioisotopes of nitrogen, oxygen, fluorine, and hydrogen (tritium). If the water coolant is not well-deaerated, radioisotopes of the rare gases (argon, krypton, xenon) and possibly carbon oxides will be produced in small amounts. Moreover, defects in the fuel-element cladding may cause leakage of gaseous fission products (bromine, iodine, krypton, xenon) to the primary coolant.

The primary coolant water in a PWR is generally supersaturated with hydrogen gas to minimize radiolysis. The short-lived radioisotopes of nitrogen, oxygen, and fluorine that are still produced are kept in solution and recycled sufficiently to cause almost complete decay. Some waste gases are released, however, in the by-pass cleanup circuit and in the overflow resulting from boron dilution. Since such waste gases are mostly hydrogen, catalytic burners are used to convert the hydrogen to water for subsequent decay in hold-up tanks or for disposal as a liquid waste. The remaining gases are generally filtered to remove solid particulate daughter products and discharged through short stacks to take advantage of atmospheric dilution. In general, gaseous wastes are an almost insignificant problem at a PWR, unless and until there is considerable leakage of noble gases through perforated cladding of fuel elements.

For boiling-water reactors, however, the gaseous wastes constitute the major routine impact on the environment. Hydrogen cannot be kept in the primary coolant of a BWR, and therefore the production of radiolytic gases is enhanced. The short-lived isotopes of oxygen, nitrogen, and fluorine, along with noble gases from perforations in fuel elements, transfer as non-condensible gases with the steam and are removed from the primary circuit through the turbine-condenser air vents. The higher halogens and the particulate solid daughters from decay of krypton and xenon generally remain in the primary coolant and are removed eventually in the by-pass cleanup circuit.

The so-called off gas from the turbine condenser is generally stored in holdup tanks for about 30 minutes to permit decay of the short-half-lived isotopes of nitrogen, oxygen, fluorine, xenon, and most krypton radioisotopes. The solid daughters formed in the off-gas lines and holdup tanks are removed by filtration, and the residual gas is then monitored and discharged to the atmosphere through tall stacks to achieve maximum atmospheric dilution. The filters are replaced frequently and hauled offsite as a solid radioactive waste.

The major radioisotope remaining in the stack discharge from a BWR is Kr-88, which has a half-life of 2.8 hours. Fortunately, a longer, half-lived isotope, Kr-85, is present only in minute traces. Owing to the high rate of off-gas production, however, it is possible for the radioactivity of the stack gases of a large BWR to reach 1.0 curie per second (86,400 curies per day) if one percent of the fuel elements develop perforations. Such releases would call for shutdown of the reactor and replacement of the perforated fuel elements.

Solid wastes. Spent diatomite, ion-exchange resins, evaporator concentrates, and other noncombustible high-activity wastes are generally fixed in concrete in 55-gallon drums and turned over to commercial firms for offsite land disposal at regulated locations in Kentucky, Nevada, New York, and Washington. Light combustible wastes such as fiber filters are generally baled, sealed in drums or boxes, and shipped offsite for land disposal. The present regulated locations for land disposal of such solid wastes appear to be ample for all conceivable future nuclear power plants.

All releases of radioactivity into the environment are controlled by the Atomic Energy Commission in compliance with the guides or standards of the Federal Radiation Council, the National Council on Radiation Protection and Measurement, and the International Commission on Radiological Protection. The specific AEC rules are set forth in the Code of Federal Regulations, Title 10, Part 20.

The meat of the rules is in a table which delineates the allowable radioactive concentration of each isotope discharged through a stack, pipe, or similar conduit at the point where the material leaves the conduit. If the conduit discharges within a restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, and/or decay between the point of discharge and the boundary.

For water, the regulations generally apply in the condenser cooling water into which liquid wastes have been diluted. Since no attempt is made to measure all radionuclides in the effluent, the gross limit in the condensing water effluent, for all practical purposes, is 100 picocuries per liter (pc/1). Concentrations, however, may be averaged over a period of one year. Experience at commercial nuclear power plants to date has shown that the average gross activity of liquid effluents during routine operation is generally less than 5 pc/1, or a factor of 20 below the AEC limit.

For air, the regulations generally apply at the site boundary, after an allowance for atmospheric dilution from monitored stack discharges. If either the identity or the concentration of any radionuclide in the diluted discharge is not known, the gross activity of the gaseous mixture cannot exceed 0.04 picocurie per cubic meter (pc/m^3) on a yearly average. If it is known that alpha emitters and certain beta emitters of improbable occurrence are not present, the gross radioactivity of the atmosphere at the site boundary can be as high as 10 pc/m^3 on a yearly average.

Operating records for existing PWR and BWR plants indicate that the radioactivity of gaseous stack discharges seldom exceeds one percent of the established limits. Offsite monitoring by utilities and by state and federal agencies indicates that there has been no detectable increase in atmospheric radioactivity or fallout that can be attributed to any commercial nuclear power plant.

Many plants and animals have the ability to concentrate specific radionuclides in certain organs or tissues. Iodine, for example, is concentrated in the thyroid of higher animals, silicon in the tests (external covering) of diatoms, calcium in the shells of mussels, strontium and phosphorus in the bony skeletons of vertebrates, and cesium in soft tissues. Concentration factors in excess of 500,000 have been reported for specific elements in some aquatic and marine organisms; but fortunately, reconcentration reaches a higher level in lower plant and animal forms such as bacteria, protozoa, and phytoplankton than in

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RETIRING THIS YEAR

Henry Borsook

HENRY BORSOOK
professor of biochemistry

Henry Borsook, noted for his work in protein synthesis and for his contributions to the field of nutrition, becomes professor of biochemistry, emeritus, this month after nearly 40 years on the Caltech faculty.

Borsook received his undergraduate and graduate degrees from the University of Toronto and came to Caltech in 1929 as assistant professor of biochemistry. His interest in proteins led him in the early 1930s to a new theory about their metabolism. Evidence at that time indicated that proteins were probably very stable, but Borsook believed that there was a continual interchange of proteins, that they were in a state of constant flux. He conducted tests (this was before the discovery of isotopes) that proved the accuracy of his theory, but it met with considerable resistance from other biochemists. The instability of molecules is now unquestioned.

