ENGINEERING | AND | SCIENCE

June 1963

Published at the California Institute of Technology

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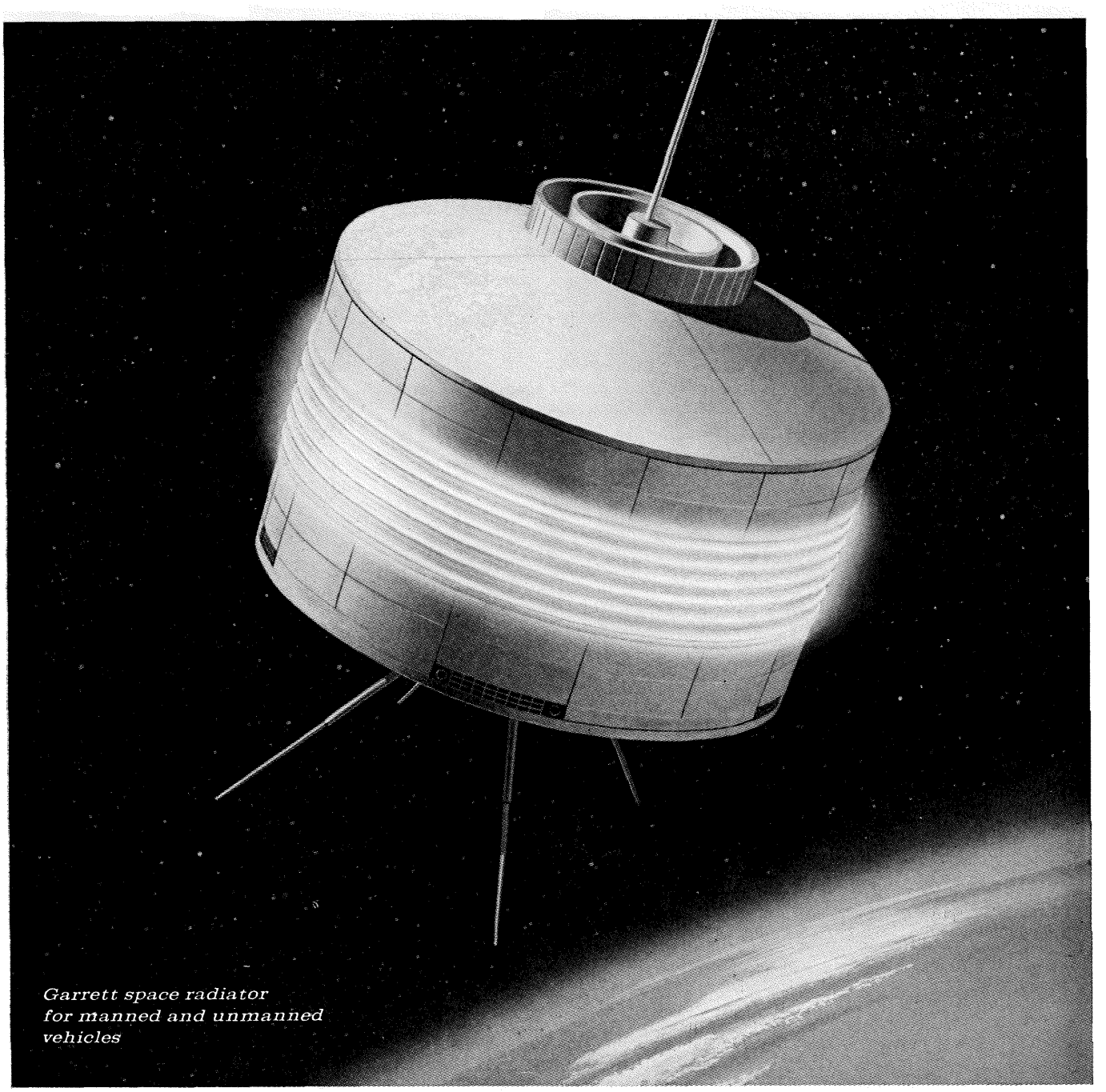

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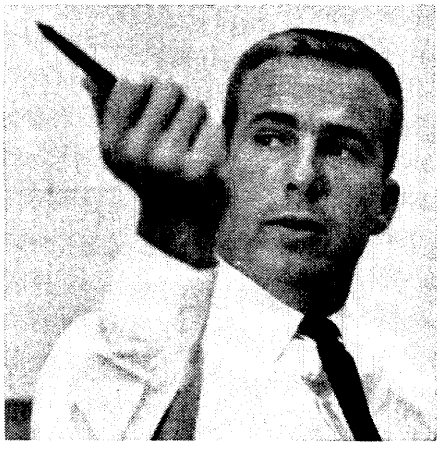
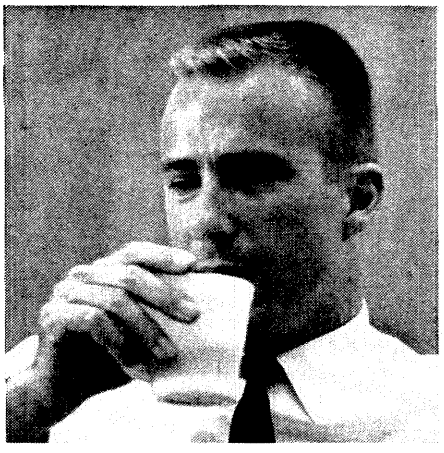
Does your wife mind your doing homework?

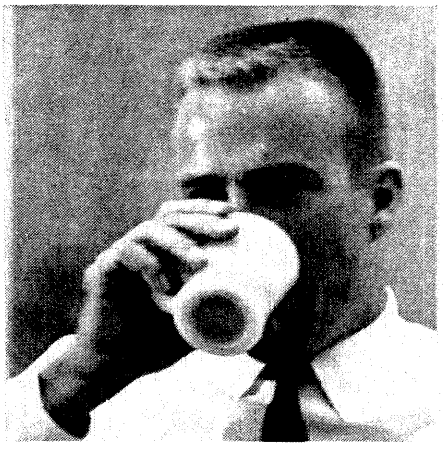
I'm not married. But even if I were, there'd be no problem. After all, my first love is right here.



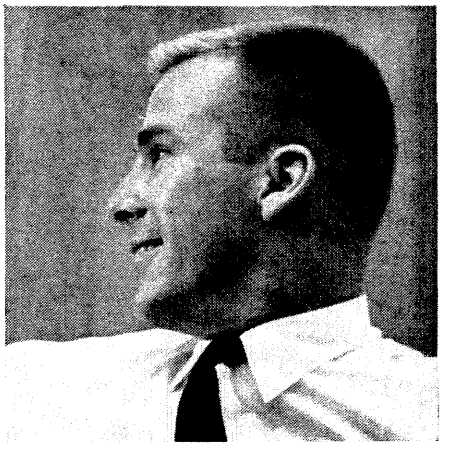
Sometimes if things are really hot, I come back to the office in the evenings. Then I may take off time here and there. The main thing is to get the job done.



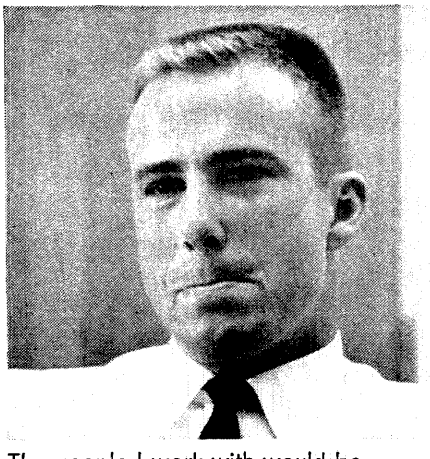
My job? Flight mechanics. I'm working on trajectories for spacecraft JPL hasn't even designed yet. Most of my work is based on advanced propulsion systems. Ion propulsion, for example.