His 1940 book, *Vitamins: What They Are and What They Will Do for You*, was one of the first to present contemporary nutritional ideas to the layman. During World War II he was engaged in research on the importance of nutrition both at home and at the front. As an extension of his research, he developed the multipurpose food (MPF) that is distributed widely to underdeveloped areas of the world by the Meals for Millions Foundation.

Currently on leave of absence from Caltech, Dr. Borsook is doing research at the University of California at Berkeley on the function and production of red blood cells. He will continue this work after his retirement.

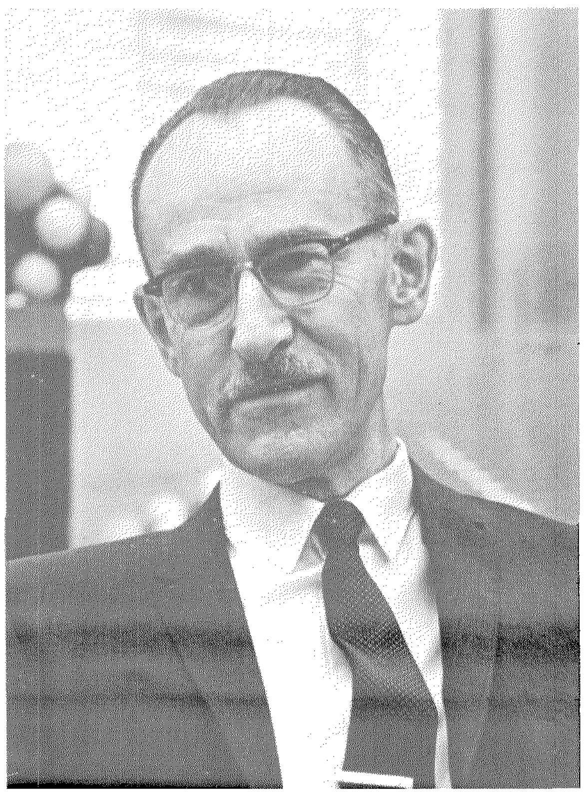
ROBERT COREY
professor of structural chemistry

Robert Corey, after more than 30 years at Caltech, will become professor of structural chemistry, emeritus, this month. After receiving his bachelor's degree from the University of Pittsburgh and his PhD from Cornell University (where he also taught for five years), Dr. Corey began working at the Rockefeller Institute for Medical Research in 1929. It was there that he became interested in the structure of molecules, work that has occupied much of his time for the past 30 years. In 1937 Dr. Corey came to Caltech for a brief stay, because the Institute had the equipment necessary for his studies in x-ray crystallography. He was encouraged to remain, however, by the stimulating atmosphere he found here and by the people interested in his field of research. Linus Pauling, then chairman of the chemistry division, had been working on the structure of proteins, but needed more information about the dimensions of the bonds and bond angles and the radius of the atom in the peptide chains—a project Corey undertook.

Except for his research on rocket fuels during World War II, he worked steadily on the development and improvement of reliable models for use in the study of protein structure. The current "CPK models" are named for Corey, Pauling, and Koltun (who developed the plastic form of the models).

In recent years, Corey has been involved in the determination of the structure of protein molecules by the investigation of the structure of protein crystals. After retirement he hopes to continue to be active in some aspects of this work.

Robert Corey



LOUIS WINCHESTER JONES, *associate professor of English; dean of admissions*

Louis Winchester Jones retires this month and will become dean of admissions, emeritus. For nearly 40 years he has had a hand in the selection of Caltech's freshman class—and thus, a hand in shaping the kind of school Caltech has become.

Winch Jones became a member of the admissions committee in the late twenties, when its chairman was James Bell, professor of chemistry. Caltech had only about 300 applicants then, nearly all from local high schools, and the Institute gave its own entrance exams. Professor Bell personally perused all the applications and selected most of the winners. Then he assembled the half-dozen members of the committee, and they settled the fate of the few borderline cases remaining. It all took the better part of one day.

The admissions program has changed considerably since Winch Jones became dean in 1937. An admissions committee of 15 members now works for nearly two months studying the records of applicants, another week or two interviewing all over the country, and another week selecting those who will make up the freshman class—about 200 from a field of nearly 1,200—and assigning scholarships.

Dean Jones has worn an assortment of hats at Caltech. From 1925 to 1960 he taught English, becoming an associate professor in 1943. Since 1960, however, he has had to devote full time to admissions and financial aid. He has been assistant dean of upperclassmen, registrar, director of admissions, and finally, dean of admissions and director of undergraduate scholarships. And he has been a trustee of the national College Entrance Examination Board, membership chairman of that board, and president of its West Coast section.

Retirement plans? Dean Jones says, "I'll figure that out after I'm retired."

Louis Winchester Jones

ROBERT B. KING
professor of physics

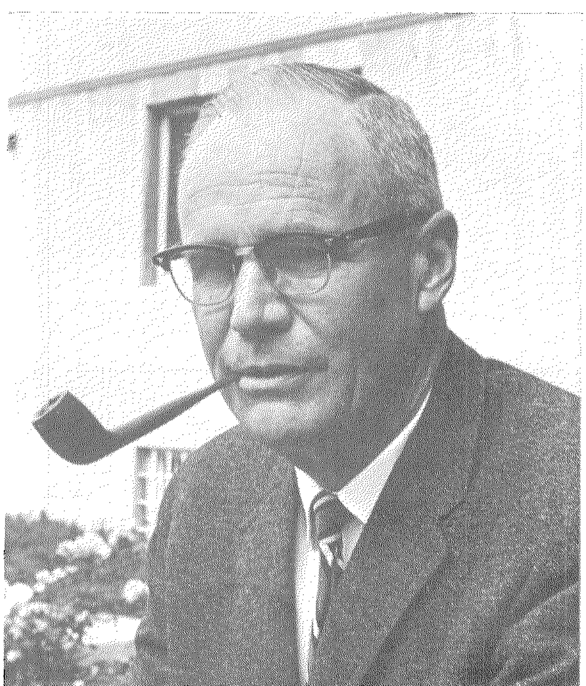
Robert B. King, professor of physics, retires this month after 20 years on the Caltech faculty. A native of Pasadena, he attended Pasadena schools and was graduated from Pomona in 1930. In 1933 he received his PhD in astronomy from Princeton.

In 1933-34, Dr. King was a National Research Fellow at Mount Wilson Observatory. He became instructor of physics at MIT in 1935, returning to Mount Wilson Observatory in 1938. He was appointed associate professor of physics at Caltech in 1948 and professor in 1952.

Dr. King, who has more than 25 publications on astrophysics, is a member of the American Physical Society, American Astronomical Society, Astronomical Society of the Pacific, International Astronomical Union, and Optical Society of America. He received the Naval Ordnance Development Award in 1945 and the President's Certificate of Merit in 1948 for his work with rocket fuzes during World War II.

Dr. King, 60, has elected to retire early in order to move to his oceanfront home near Mendocino.

Robert B. King



Arthur L. Klein

ARTHUR L. KLEIN
professor of aeronautics

In 1927, when Arthur Klein was a research fellow in physics, a mathematician named Clark Millikan occupied the office across the hall. When Millikan and Theodore von Kármán began formulating plans for the construction of Caltech's Guggenheim Laboratory of Aeronautics and for a wind tunnel, Klein began to see more and more of his two associates. He had studied engineering as an undergraduate and graduate student at Caltech, and there were questions about engineering problems, about the practical application of their ideas in terms of equipment. Within a year Dr. Klein was doing all the designing and engineering for aeronautics, from the building of Guggenheim to the construction of the wind tunnel and the design of experimental equipment connected with it. Dr. Klein became a member of the aeronautics faculty in 1929. Only now, after 40 years, is the equipment in Guggenheim Laboratory being renovated and replaced. And once again Dr. Klein is supervising the design and installation.

In 1937, Dr. Klein began spending half of his time with Douglas Aircraft, where he had been an intermittent consultant since 1932, and he has been instrumental in the design of many of their aircraft over the last 20 years.

After his retirement this month to become professor of aeronautics, emeritus, he will complete his work on the new apparatus in Guggenheim and will retain his position as consultant to Douglas Aircraft.

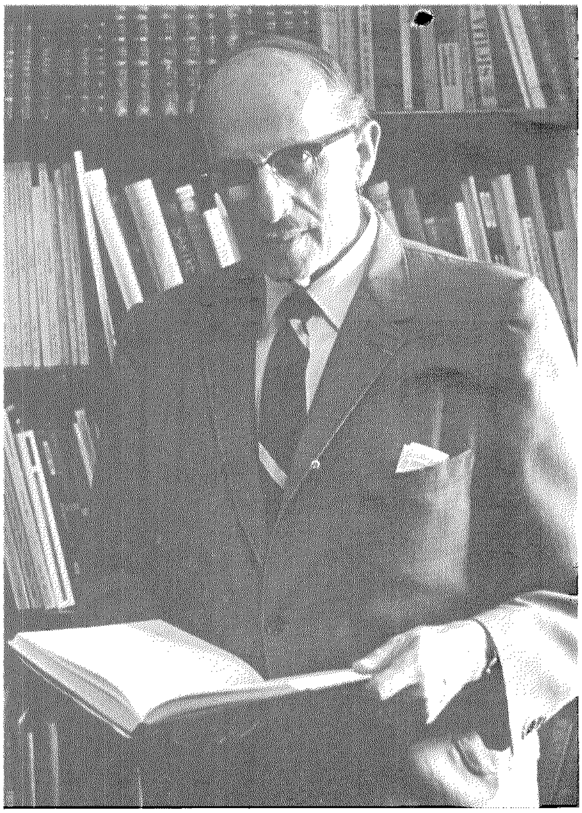
ALFRED STERN
professor of philosophy and languages

After 21 years at Caltech, Alfred Stern retires this month to become professor of philosophy, emeritus. A native of Vienna, Austria, he received his PhD from the University of Vienna and later taught philosophy at the University of Paris and the Institute of High Studies of Belgium. During World War II Dr. Stern served as a volunteer in the French Army. After his demobilization in 1942, he went to Mexico, where he taught at the National University and the French Lyceum. In 1947 he came to Caltech and taught French and German language and literature, and later, philosophy. His courses in "Philosophy and Literature" and "Contemporary European Philosophy" became very popular.

Dr. Stern is the author of several books and a contributor to philosophical journals of many countries. His book, *Sartre–His Philosophy and Existential Psychoanalysis,* appeared in English, Spanish, and Japanese editions; his *Philosophy of History and the Problem of Values* was published in five languages. Dr. Stern is fluent in English, French, German, and Spanish and did most of the translations himself. He also published: *Philosophy of Laughter and Tears* and *The Philosophy of Values* in French and Spanish, *The Philosophical Foundations of Truth, Reality and Value* in German, *The Philosophy of Politics* in Spanish, and *The Concept of Will in Schopenhauer* in German. His latest book, *Philosophical Vistas–A Search for Meaning,* will be published in English.

In 1964 Dr. Stern was elected president of the Pacific division of the American Philosophical Association. He is a Knight of the Legion of Honor of France, vice president of the Alliance Francaise of Los Angeles, and editorial consultant of *Folia Humanistica* in Barcelona, Spain.

After his retirement Dr. Stern and his wife, the Puerto Rican writer, Marigloria Palma, will move to their 200-year-old Spanish house in San Juan. Dr. Stern will teach philosophy–in Spanish–at the University of Puerto Rico in Mayagüez.



Alfred Stern

HENRIETTA SWOPE
research fellow in astronomy

Henrietta Swope, research fellow in astronomy at the Mount Wilson and Palomar Observatories, retires this year after 16 years on the staff. Her retirement, however, will not mark the end of her research on variable stars.

Although Miss Swope traces her interest in stars back to her childhood, she became professionally interested in astronomy while getting her AB degree in math at Barnard. In 1926 she began doing graduate work in astronomy at Radcliffe, spending most of her time at the Harvard College Observatory in Cambridge. She became a research assistant there that same year and held this post until World War II, when she was asked to go to MIT's Radiation Laboratory to help develop a secret form of navigation called Loran.

After the war Miss Swope taught astronomy to undergraduates at Barnard and at Connecticut College for Women, but her real enthusiasm was for research, and in 1952 she welcomed an opportunity to come to Pasadena as research assistant at the Mount Wilson and Palomar Observatories, assisting Walter Baade with his research on variable stars.

One of her most significant contributions to the field is her calibration—the most accurate to date—of the distance from the earth to Andromeda, by means of determining the brightness of the cepheid beacons in the spiral arms of that galaxy This measurement has become the "cepheid yardstick" by which other relative distances in the universe are calculated.