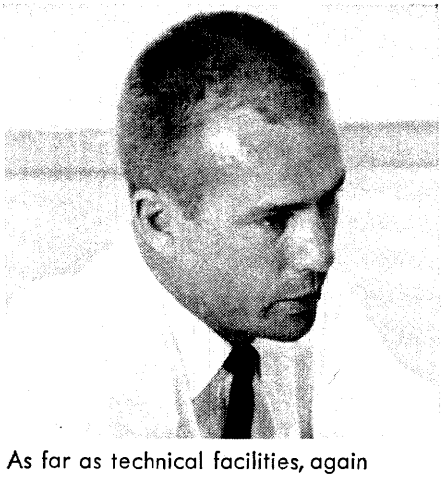
I did my undergraduate work at UCLA. In 1956, I began working at JPL part time, while I was in graduate school. When I got my doctorate, I just naturally stayed on here.



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



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



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

You've just been talking with Dr. William Melbourne, scientist at Jet Propulsion Laboratory. He's been at JPL for six years. And he's here to stay. If you'd like to work with men like him...if you'd like to be part of the challenge he faces...then write to JPL today.

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ENGINEERING | AND | SCIENCE

On Our Cover

President L. A. DuBridge, Carole Lois Hamilton, and H. F. Bohnenblust, professor of mathematics and dean of graduate studies, at Caltech's 69th Commencement on June 7. Miss Hamilton, a graduate of Colorado State University, received her PhD in chemistry. This year a record number of graduate students received their doctorates from Caltech — 3 women and 87 men.

Ray Bradbury

is a well-known writer with a talent for fantasy and science fiction. He visited the campus on February 6 as a guest speaker on the ASCIT-Alumni Assembly Series. These programs are arranged and conducted entirely by Caltech undergraduates with a financial boost from Caltech alumni.

Mr. Bradbury, a pioneer in space-age writing, is now preparing the film script of his book, *The Martian Chronicles*, which will be the first multimillion-dollar picture to be made about space. A recent film, *Icarus Montgolfier Wright*, written by Mr. Bradbury and illustrated by Joseph Mugnaini, has won the 1963 Gold Eagle Award given by the U. S. Government for being an outstanding picture to represent the United States abroad. On page 10 — a transcript of Mr. Bradbury's talk.

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Cover — Mike Opalenik
5, 19, 20 — (top, lower right) James McClanahan
10 — Helen Miljakovich
14 — Joseph Mugnaini
18 — Robert Jeffrey
20 — (center) Aerospace Corporation

JUNE 1963 *VOLUME XXVI* *NUMBER 9*

STAFF

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Photographer.....James McClanahan

Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena, Calif. Annual subscription $4.50 domestic, $5.50 foreign, single copies 50 cents. Second class postage paid at Pasadena, California, under the Act of August 24, 1912. Manuscripts and all other editorial correspondence should be addressed to: The Editor, *Engineering and Science*, California Institute of Technology.

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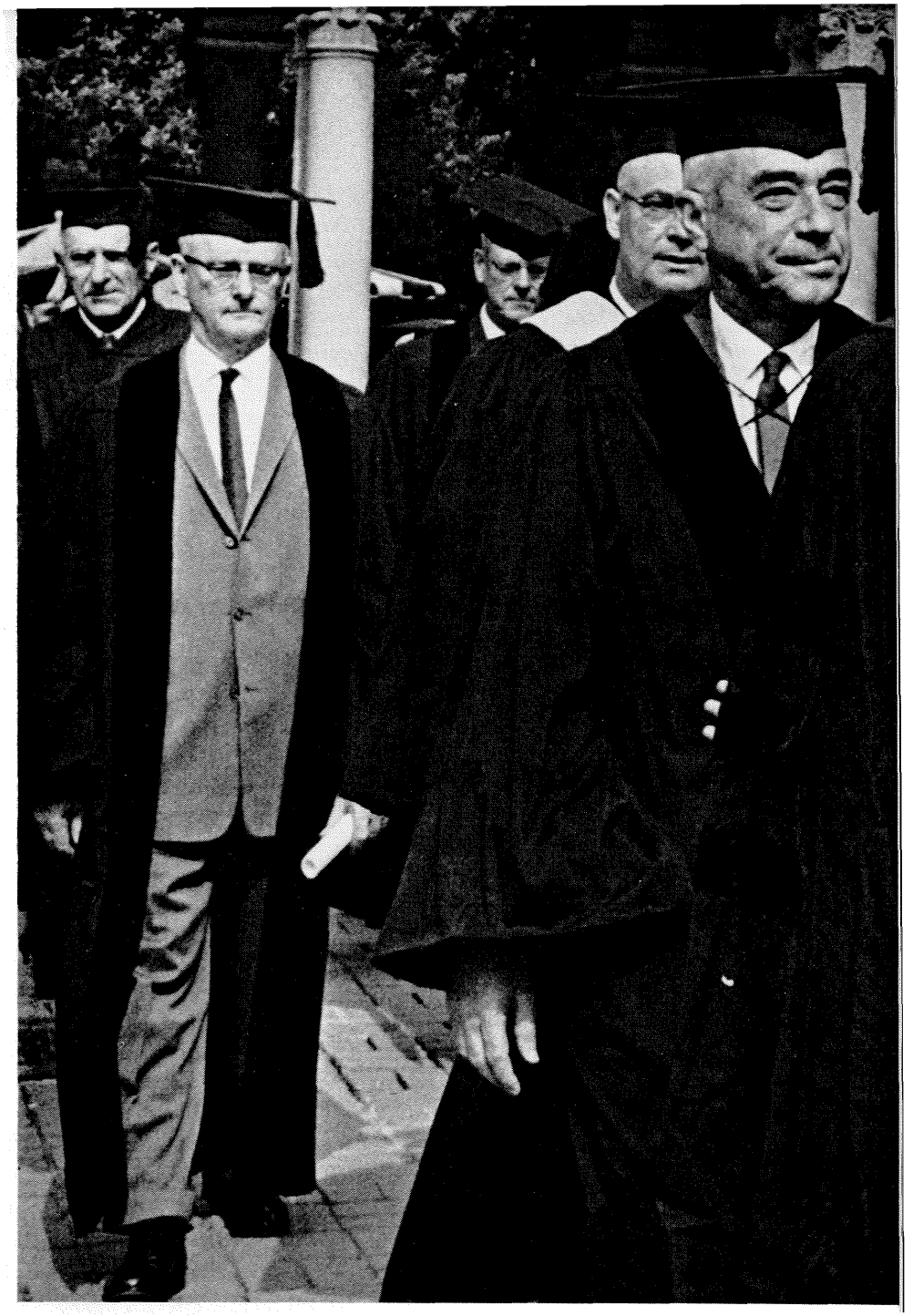
ENGINEERING AND SCIENCE
June 1963, Volume XXVI, No. 9

HIGHER EDUCATION — CHANGE AT THE TOP

by Robert L. Minckler



Caltech's Board of Trustees in the academic procession at Caltech's 1963 Commencement

During most of human history, management of affairs has been in the hands of individuals or small groups of individuals whose authority had certain features which would be considered very bad today:

1. The authority of the management was absolute. There was no machinery at all for questioning the decisions of management in political or religious or economic matters.

2. Managers were self-appointed. The people most affected, those who were being managed, had no voice in the selection of managers.

3. Management was self-perpetuating. The authority of the king automatically passed to the prince, that of the Pope to another Pope selected by a small group from its own members, that of the rich man to his eldest son.