Henrietta Swope

Ray E. Untereiner

RAY E. UNTEREINER
professor of economics

After 43 years at Caltech, Ray E. Untereiner retires this month to become professor of economics, emeritus. Born in Redlands in 1898, he was graduated from the university there in 1920, received his MA in economics from Harvard in 1921, his law degree from Mayo College in Chicago in 1925, and his PhD from Northwestern in 1932.

Dr. Untereimer first taught history and economics at Caltech in 1925, and in addition maintained a law practice in Los Angeles until 1931. From 1939 to 1943 he also served as dean of freshmen.

During the late twenties and early thirties Dr. Untereiner's history classes included as many as 160 students and were conducted in Dabney Lounge—the only room large enough to accommodate the group. William Pickering, now director of JPL, used to grade examinations for him for 75 cents an hour. Social activities then centered around the Robert Millikan home. Every year Dr. Millikan invited freshmen to Sunday dinner, in groups of about 30. The Untereiners were always in attendance, their duty being to make sure that the boys asked to see Dr. Millikan's medals—and left the house promptly at 10 p.m.

The Untereiner family lived on San Pasqual across the street from the campus for 34 years. Once, to their surprise, they discovered that the "old gentleman down the block" who had been voluntarily tutoring their son in grammar school "numbers" was Albert Einstein.

Dr. Untereiner has been active in local and state government affairs. He has served as chairman of the Los Angeles County Citizen's Committee on Local Taxation, president of the Pasadena Board of Education, and chairman of the City Recreation Commission and as a member of the California State Public Utilities Commission. Following a summer Caribbean cruise, Dr. Untereiner plans to continue his legal consultation practice.

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FRITZ ZWICKY, *professor of astrophysics; staff member, Mount Wilson and Palomar Observatories*

Fritz Zwicky retires this month to become professor of astrophysics, emeritus. A pioneering astronomer, Zwicky was born in 1898 in Varna, Bulgaria, and received his BS and PhD degrees from the Federal Institute of Technology in Zurich. A Swiss citizen, Zwicky came to Caltech in 1925 as an International Research Fellow in physics for the Rockefeller Foundation, after five years as a research assistant at Zurich. He still speaks of his early years here as some of the happiest of his life.

The faculty in the late 1920s was a close-knit group which shared social activities as well as working relationships in classrooms and laboratories. Physics department dinners were almost weekly events, and on weekends the physicists were often mountain climbing or skiing together.

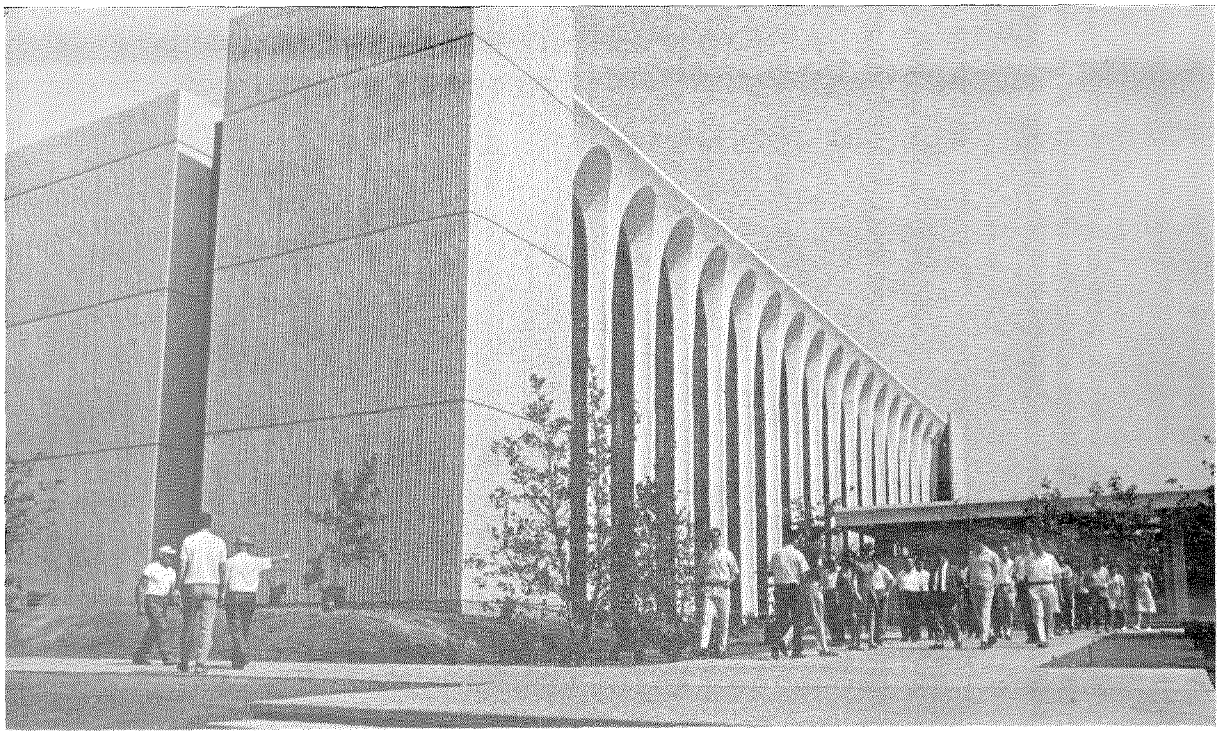
Dr. Zwicky has gained worldwide recognition for his discovery of 45 supernovae. He has published more than 300 articles on physics, jet propulsion, astronomy, and the philosophy of science, and he has written seven books. After 30 years of work, he and four collaborators have completed a six-volume catalog of galaxies and clusters of galaxies. He has been a professor of astrophysics since 1942 and a staff member of the Mount Wilson and Palomar Observatories since 1948. He was awarded the U. S. Medal of Freedom by President Truman in 1949, the U.S. Army Air Forces Commendation for Meritorious Civilian Service for his work with rocket propulsion during World War II, and the Gold Medal awarded by the Pestalozzi Foundation, which supports about 60 villages for war orphans and destitute children on all continents. He is the founder of the International Society for Morphological Research and vice president of the International Academy of Astronautics.

A New Chemical Physics Laboratory

The completion of Caltech's new $4 million Arthur Amos Noyes Laboratory of Chemical Physics was celebrated on May 6 and 7 with a two-day symposium and dedication ceremony. More than 200 distinguished scientists and educators attended, some of them former students and colleagues of the man for whom the building is named—A. A. Noyes, director of chemistry at Caltech from 1919 to 1936. Noteworthy among these were Linus Pauling, Earnest Watson, and Ernest Swift.

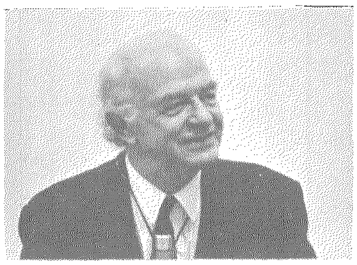
Dr. Pauling, now professor of chemistry at the University of California at San Diego, came to Caltech in 1922 to do graduate work under Noyes and eventually succeeded him as chairman of the chemistry division when Noyes died in 1936. Dr. Watson, professor of physics, emeritus, came to Caltech at the same time as Dr. Noyes and was a close personal friend for many years. Dr. Swift, professor of analytical chemistry, emeritus, joined Dr. Noyes' chemistry department in the early twenties and, in 1958, succeeded Dr. Pauling as division chairman.

The symposium featured lectures by five scholars in the field of chemical physics from four western universities and by Donald F. Hornig, special assistant to President Johnson and director of the office of science and technology.



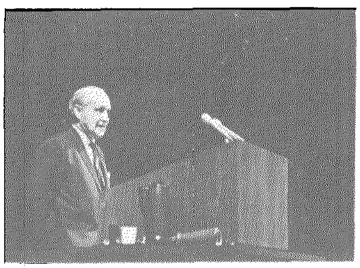
The new Noyes Laboratory—five stories, 90,000 square feet of offices, laboratories, and workrooms—was made possible by a gift from an anonymous alumnus and matching funds from the National Science Foundation.

Speaking of Noyes . . . . .



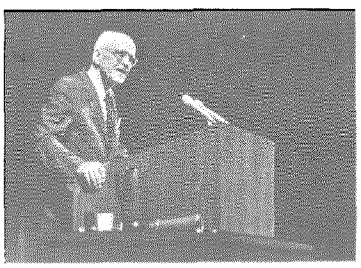
LINUS PAULING

"The California Institute of Technology is based upon physical chemistry. This was the first field of work in which there was any significant activity above the level of training engineers . . . A. A. Noyes was acting president of the Massachusetts Institute of Technology in 1913, but he also took three months off to come to Pasadena as a visiting professor . . . In about three years he came here full time. Along about that time physics began to build up too. It had a late start and has never quite caught up."



EARNEST C. WATSON

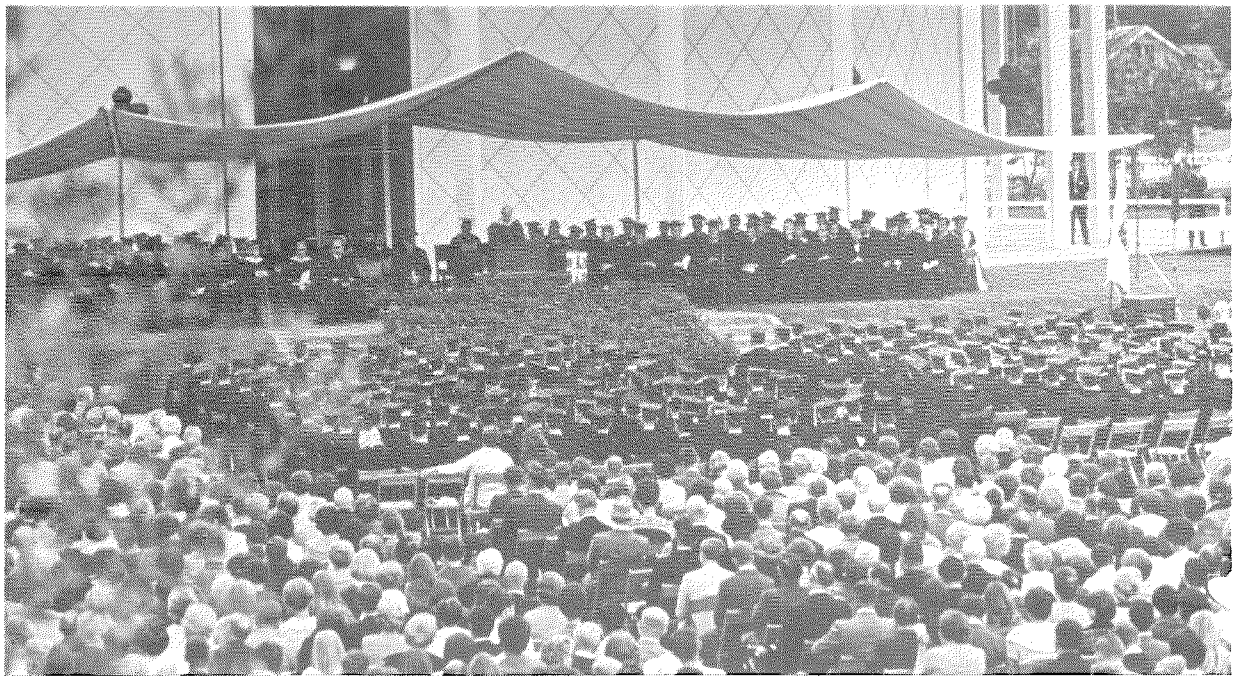
"It was Noyes more than anyone else who, after strong research in biology had been started at Caltech under Thomas Hunt Morgan, persuaded the Rockefeller Foundation that they should support work in the interdisciplinary fields between biology and chemistry and between biology and physics. All this was relatively easy and natural at Caltech because the divisional rather than a departmental administration system had been set up. It was also facilitated because of Noyes' high principles, idealism, and unselfish devotion to science and to the Institute."