As time wore on, and as human society grew in complexity, this system of autocratic, automatic management showed inherent weaknesses; the ideas of individual rights and social justice became widespread, and the system fell apart. The kings were dethroned or their authority was removed; managers of affairs were elected by the common people; there was the splintering of religious authority through the Reformation; stock-

"In the western free world, about the only example of the old autocratic, undemocratic system of management is found in the Boards of Trustees of American independent universities and colleges such as Caltech."

holders in business enterprises threw out the incompetent sons of the founder's family; estate and inheritance taxes absorbed large estates and were applied to public purposes.

Today, there are very few examples left of the old system of management. There are still a few divine-rights kings left; there are the communist countries in which small groups operate as the kings-of-old did.

But in the western free world, about the only example of the old autocratic, undemocratic system of management is found in the Boards of Trustees of American independent universities and colleges such as Caltech.

Make no mistake about the absolute authority of the Caltech Board of Trustees. Let me quote various provisions from our charter and by-laws:

"All corporate powers of California Institute of Technology shall be exercised by or under authority of, and the business and affairs of the Corporation shall be controlled by, a Board of Trustees." The Board of Trustees may elect a President of the Institute to hold office at the pleasure of the Board . . . He shall have such powers, duties, and privileges as may from time to time be prescribed by the Board of Trustees . . . All faculty members of the Institute are appointed by the Board of Trustees . . . All officers and instructors shall receive such compensation as may be fixed by the Board of Trustees."

These few quotations should demonstrate the unquestionable fact that the authority of the Caltech Board is absolute in all the operations of the Institute.

And who decides who shall have these unlimited powers? Why, the Board itself, of course. We elect ourselves. There is none of that democratic nonsense permitted, which might allow some voice to those most directly affected — say the faculty, the students, the alumni.

The Board is self-perpetuating. We re-elect ourselves and we fill vacancies on the Board by our own exclusive franchise.

There is nothing unique to Caltech in this system of management; the pattern is much the same in most of the independent colleges and universities in America, and the system dates back to the establishment of the earliest educational institutions in our country. These early colleges were founded, in most cases, by church groups. An early Board of Trustees was, in most cases, made up of ministers of the founding church, whose principal interest was to assure that only the real truth, as established only in their particular sect, would be taught in their college! So, they established this autocratic control and they wrote minute instructions for the proper conduct of faculty and scholars. For example, a document titled "The Lawes Liberties and Orders of Harvard Colledge confirmed by the Overseers in the Yeares 1642 to 1646 and published to the Scholars for the perpetual preservation of their welfare and government" includes the following decree: "Scholars shall bee slow to speake, and eschew not only oathes Lies and uncertain Rumours, but likewise all Idle, foolish, bitter scoffing, frothy wanton words and offensive gestures. . . . Nor shall any without the license of the Overseers of the Colledge goe out to another towne."

The Caltech Board has never issued such detailed instructions concerning the conduct of faculty members of the Institute, although it must be confessed that there have been occasions when such action looked pretty attractive to some members of the Board.

It is a strange fact that under this autocratic form of management, in which not even the most powerful electron microscopes can detect a single chemical trace of democracy, our private colleges and universities have come to represent, in their

actual operations, the very essence of democracy and freedom and tolerance. It is almost universally accepted that a faculty member has an absolute right to make a fool of himself without any fear of reprisal from the Board of Trustees. There are cases in which the faculty member is required to follow the party line, to conform to predetermined doctrine, especially in some schools of economics and education, but these violations of the principle of academic freedom have been imposed by the faculties of these schools, not by the Boards of Trustees.

The system of American college trusteeship has worked out very well, despite its authoritarian form, because Boards of Trustees have, on the whole, demonstrated remarkable wisdom and restraint in exercising their great powers. Over the years, there has developed a rather clear and rather universal concept of the roles to be played by the trustees. Their particular field of interest is in finance, in raising money, in managing the endowment portfolio, in protecting the property of the institution, in establishing rules for budget control, in setting salary scales, in hiring auditors —things of that kind.

Another task which is definitely assigned to the trustees is the selection of the president of the institution, but this is a task which does not come up very often. College presidents seem to lead charmed lives; they live forever and they hang on to their jobs forever.

No meddling

As to the principal operations of the institution the trustees are supposed to be managing, instruction and research, their duties are practically non-existent. Their role is a negative one, described in two words: "Don't meddle." One study of the management structure of 91 institutions found only five that had trustees' committees concerned with academic policies.

Now there is a strange stirring going on in the academic world, a new cycle of interest in the management of higher education, and this has extended to cover new consideration of the role of trustees. The result has been a great number of studies, books, and articles on educational management, probably more in the last five years than in all preceding time.

The reason for this great new interest is quite obvious: it is the very large and very rapid increase in the size of the college operation. Caltech is an example of what has happened. Five years ago, Caltech's campus expenditures for instruction, research, student aid, plant operation, and administration were $8,100,000. Our budget for next year for these same operations is $20,560,000. Five years ago the net asset value of Caltech at market prices was $83,500,000. A year ago it was $137,000,000 and today is in excess of $150,000,000.

Despite this enormous and rapid growth, which has occurred not just at Caltech but throughout all institutions of higher learning, the public demand for growth has not been met, and it is probable that we face, for some years to come, rates of expansion something like the ones we have experienced in the past few years.

Problems created by growth

This has naturally brought up questions about our capacity to handle the problems created by growth. In the fields of instruction and research, can we attract sufficient numbers of qualified scholars to meet the demands? Can we provide the space and tools required by the scholars? Can we sort out from the great variety of growth projects the ones which should have priority or which fit the particular field of activities in which a particular school is especially knowledgeable?

Can we prod instructors to make the necessary changes in curriculum to adequately challenge the better prepared students? Can we intelligently plan and program the changes in personnel, in buildings and equipment, in methods and procedures, in curriculum, at the kind of an institution we operate, so that the objectives we have, both short-range and long-range, can be realized?

It is certain that many of these challenges must be met by the faculties. Certainly the faculties alone are qualified to determine what shall be taught and what teaching methods shall be used. Certainly the faculties alone must determine the fields of research in which they shall work, and they must establish the methods and programs to be followed in research.

In a static or slow growth situation, leaving these matters in the exclusive hands of the faculties presented no particular problems, and that was in general the situation up to only a few years ago. But the explosive growth of the recent past has brought about new kinds of problems which might be described as those of planning and programming growth and expansion. It is no longer sufficient that the faculty knows what it would like to do in education and research; these ambitions must be geared into the financial framework of the overall operation. It is now necessary to do long-range planning of the kind carried out

in large business organizations.

The training and experience of most scholars do not provide them with know-how in this operation of long-range planning and programming. The best teacher or researcher is one who firmly believes two things – that the work he is doing is the most important thing going on in the world, and that he is the best qualified person in the world to do that work. These attitudes are of enormous importance in doing a really superior job, but these attitudes are not the kind which are particularly helpful in setting up plans and programs for the overall operation of the institution and the establishments of priorities among the expansion projects.

In the past, Boards of Trustees have depended almost entirely upon the faculties and staffs for the initiation of projects, for budgets, for programs in instruction and research. Trustees have conceived of their part of the process as just consideration and usually just pro-forma approval of the recommendations of the faculty and staff. This has not been an entirely satisfactory system in a period of rapid growth. Things, on occasion, got out of balance.

Out of balance

An institution might get a new computer, for example, a year or more ahead of the time when there is a building to put it in. Substantial funds for a specific purpose might be received before a program of spending those funds for that purpose is established. Overall resources might grow faster than an overall balanced expansion plan is established. Certain activities might be overfinanced by specific grants while other activities are starving for funds. Some department chairmen and deans might be more aggressive in devising ways to spend money than others are.