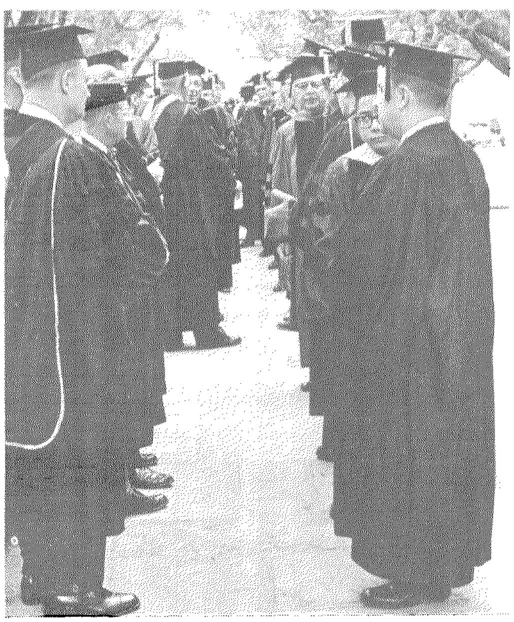


ERNEST H. SWIFT

"Because of his reserve, it is remarkable that he was so successful in establishing such warm personal relationships with undergraduate students . . . He was continually searching for promising students and devising some means of expediting their progress. In 1925 . . . he arranged for 10 selected freshmen to take their sophomore analytical chemistry course by a period of intensive summer work . . . to enable them to take advanced courses or do research in their junior and senior years. He asked me to teach the course, but only later did I learn that he also paid my salary."

COMMENCEMENT 1968





June 7 was a day of academic milestones at Caltech. At the Institute's 74th annual commencement exercises a record of 396 degrees were conferred—154 bachelors of science, 127 masters of science, 5 engineer degrees, and 110 doctors of philosophy. Almost one-half of this year's seniors graduated with honors. These are students who have maintained a B-plus average throughout their four years at Caltech. Also among this year's seniors were 15 graduating with degrees in the humanities. The first degrees in the humanities and social science options were awarded only two years ago.

Dr. Frederick Seitz, president of the National Academy of Sciences, delivered the commencement address, "Science and Society."

higher forms such as vertebrates. There appears to be an inverse correlation between the complexity of body structure and the concentration of a specific radionuclide. In general, adsorption and absorption are governing mechanisms for the lower forms of life while ingestion is the principal route for predators.

It is conceivable, although highly unlikely, that the proliferation of commercial nuclear power reactors along a river or estuarine system, or on the shores of the Great Lakes, especially Lake Michigan, could result in reconcentration of radionuclides in aquatic or marine animals to the extent of causing a hazard to human health, despite the fact that each discharger meets the requirements of the AEC regulations. Extensive monitoring and evaluation of the Columbia River below Hanford and the Clinch River below Oak Ridge have revealed no cause for alarm to date, but the potentialities of the situation warrant continued careful surveillance.

ACCIDENTAL RELEASES

In the light of these facts it should be evident that normal operation of nuclear power plants will present no significant radiological hazard to air or water resources. But what about abnormal operation? What are the possibilities and the consequences of a serious accident?

A nuclear power plant cannot possibly explode as an atomic bomb because the ratio of fissile uranium to total uranium is far too low, because there is a high degree of moderation by the primary coolant and the control rods, and because the spacing of fuel elements within a reactor precludes a chain reaction fast enough to cause an explosion.

It is possible, however, for the multiplication factor (the rate of neutron production divided by the rate of their capture or escape) to exceed 1.000 for a period sufficient to cause a nuclear excursion that would lead to overheating of the core, to a possible meltdown of the cladding material, and to a release of fission products. A nuclear excursion might result, for example, from an environmental disturbance such as an earthquake, tornado, or seismic sea wave; from a failure of the complex and sophisticated instrumentation; from human errors; from deliberate sabotage; or from the sudden rupture of a pipeline or pump, which would discharge the primary coolant as steam and remove the moderator from the core.

The fission products held within the cladding of fuel elements in a 500 MW(e) reactor after 180 days of full-power operation have a total radioactivity of about 1.4 billion (10^9) curies. The discharge of all or a significant part of this activity to the environment might result in a serious hazard to the health and safety of the public, especially if the reactor is near a population center.

To forestall such an accident or to minimize its consequences, modern reactor design includes a series of engineered safeguards, generally with redundancy or backup. Systems are provided for spraying and/or flooding the reactor core in the event that a pipeline rupture causes a loss of coolant. Emergency diesel power is available to operate these systems if offsite power should fail.

If, in spite of the emergency cooling provisions, the core still melts and releases fission products, an added safeguard or backup system is available in the containment structure. This is typified by the huge dome that characterizes pressurized water reactors. The containment is designed to retain all gases and volatile fission products at internal pressures of 40 to 60 psi with a leakage rate of less than 0.1 percent per day, by volume. To assist in cooling and concentration of radioactivity in a containment, air recirculating systems with heat exchangers and iodine filters are provided. There are also containment spray systems with injected thiosulfate. For boiling water reactors the containment has the shape of an inverted light bulb, surrounded at the bottom by a torus, which acts as a pressure-suppression pool. Water is recirculated from the torus into the core spray systems.

The safety record to date of commercial nuclear power plants in the U. S. has been outstanding. There have been no deaths or injuries from radiation at any commercial power reactor. There have been no measurable effects of radiation on the public. Indeed, there have been no accidents at any reactors (commercial or research testing) that have been operated routinely at normal power levels. The only accidents have occurred at experimental test reactors at Los Alamos and at the Idaho test site where reactors are purposely put under heavy stress conditions.

The fact that the safety record to date has been exemplary does not mean that a serious accident cannot occur. In early 1968 the largest operating plants were only 462 MW(e) and 430 MW(e); yet several plants of 1,065 MW(e) are now under construction or planned. Although additional safeguards are being developed for the newer plants, the designs call for higher core power densities, and they utilize lower safety factors with respect to nucleate boiling than do the older plants. The increased power, the shortage of experience with large reactors, and the specters of human error and deliberate sabotage justify conservatism in the siting of nuclear power plants.

The populations within various distances of several existing and planned reactors in California are shown on the next page. Consider the consequences of an accident at San Onofre, with a resultant melting of the fuel elements and a release of steam and gaseous fission products within the dome-shaped containment. Consider also that aging for several decades, unequal settlement, corrosion, or small earthquakes have so weakened the containment that it leaks excessively (say 10 percent per day by volume) and that a gentle, persistent breeze is blowing toward the nearest population center. Even with a combination of these highly improbable adverse events, it would still be possible to prevent excessive radiation to the public because ample time and facilities would be available to evacuate the 20,000 to 30,000 people within ten miles of this reactor. Such effective evacuation was accomplished in about four hours just prior to the failure of the Baldwin Hills Dam in Los Angeles.