There has been a general and widespread recognition of the difficult administrative problems which have arisen under the old system, and a rather general acceptance of the idea that the trustees might be helpful in establishing more orderly procedures in the growth process. So there have been a considerable number and variety of programs established in various institutions to bring the trustees into closer contact with the educational and research activities.

There is no pattern as yet established to accomplish this, but there are a lot of experiments going on. For example, Columbia University has formally added a definite educational function to the duties of its Board of Trustees, as follows: "To oversee and approve the *kind* of education offered by the university, and make certain that its *quality* meets the highest standards possible."

In some institutions, dual Boards have been established – the Board of Trustees retains its position of formal control with absolute powers, but a second Board or Committee on Educational Policy deals with the faculty in matters of instruction and research, but without any authority. In some institutions, visiting committees or advisory councils for individual schools or departments have been established, with some trustee members but also with community representatives, to discuss with the faculties the educational and research programs and the ways in which the programs can be made more effective in meeting the needs of the community.

Out of these experiments there may in time come a pattern of what is the correct procedure, but it is more likely that the elements of individuality in the separate institutions will make it desirable that no common pattern will result. What works at Harvard may not work elsewhere.

At Caltech, we have established certain procedural and organizational changes designed to create effective and continuing communication between trustees and faculty. Thus the trustees will have a better understanding of the educational and research programs being carried out, and the faculty members will have a better understanding of the overall resources of the institution available to carry out these operations. Both trustees and faculty members will participate in long-range planning, fitting together the duties of the faculty to make Caltech preeminent in the quality of its educational and research efforts with the duties of the Board to manage the financial affairs of the Institute so that this ambition can be realized.

Faculty reports

So we have done several things. At each monthly meeting of the Board, we have a report from a faculty member on some phase of educational or research activity. At the annual budget meeting, certain faculty members hear the budget presentation to the Board and the discussion of the budget by the Board.

We have re-established meetings of the Executive Committee of the Board to take care of the routine details of personnel appointments, contract approvals, and consideration of proposals, leaving the Board meetings open for discussion of overall policies and a chance to consider where

we stand in the overall condition of the Institute.

In my personal view, the most important action the Board has taken is the establishment of an Advisory Council for each of the departments of the Institute. On each Council are three or more members of the Board and three or more faculty members.

This organization change is still experimental, but the idea is that the Councils will operate in about the following manner. Each council will meet more or less regularly, perhaps three or four times a year. At these meetings, it is expected that the faculty members will educate the trustee members on the kinds of educational and research programs going on; on the needs of the department for personnel, space and equipment; on the opportunities for growth and expansion which exist and what is required to convert those opportunities into accomplishments.

The trustees' contributions

On the other hand, it is expected that the trustee members of the Councils will bring to the meetings their knowledge of the overall resources of the Institute and their knowledge of business-like procedures in converting dreams into programs and, hopefully, into realities. At these meetings, there should be open and frank discussions of problems and weaknesses that may exist, potential blind alleys which may be developing; needling as to why certain programs may be faltering, why programs for which funds are available may not be proceeding, why the services of that outstanding scholar could not be secured, or why we are losing a very promising fellow.

One result of these Council activities will be the annual budget for the department with which the trustee members of the Council are thoroughly familiar. The trustee chairman of each Council is also a member of the Board Budget Committee, so that when the Board committee considers the overall budget of the Institute, it will have members who are thoroughly grounded in all of the department budgets.

Also, it is expected that each Council will come up with a three-year forecast, incorporating the expansion programs which have been considered by the Council and judged to be necessary or desirable. This three-year forecast will not be just an exercise in guesstimating. For example, if it is determined that some new research program should be undertaken, but that the problems of creating space, securing equipment, and staffing the operation will extend beyond the one-year budget period which is the only budget at present approved by the Board, the Board may definitely approve the project, after the Ways and Means Committee of the Board has determined that funds will be available. This three-year forecast provides the machinery by which a department chairman may make a definite commitment to that outstanding scholar who will not be available until two years from now that there will be a job for him at that time. This forecast is not an idle dream; it can be a very important tool in long-range planning.

Also, in time, we expect that each Council will produce a ten-year outlook. This will, of necessity, be highly speculative, but it will supply some possible parameters of the size of the operation which may be going on in the distant future; and it will point up trends which may unbalance ratios between education and research, or between the sizes of undergraduate and graduate student bodies, or between one discipline and others. These may be desirable or undesirable, but they should be recognized long before they are upon us. In any event, this formal procedure for long-range planning is better than just extrapolating past rates of growth into the dim and hazy future.

More effective service

These are the ways in which it is hoped that the trustees can increase the scope and effectiveness of their services to the Institute. We have on our Board some very capable men, who in long and responsible business careers have acquired experience and skill in the arts of long-range planning and financial management, and these are the qualities needed, along with the professional skills of the faculty in educational and scientific disciplines, to make Caltech the kind of an institution which the nation needs and must have.

As I visualize the results, each of the three parts of the operation — faculty, administration, trustees— will perform those duties which it is best equipped to do: the faculty, instruction and research; the administration, coordination and leadership; the trustees, planning and finance — but each group will be thoroughly informed about the operations of the others. In this way, we will maintain at Caltech, during this period of rapid growth in size and scope, the same kind of friendly, cooperative, constructive community which it has always been in periods of less vigorous growth and less complexity.

Science fiction writer Ray Bradbury.

CREATIVITY IN THE SPACE AGE

by Ray Bradbury

I think I should start by telling you how unscientific I am. It's the only way out of an embarrassing situation.

I am constantly afflicted by, not 14-year-old boys (which would be acceptable), or 12-year-old boys (which might be endurable), but by 9- or 10-year-old boys who come up and say, "Mr. Bradbury?"

I say, "Yes."

They say, "That book of yours—*The Martian Chronicles*—"

I say, "Yes."

"On page 194—"

"Yes."

"Where you have the moons of Mars rising in the east—"

I say, "Yes."

They say, "No."

At which point I feel like hauling off and hitting them. But I have never gone back to my book to check the facts; I refuse to be intimidated by 9-year-old boys.

So that's the kind of guy you have before you today. I started reading *Amazing Stories* when I was seven. I started collecting Buck Rogers comic strips when I was eight. I started writing science fiction when I was twelve. I was considered the nuttiest student at L. A. High when I was seventeen; that is, I was writing about the Space Age 25 years ahead of time, which means I didn't get on very well with the girls at school. A reputation for writing about rockets gets around fast and I sort of had to work my way along with it until finally Sputnik and a few other missiles and people began to do me favors five years ago. I've had much fun the last five years telling everyone, "I told you so." I am not humble about it. I come right out and say it. Which makes me, I guess, a sort of Method sadist.

For most of my life I have had to endure the title of "science fiction writer." I have always been uneasy with that. I have never quite known what it meant. Now I am called a "space age writer." I'm not quite sure about that, either. It sounds a little bit more respectable. Actually, I think I am a writer of ideas. I am fascinated by ideas – and I am constantly amazed at the fact that we live in a culture *built* on ideas. Yet, how strange it is that in American arts, in television, motion pictures, novels, and short stories, how rarely do we *confront* ideas! Even though a school like this bursts with new concepts, how rarely all this filters out through our artistic society. That's why I am glad *I* work in the field of science fiction, where I can move your ideas out into our culture.

"*Creativity in the Space Age*" is a transcript of the talk given by Ray Bradbury, science fiction writer, at the ASCIT-Alumni Assembly hour in Dabney Lounge on February 6.