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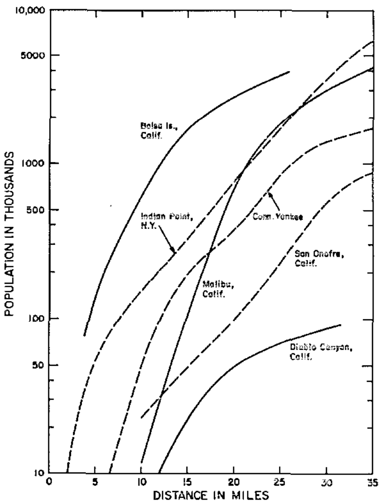

Populations within various distances of several existing (dashed lines) and planned reactors.

In contrast, consider a similar accident at the proposed site on artificial Bolsa Island near the metropolitan areas of Orange County and Los Angeles County. There the prevailing winds are onshore, and the population within ten miles approximates 600,000. Could this number of people be evacuated in six to ten hours, and if so where could they be housed for several weeks until they could return to their homes?

In addition to radioactive atmospheric contamination, a serious reactor accident could also jeopardize municipal water supplies if the reactor is situated on certain rivers or freshwater lakes. This impact might result from rainout of airborne particulate daughter products and/or from direct spillage of condensed steam and emergency core cooling water. About 30 miles upstream from Minneapolis, for example, a 472 MW(e) reactor is being built at Monticello on the Mississippi River. Every conceivable precaution is being taken to preclude the accidental discharge of radioactive liquids to the river, but if such an unlikely event should occur, the waterworks intake at Minneapolis would have to be shut down until the river had flushed all significant radioactivity past the city. Downstream communities would have to take similar precautions, although dilution and decay would make the problem less acute with distance.

Rivers have a fortunate facility for flushing themselves, but the replacement of water in many lakes may be almost interminable. The Great Lakes are especially vulnerable in this respect, and approximately 30,000,000 people depend on these lakes for municipal water supply. It has been estimated that the average retention time is 189 years in Lake Superior and almost 31 years in Lake Michigan. Moreover, the time required to remove 90 percent of a pollutant by natural flow is about 500 years for Lake Superior and 100 years for Lake Michigan. At the present time, ten large nuclear power plants are under construction or being planned on the shores of Lake Michigan. If any one of them should ever have an accident and release millions of curies of mixed long-lived fission products to Lake Michigan, the impact on this water resource would be catastrophic.

THERMAL CONSIDERATIONS

The efficiency of a steam-electric-power plant for converting heat energy into electric power is generally in the range of 30-40 percent. The remaining 60-70 percent of heat is dissipated into the environment. At fossil-fired plants (about 36 percent efficient) some of the waste heat escapes to the atmosphere through stacks, but most of it is discharged by means of the condenser cooling water. At modern nuclear-fired PWR and BWR plants (about 32 percent efficient) almost all waste heat is dissipated to surface waters through the condenser cooling circuit. Hence, although all steam-electric-power plants discharge heat to the water environment, the abnormal enthalpy (total heat) modifications from nuclear power may be expected to be greater than those from fossil-fired plants.

Consider, for example, the nuclear station being built in Minnesota. The rated electrical output is 472 MW, but the thermal capacity is 1,675 MW; hence about 1,200 MW will be discharged to the Mississippi River. The maximum flow of condenser cooling water will be 25.2 cubic meters per second, from which the temperature rise in this cooling water is calculated to be 11.4°C.

The river upstream from the Twin Cities can hardly be called the "mighty Mississippi." In fact, about 8 percent of the time the river discharge is less than the rate of flow through the condensing circuit of the power plant. For the average discharge of the river the temperature rise is calculated at 2.2°C, and for the minimum 10 percent flow, it will be 9.2°C. During summer months, this rise will cause the temperature of the river to exceed the upper limit of 33°C considered tolerable for game fish. Hence, the power company is planning to install cooling towers for use during warm weather and periods of low stream flow.

Are such modifications in enthalpy likely to be deleterious or advantageous to natural waters? The answer varies widely with the beneficial use to be made of the water, the season, the location, and many other factors. On the favorable side, for example, increased water temperatures may improve navigation in traditionally icebound rivers or harbors, lengthen the bathing and recreational seasons in cold climates, and favor the spawning of oysters. On the other side of the ledger, higher temperatures of water diminish its absorptive capacity for dissolved oxygen while simultaneously increasing the rate of oxygen metabolism and respiration by fish and other biota; accelerate corrosion; decrease the effectiveness for subsequent downstream cooling; enhance the toxicity of many substances; prevent the hatching of trout and salmon eggs; and, when sufficiently high, cause the death of some species.

It is generally considered that the deleterious effects from upward modifications of enthalpy outweigh the potential benefits, although these factors must be evaluated at each location and at each time of year. In any event, it is certain that average temperature change of 1.0°C or even less will have a major long-term impact on the ecology of nearby surface waters. Almost every action taken by man—indeed even his very existence—produces an ecological syndrome. Insofar as possible, these changes should be anticipated, evaluated, and optimized to the benefit of all mankind.

PRODUCT DEVELOPMENT CONSULTANTS

gives inventors, scientists and engineers 5 pointers on obtaining royalty income

1

WHO NEEDS NEW PRODUCTS? One of our clients—a relatively small metalworking division of a billion dollar company—is seeking new proprietary products. If you have a good invention, they might want to be licensed to make and market it in exchange for paying you royalties. Of course such a product must be novel, needed, and protectable. In addition it should be compatible with either the technology or markets of one of the products listed below.

2

HERE'S HOW YOU COME IN: If you have an invention which could fit with any of the products listed below we would like to hear from you now. You can deal with us in confidence since we are neither a manufacturer nor an agent of our client, nor do we conduct original R&D. Furthermore, our services cost you nothing; Product Development Consultants is paid entirely by our clients. We serve professional inventors and R&D facilities by helping to turn dormant inventions into royalty paying license agreements.

3

OUR CLIENTS NEW PRODUCT AREAS are electrical products and industrial specialties.