Why do I *want* to do this?

First of all, because you are the ardent blasphemers; each one of you sitting here today is a blasphemer. You are working directly against God, as God was seen in other ages. Consider almost any project you are working on today in the light of the intellectual activities of the past. We came to this continent, didn't like the size of it, so we began to tinker with space and time. We cut down the mountains and built skyscrapers in their place. We invented the locomotive and charged across the prairies to change that space and time. We invented airplanes and jets to further cut earth and air down to size.

Well, these are blasphemous activities. And we were the first of the ardent blasphemers in the world. We took the results of the Industrial Revolution, brought them here, and let them loose on this country. And since then we have been busy changing the look of death. We don't approve of death. We don't approve of old age. So we are doing things about them with our sciences.

Any one of these activities, a hundred years ago, would have caused most of us to be burned at the stake. And suddenly we hear a Pope — six years ago — Pope Pius XII — stating to a group of astronautical scientists visiting in Rome, "God does not intend to set limits to man's inquiry into space." Any Pope saying that, up until our time, would have been thrown out of the Church. We live in a blasphemous age — and resultantly a very exciting one because of all these new ideas that are beginning to form under rocket fire and pressure.

Herman Melville and Jules Verne

Now, I have admired and made a comparison recently of two writers who I think are the most American writers in our history — Herman Melville and Jules Verne. Why do I call Jules Verne an American writer? Because he is an ardent blasphemer in the tradition of Herman Melville. Let me illustrate for you. Ahab, in *Moby Dick,* says, "I don't like the universe. I don't like the way it is set up. I don't like God's laws or rules. I don't like the way God worries and tears at man through the manifestation of the mystery of the universe which looms before me in the guise of Moby Dick. Therefore, I will go strike through that mask, with my harpoon; I will peel away the layers of the universe. I will solve the mystery of death, time and existence. If need be, I will destroy this existence. If need be, I will kill myself and kill all my crew to solve this."

So mad Ahab goes forth in his ardent blasphemy and does *not* instruct himself well in his duties as blasphemer. So he goes down to his death in his ship and takes all with him save Ishmael.

This is the first of our most American writers who personifies the attitude that we have in this very school you are attending; the spirit of inquiry, the spirit of blasphemy, the spirit of finding out more about God's universe, of tearing it down and putting it back in new shapes. Ahab represents this, but demoniacally, destructively.

Along comes, at the same time, Cousin Jules Verne and says, "Now, Herman, this is all very well, and I appreciate how you feel about that whale that took off a leg. But what are we going to do? We are not going to destroy God. Let us instead plug in on the juice of the universe. Let us utilize the power lying all about us prisoned in dumb, blind immovable or moving matter. Let's be constructive in our blasphemy."

What does Jules Verne do through *his* mad captain Nemo? He constructs. Nemo says, "Give me your White Whale. I will not rend it; I will rebuild it. I will weld the first mechanical whale in history, and I will name it the *Nautilus,* and I will sail the seas of the world. I will not seek to destroy this symbol. I will live *inside* this symbol of mystery. And I will instruct men on moral attitudes toward one another." See the difference?

You start out with acts of blasphemy. But Melville annihilates; Verne comes along and builds scientifically on this knowledge. So he rears up the *Nautilus.* It sails the seas of the world, and he defies men in the middle of their cruel activities; he strikes down warships. He preaches with demoniacal ferocity: "Be better to one another. Let's not worry about God's relationship to man or man's relationship to God. Let's worry about man's relationship to man and what we do to each other with our machineries and sciences."

Two sides of the scientific coin

So the *Nautilus* sails forth and becomes known as what? Moby Dick! In the first chapter of *20,000 Leagues Under the Sea* the rumors that spread around the world refer to this *Nautilus* as the white whale. We know then that Verne read Melville. Thus these two fantastic authors represent the two sides of the scientific coin — the two sides of a blasphemous attitude about the universe and our place in it.

But one is more constructive, even though dedicated and a bit mad. And it is this latter attitude which makes Verne even more American and

represents your activities in the many, many years ahead of you and in the kind of studies that you are carrying out today. Verne says, "Let's take this juice, let's take this energy, let's inform ourselves – and from this information build new moralities, new attitudes, with which to go on building."

I have made this comparison in an introduction to a new edition of *20,000 Leagues Under the Sea* that just came out from Bantam Books. I think it's the first time anyone has ever fused these two writers, but I think we *must* fuse them, because we are going to go through an upheaval now, in the next 50 to 100 years, where all the religions of the world are going to turn topsy-turvy in their attitudes toward the problem as argued two ways by Melville and Verne.

We have already seen the beginning of this change in attitude in the declaration of Pope Pius XII that I mentioned. Now all the other religions must follow or automatically go out of business. The thing for you to remember in the coming 50 years is that you are going to be providing information to the religions, and if they carry out their function, they will be giving you back philosophical and religious guidance in relation to the facts. Both sides need each other. It is not enough to collect facts. It is fascinating to collect them, but you must go to someone with them, or instruct yourself in how to act on the given facts.

I am not interested in how to build an atom bomb. I am interested in what we *do* with it after we build it, and how we move it into constructive channels, and use it to fire the light bulbs of the world. This is where our moral decision has to be made, and this is where your challenges will arise, ahead. This is the attitude I have toward writing science fiction then, and why I love working in this field.

A remarkable age

Consider what a remarkable age this is, what an exciting time it should be for you. Up until a hundred years ago mankind's ideas rarely existed outside himself. They only existed in a few forms. He could paint himself a picture and thereby put out on display in pictorial form an idea of his, in two dimensions. Or a sculptor could give us a statue, which was three-dimensional, which we could walk around, which we could touch. Or we had architecture, an idea fused into brick and mortar that we could go inside and live with, an idea then put out in three-dimensional form. And a few inventions in the world: for instance, the wheel, and the use of the wheel revving up to explode in the Industrial Revolution.

Then quite suddenly, roughly a hundred years ago, man's ideas began to come on display in three-dimensional form, in multitudes – by the millions, and then by the billions – until suddenly now we live inside a robot society where we are a world of three billion people, serviced by anywhere from forty to fifty billion ideas, fused into machines. So, for the first time you have an idea which is blueprinted and put into a machine so that that idea can be looked at and handled. You can carry it in your pocket and listen to it, as with radio. You can ride in it, as in the case of automobiles or jets. You can work miracles with time and space as a result of these ideas being concretized, extruded from their original thought and blueprint.

This is a remarkable thing to make note of, all the more remarkable because most people make no note of it at all! So I *must* work in this field because I can grab these beautiful symbols to work with.

Fahrenheit 451

I had great fun during the McCarthy era writing my novel *Fahrenheit 451,* which concerned the firemen of the future. With all buildings made of fireproof plastic, the firemen no longer have a function in society. Therefore the politicians say, "Well, since you're not putting out fires any more, we've got a new job for you. When people send in alarms, you go out and you *burn books* – for starters; and then when you get the books burning merrily, you burn the house, and then you burn the people in the house – if they are subverts who read the Bible or the Koran or the Torah, or if they are just reading Shakespeare." This is a parable then – of the future – in which the firemen become our censors.

I wrote this as a protest against Senator McCarthy, and, strangely, he never laid a hand on me. I just stood there waiting for him to shake his head so it would fall off. He didn't know I had cut his throat from here to here. So there you have one of the great delights of writing science fiction, even though it is not as new-fashioned as it seems. For in the history of the world people have consistently worked in parables. Jesus made a good thing of it for quite a while before they stopped him. In Mussolini's Italy, people like Elio Vittorini and others wrote parables, fantasies, science fiction, so they could continue working under the nose of the dictator without discovery.

In line with this, people are always asking, "Where do you get those strange ideas of yours?" Let me give you an example:

About 12 years ago I was walking with a friend of mine down Wilshire Boulevard near Western in Los Angeles, talking about novels and short stories, when a police car pulled up. A policeman got out and said, "What are you doing?" And I said, "Well, we're putting one foot in front of the other – it's an old fashioned thing called 'walking'."

This disturbed the policeman. First of all, he hadn't seen a pedestrian in years – especially at night on Wilshire Boulevard near Western. Occasionally you see a few people get out of cars and walk ten doddering steps to a drug store or to mail something, but that's pretty rare. And to see people actually walking three or four blocks at a time – well, it's pretty unnerving.

So he kept questioning us, and the more he questioned, the angrier I got. My democratic rights were being breached, etc., etc. You know, liberals are crazy when it comes to this sort of thing. You touch them and you have a madman on your hands.

Burgling the modern way

So I said, "Look, let's imagine I'm a criminal, imagine I'm Jimmy Dale or a good friend of Dr. No's and I'm going to burgle a place up the street. How would I *do* this? I'd drive up in my Rolls Royce. I'd go in with my little silver tool kit and I'd burgle the place. I'd come out with the loot and I'd drive away. Nobody would pay any attention. This is the way crime is carried out in our technological society – under the guise of the normal function. Now I'm not going to call attention to myself by doing a crazy thing like *walking* up to a house, because all the dogs in a neighborhood get hysterical when they hear you walking by, even if you're wearing your new pair of light, whipped cream, marshmallow tennis shoes."

The logic of this began to filter down, down, down through the various retorts in the policeman's head. He gave off a noise like the device in *The Man in the White Suit*. He grunted. I couldn't tell if it was affirmative or negative. I got even more infuriated.

My friend and I had been eating soup at a drive-in down the way and I, on the way out of the restaurant, had put a little packet of soda crackers in my pocket. Now, as I talked to the policeman, I took the crackers out, put them in my mouth, started chewing, and sprayed him with flakes. Well, he wasn't quite sure whether I was being hostile or not. He contented himself with brushing the flakes off and letting us go.

I went home in the middle of my fury, and wrote a short story called "The Pedestrian," which became a part of my book, *The Golden Apples of the Sun*, in which, in the future, a man went for a walk and the same thing happened, but instead it's a robot police car that drives up and says, "What are you doing?"

"Walking."

"What for?"

"To breathe the air."

"Don't you have an air-conditioner in your house?"

"Yes. But I'm walking to *see*."

"Don't you have a *television* in your house?"

And the logic of the thing grinds him and grinds him down to the ground until finally a cell door opens in the back of the police car and he's invited in and driven off for psychiatric investigation – for being "different."

Don't think

This is the way I come on my ideas – this kind of maddening exchange between myself and our semi-fraudulent society. I respond angrily, which is good. If you're going to work in any of the creative fields, you must live by your emotions. I have a large sign over my typewriter – it's been there for years – which says, "Don't think." It's just the reverse of the signs they hang at IBM. But I find it's true. It's all right to think before and after the fact, but during creation you must be emotional. You must love what you're doing. You must run with ideas, just as I ran immediately into "The Pedestrian."

If you are a real child of your time, you grow up inside this particular age full of ideas. We're surrounded by them. We're being shaped by them. We're being destroyed by them.

The idea of the automobile, for example, has changed the whole American family set-up in 70 years, has changed the mating habits of our society, has caused, one often thinks, one-third of our population to be conceived in drive-ins, and be entertained with Cary Grant at the same time. All these things are worth thinking about and writing about, and it's not being done. My reason for being alive then, is to explain the age to you in metaphorical terms, to excite you to it, so you will go and carry on many of the jobs of research to implement that age and build it yet again. And after I am gone, yet other people will rise up to

A painting from "Icarus Montgolfier Wright" prize-winning film written by Ray Bradbury and illustrated by Joseph Mugnaini, prominent American painter and art teacher at Otis Art Institute in Los Angeles.

cry, "This is what *our* age means."

Let me give you an example of this explaining an age to its inhabitants. I wrote a short story a few years ago called "Icarus Montgolfier Wright," in which I experimented with mythologies of the past, with scientific knowledge as we know it in the recent past and present, and projecting it into the immediate future. I tried to fuse, into one parable, man's age-old desire to fight his enemy, gravity — to fly, like the birds at morning, to get into the air, to get away from this earth which might destroy him some day. I wanted to say to our Time, "This is the old dream. We are now building the ships that will put the old dream into action, and we're going off into space." So I got Joe Mugnaini, the well-known American artist, to do 800 drawings and 200 final tempera paintings. It took him two years to do this — all on his own. These pictures were then photographed and made into a semi-animated film which won us an Academy Award nomination. Our purpose in making the film was to try aesthetically to excite people to the space age. Very simply that. Whether we have succeeded or not, it's an honest endeavor — a work of love. We had no money. The whole thing was done free. We all put our time in it. And the biggest involvement of time was the artist's.

You are at the *start* of our Renaissance. All of our art, all of our drama, must partake of these ideas. And if I do nothing else in the next — God willing — 20 years of my life, I want to pollinate artists and writers and dramatists and people like you to go out and grab these ideas and take them to other people and say, "For God's sake, why aren't you doing something with them?"

I have always been very curious about the creative process. Nine years ago, when I lived in London, I called Bertrand Russell and asked if I mightn't come out for an evening because I wanted to talk to him, try to verify *his* processes — how he collected facts, what he did with them, how he trusted his subconscious to do his thinking for him. I discovered years ago there is a certain point where you must turn away from research, turn away from facts. When you have stuffed yourself as completely as you can with those things you feel are necessary to solve your problem, there is a certain point beyond which you can not push, because the harder you push, the more elusive the problem becomes.

Lord Russell was most gracious. He told me how he wrote some of his essays and books. And his was the exact process which I had instinctively come upon: he gave himself the information he needed, but at a certain point called a halt, and said, "I forget about it. I put it out of my mind. I turn to other things. I walk away." The next morning, a week, or a month later, he woke up and there the answer stood in the center of his head.

Now, this is the *intuitive* process you must learn to be comfortable with, to help you in your own work. At a certain point, *if* you've done your research, you *must* trust your subconscious to favor you with solutions. These are quite often emotional explosions when they come, especially for writers. I go *with* the explosion. I don't worry it. I don't ask myself what I am thinking or where I want to go; I just go, and the story writes itself.

As you can imagine, I was pleased to find that Bertrand Russell worked this way. It made me feel more comfortable with my own crazy habits. For I had got into a series of heated arguments with John Huston, you see, on this very subject. I was in Ireland at the time writing the screenplay of *Moby Dick* for Huston, and at a given point in trying to understand *Moby Dick*, we despaired. It was just too much to assimilate and we were having trouble lining the scenes up. One night, I protested, "Look, John, we're *pushing* too hard. We can't stay up till three in the morning every night for weeks on end and get results. It's impossible. Now we know the book pretty well. We know what our problem is. Let's state it for ourselves again, right now. Then I'll go back to

the hotel in Dublin and put a pad and pencil by my bed before I go to sleep. You do the same. *One* of us will wake up in the morning with the solution to this lousy literary problem, which is destroying the entire screenplay."

Huston said, "You're crazy!"

I said, "No. I believe in this. I've experimented with it before. I don't know if *I'll* get it or if *you'll* get it, but one of us will."

The next morning my phone rang at seven o'clock. It was Huston on the phone, gibbering, "Ray, Ray, I've got it. I've got it. You were right. I woke up, I reached for the pad and paper, and I wrote it down."