Electrical products:	Industrial specialties:	
Unique conduit designs	Flexible hose, tubing or shafting	Swivel joints
Explosion proof fittings	Push-pull controls	Cryogenic equipment
A better junction box	Remote monitors or controls	Hydraulic products
Special fittings	Unique bellows designs	Deaerators
Electricians tools	Plastic or rubber hose designs and fittings	Expansion joints
Rigid or flexible conduit	Dry break couplings	Pressure relief devices

4

SUGGESTIONS REGARDING YOUR INVENTION: You may have an invention which fits exactly with one of the products or markets listed above. But if not, our clients' interests are broad. They will consider the manufacture and licensing of any new product which is a specialty item used in the fields of industrial heating, refrigeration, cryogenics, hydraulics or electrical wiring. If you have such a product, and wish to explore a possible royalty arrangement, we suggest you read point five, which follows.

5

SUBMISSION DIRECTIONS: To be able to assess your project for our client, you must share with us a closely reasoned description of your invention. In a one or two-page typewritten report, please concisely and clearly report on each of the following:
Description: Generally describe what the invention does and of what it consists.
Function: Very specifically, what does the invention do? What actions does it perform?
Operation: Very specifically, where and how would one use this particular device?
Market: Who would buy this device? What price would he pay? What is your estimate of the total dollar sales volume per year? What do you know of competitive products?
Required Capabilities of Licensee: What technical, production, and marketing skills should the prospective licensee possess?
Licensor: What can you provide? Models? Drawings? Consulting time?
Protection: How is your idea protected? Patent? Patent application? Witnessed disclosure? Secret know-how?
Your submission will be promptly acknowledged and will be evaluated as quickly as possible. It's all part of the service we've been supplying to inventors since 1953—as your nearest bank or patent counsel can readily confirm.
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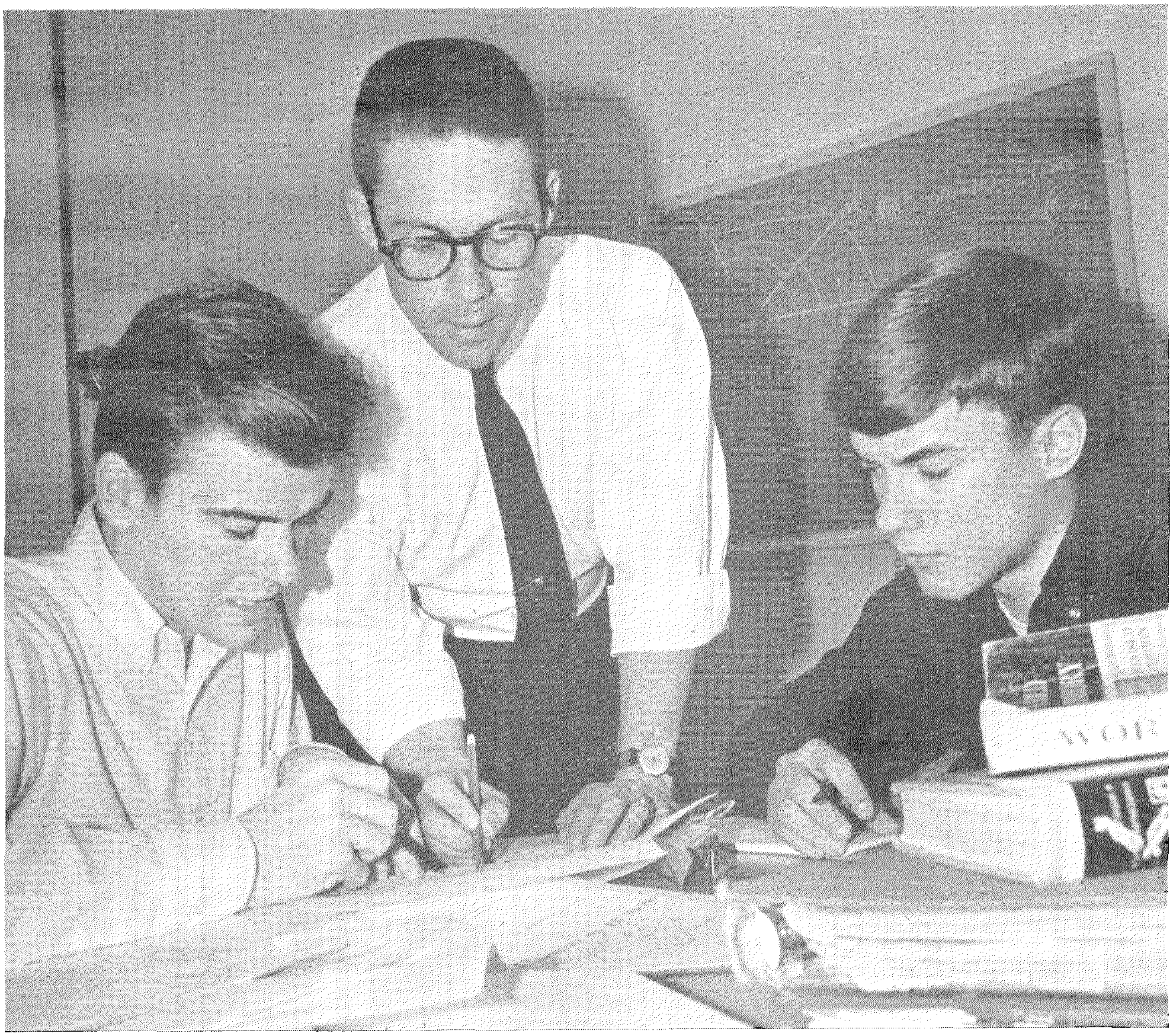

Pete Drobach has a knack for getting to the root of a problem.

High school students John Magish and John Ripley would be the first to agree.

They're both student members of a "big brother" program that Pete sponsors. Each week, they spend several hours of their own time helping less advanced classmates with their studies.

Pete is more than a sponsor. He's also a consultant—particularly when they're stumped by the logic of a tough "new math" problem.

But when Pete graduated from Rutgers in 1964, it wasn't these youngsters with their homework problems that brought him to General Electric. It was the chance to help people in industry solve tough technical problems. A career in technical marketing at General Electric gave him the opportunity.

Today, Pete's an application engineer in steel mill drives and automation systems. His ideas on how to apply products from many of GE's 160 separate businesses enable his customers to improve the efficiency and productivity of their plants.

Like Pete Drobach, you'll find opportunities at General Electric in R&D, design, production or marketing that match your qualifications and interests. Talk to our man when he visits your campus. Or write for career information to: General Electric Company, Room 801A, 570 Lexington Avenue, New York, N.Y. 10022.

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