He was right. He got it. And we went on from that point and had no trouble.

Now, there is a relationship between the things you are doing here at Caltech and the things I have gone through in my own work. The function I described to you with Bertrand Russell, and these other things I've been talking about, is the same thing that should be happening to you. It took a lot of work, a lot of reading, a lot of preparation, to finally come to a time where I relaxed utterly. At the time I relaxed I could start to be creative. Every creative product in the world, whether it's an invention, a social theory, a painting, or a book, is based on this very process. Avid preparation, a declaration of love in a given field – where you simply can't imagine yourself doing anything else *but* the thing you are doing – that's the first thing. Because love must carry you through all the hard work. If you don't have real affection for the thing you're doing, you can't get the work done.

So the prime mover of the world really should be that old-fashioned word "love." We don't teach it often enough. We're afraid to talk about it. We're afraid of being considered sentimental. But, my God! – you wouldn't be here, would you, most of you (at least I hope you wouldn't) if you didn't *love* your studies in some way? You have *one* thing, most of you, in your lives that you are really avid about. And when you leave here, you are going to go out after this thing. And this fills your lives up. It should – absolutely – or you shouldn't be here. You should be out in the world finding that thing that you really love.

Your love and exultation about your work must burst your skin. Then you can go and do all the hard work, all the research, and fill yourself so completely with it that original thought can occur. These things have to be lined up: Love, hard work, relaxation, creativity. In that order. Each helps the other. When you get the cycle going, the whole thing turns over and you begin to get *more* ideas. The more you work, the more you love, the more you relax, the more you create, the more you *want* to work, the more you love, the more you relax, the more you create.

The point cannot be made too strongly. Remember it. And when you feel yourself falling away from this grace – which is the greatest grace given mankind – turn back to it. You must, because there is no reward in the world except your work and the way you apply yourself to it.

But you're lucky. Here you are in an environment which is conducive to creativity if you take advantage of it and remember these points we've been discussing.

This is the greatest age in history. And here *you* are on the threshold of the whole damn era. We're going to go into space. We're going to populate the planets. We're going to solve more secrets of the atom. We're going to do away with more death. We're going to destroy more disease. And you'll be part of this wonderful blasphemy that will turn into a new religion. The act that was blasphemous will become the act that is idolized and made use of constructively in religions we can't imagine and philosophies we can't guess.

The space age means for me our chance for immortality. In other words, though we don't voice it, when we cross space and colonize the planets, and move toward the stars, eventually this gift of life will pass on forever.

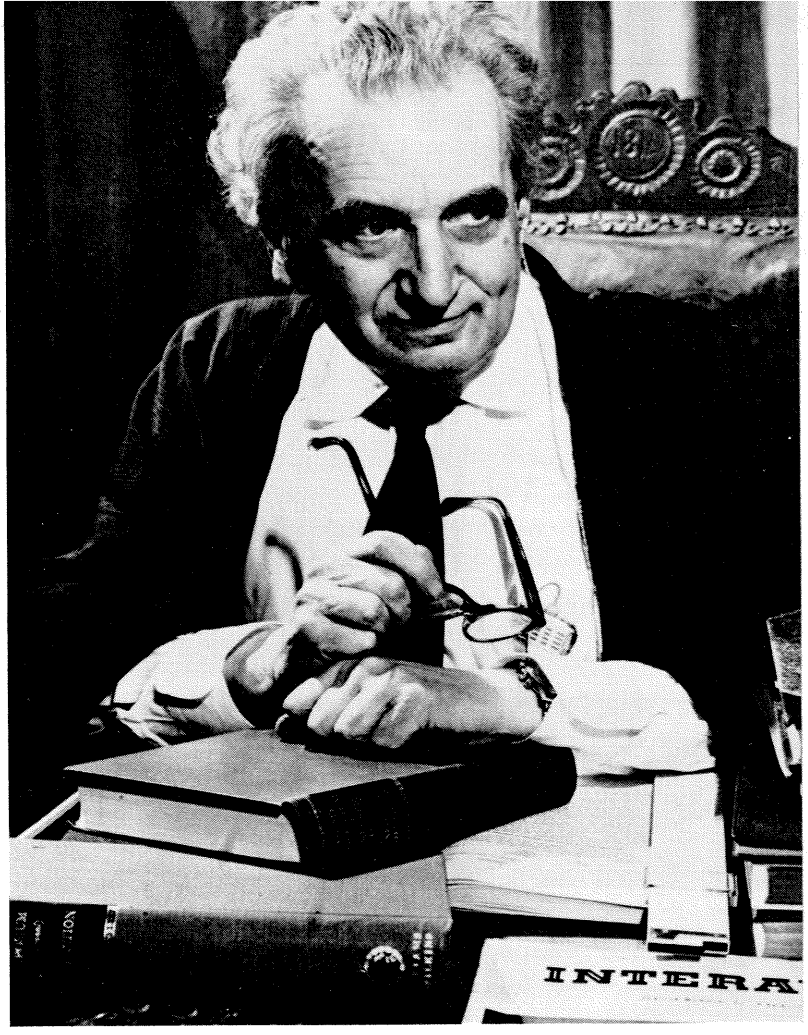
I think this is worthwhile. And you are part of this endeavor. This effort we will be making to live forever. For billions and billions of years our seed can be planted on planets circling suns billions of miles from here.

We're going to do this. We think of it now as a large problem; we haven't the faintest idea how we're going to build the starships that will take us from our own solar system, but we're going to do that too.

We are already experimenting with suspended animation, to take us on 50- and 100-year flights away from our solar system, and we're going to do it because we love life more than we hate it and because we do fear death and we do fear darkness.

We're going to move out. We're going to conquer darkness. This is the reason for the space age. All the other reasons are political. All the other reasons have nothing to do with the regeneration of mankind into infinity. This is the reason *I'm* in the effort.

I hope you will join me.



Theodore von Kármán

1881 - 1963

by W. D. Rannie
Robert H. Goddard Professor of Jet Propulsion

Theodore von Kármán, Professor of Aeronautics Emeritus, died after a brief illness in Aachen on May 7, 1963, a few days before his 82nd birthday. Although his career was directed toward engineering research, principally in aeronautics, his influence in many fields was so great that no one person can pay him adequate tribute.

Theodore von Kármán was born in Budapest on May 11, 1881, the son of Maurice von Kármán, professor of philosophy and outstanding teacher at the University of Budapest. In the stimulating intellectual atmosphere of his home, Theodore showed a flair for mathematics at an early age, and his interest in science led him to the Royal Technical University in Budapest where he studied mechanical engineering, graduating with high honors in 1902. After a period of employment as an engineer in Budapest, he entered the University of Göttingen in 1906.

Von Kármán quickly established his reputation at Göttingen, a center renowned in mathematics, mechanics, and physics. He became a student of Prandtl, received his PhD in 1908 and stayed on to teach. His publications in this period were concerned principally with elasticity and its applications to structures, but he also began investigations in fluid mechanics. He discovered the condition for stability of the vortex street that since has carried his name. He made important contributions to the theory of specific heats of solids.

Von Kármán was invited to become the first director of the newly formed Aeronautical Institute at the University of Aachen in 1912. Under his leadership, which continued for 18 years except for a period with the Austro-Hungarian Air Corps in the first World War, the Aeronautical Institute became recognized as the foremost school for aeronautics in the world, and students came from many foreign countries to work under its distinguished director. Von Kármán's publications in the Aachen period covered a wide variety of aeronautical subjects. He wrote definitive papers, many forming the basis for all subsequent work, in the theory of airplane stability, airfoils, helicopters, propellers, and airships. Of less specific application, although still with aeronautical flavor, were his important contributions in boundary layer theory, similarity theory in turbulent shear flow, and theory of thin-walled structures.

Von Kármán visited the California Institute of Technology to give advice on the construction of the Guggenheim Aeronautical Laboratory, and spent half of his time in Pasadena, the other half in Aachen from 1928 to 1930. In 1930 he became

full-time director of the Guggenheim Laboratory at the Institute, and Pasadena soon replaced Aachen as the leading school for aeronautics. The 10-foot wind tunnel in the Guggenheim Laboratory had been constructed to specifications set down by von Kármán, and the value of his advice became evident in the early 30's as the aircraft industry throughout the country came to Pasadena for aerodynamic tests.

Father of the supersonic age

Many able students came to Pasadena to work with von Kármán, and in the decade preceding World War II his scientific output was astonishing in quantity, diversity, and importance. He introduced new concepts and theories for nonlinear buckling of thin-walled structures and for isotropic turbulence. He worked and encouraged others to work on problems of supersonic flow. His paper on resistance in compressible fluids presented at the Volta Congress in Rome in 1935 was of extreme importance in pointing the way to supersonic flight. He began extensive investigations of rockets, anticipating by 20 years the developments in this field. His contributions to the development of the X-1, the first airplane to achieve supersonic speed, earned for him the popular title of "father of the supersonic age."

As it became clear that war would occur, von Kármán began to turn more of his attention to the immediate and long range problems of the armed services. He and his associates demonstrated the feasibility of rocket assisted take-off for airplanes, and as the need for large numbers of JATO devices became apparent, he founded the Aerojet Engineering Corporation, now Aerojet-General. He was the chief technical adviser of the corporation until his death. In the same period, he founded the Jet Propulsion Laboratory as a center for rocket research and development and became its first director. He took leave of absence from the Institute in 1944 to devote more of his time to Air Force planning, and formed the Scientific Advisory Group to advise the Air Force on preparation for expected technical developments in the next 20 years.

Still active after his retirement from the Institute in 1949, von Kármán turned his attention to ways of bringing about more international cooperation in engineering research. Toward this end, he was responsible for forming the Advisory Group for Aeronautical Research and Development (AGARD) as a NATO agency in 1951. He was elected chairman of AGARD and devoted a major part of his time to it until his death.

Von Kármán received honorary degrees and awards from universities, scientific societies, and governments throughout the world in recognition of his inspiration and leadership. Most fittingly, he was chosen to be the first recipient of the National Medal of Science, presented by President Kennedy last February.

The "Collected Works of Theodore von Kármán," published in 1956, contain in four volumes all of his papers from 1902 to 1951. These volumes are not solely of historical interest; surprisingly few of the papers are dated, even in subject matter. Von Kármán had an extraordinary ability to isolate the essential controlling factor in a complex physical problem, to represent it in a concise mathematical equation, and to find an elegant solution by a novel application of relatively simple mathematics. This insight is evident in all his publications as it was in his lectures and in the advice he gave to those who consulted him.

The warmth of von Kármán

The papers that he wrote and the organizations that he founded are lasting and impressive monuments to von Kármán's versatility, but they represent only a small part of his contributions to the world. Much of his influence stemmed directly from the exceptional character of his wit, charm, and warmth. No one who once came under his spell could ever forget him. He liked people and was easily approached by anyone. Because he considered teaching his most important function, his students were specially favored with attention and he spared no effort in awakening their enthusiasm. His teaching was very personal, by no means confined to the classroom or restricted to scientific subjects.

Von Kármán remained a bachelor and, until their passing, lived with his mother and his sister, Josephine, both women of unusual talent. The family ties were very close, and much of von Kármán's activity centered about his home, which was always open to students, colleagues, and friends. There were many visitors, and students coming to his home to work with him were absorbed into a fascinating gathering of von Kármán's friends, who included people of every nationality, profession, and station in life.

Von Kármán was gifted with a rare combination of high intelligence, warm understanding, and respect for man's dignity. Throughout his life he shared these gifts generously with others and has left a rich legacy for those who follow.

The Month at Caltech

Ying-Chu Lin Wu, who received a doctorate in aeronautics, and her two sons, Albert and Ernest.

Commencement 1963

At Caltech's 69th annual commencement on June 7, a total of 350 students received degrees—133 Bachelors of Science, 114 Masters of Science, 90 Doctors of Philosophy and 13 Engineers. Of the 52 men who graduated with honors, 2 received both academic honor and Student Body Honor Keys: Henry Abarbanel and Lawrence Gershwin. Student Body Honor Keys were also received by Thomas Bopp, David Ollis, Larry Rabinowitz, Arthur Robinson, Joseph Russo, James Sagawa and Robert Schmulian.

Presented for the first time this year was the E. T. Bell Mathematics Prize, which is awarded to one or more juniors or seniors for outstanding original research in mathematics. It was won by seniors Edward A. Bender and John H. Lindsey II.

This year's commencement address was delivered by John William Gardner, president of the Carnegie Corporation of New York.

Dr. Henry Eversole

Dr. Henry Eversole, physician and former research associate in plant physiology at Caltech, died on June 1 at his home in Santa Barbara, California. He was 86. He was a pioneer researcher in chest diseases and in the environmental control of plant growth.

A native of Middleport, Ohio, Dr. Eversole came to Los Angeles after serving in the Spanish-American War. He was graduated from the medical division of USC in 1906. After two years of postgraduate studies at Johns Hopkins University in Baltimore, and in Berlin and Vienna, he returned to Los Angeles to specialize in new techniques for treating chest diseases.

During World War I, Dr. Eversole served as a major in the American Red Cross. Attached to Allied forces that were supporting White Russians against the Bolshevik advance in Siberia, he was active in efforts to evacuate cities, fight typhus, and free prisoners from concentration camps. Upon withdrawal of the Allied troops from Siberia, he conducted hundreds of lost Russian children through the Panama Canal to Finland for repatriation.

From 1923 to 1927 Dr. Eversole was a member of the Rockefeller Foundation international staff, serving as European director of its division of medical education.

In 1929 Dr. Eversole returned to California and began intensive research on the environmental factors in plant culture. In the mid-30's he offered to help Caltech in the planning and construction of a research greenhouse in which all the climatic factors influencing plant growth could be artificially created and regulated. The results were the Clark Greenhouses and the Earhart Plant Research Laboratory. These installations received worldwide recognition for their contributions to the understanding of plant physiology, and the principles and techniques of their operation led to the establishment of dozens of other laboratories throughout the world.

Horace W. Babcock

Horace W. Babcock, assistant director of the Mount Wilson and Palomar Observatories, has been named associate director by the Carnegie Institution of Washington and Caltech, which operate the observatories. He will become director upon the retirement of Ira S. Bowen, present

director of the observatories, in June 1964. Dr. Bowen, who received his PhD from Caltech in 1926, has been director of both observatories since Palomar Observatory was established in 1948, and was director of the Mount Wilson Observatory for two years prior to that. He was formerly professor of physics at Caltech and has been on the faculty since 1921.

Dr. Babcock has been a member of the observatory staff since 1946. His father, Harold D. Babcock, was physicist at Mount Wilson Observatory from 1909 to 1948. Although the elder Babcock has retired, he and his son have constructed and put into operation the magnetograph at the Hale Solar Observatory in Pasadena.

Horace Babcock graduated from Caltech in 1934 and received his PhD from the University of California in 1938. His astronomical work has been concerned with variable stars, the rotation of spiral galaxies, the light of the night sky, and, in particular, Dr. Babcock has pioneered in research on the magnetism of the sun and stars.

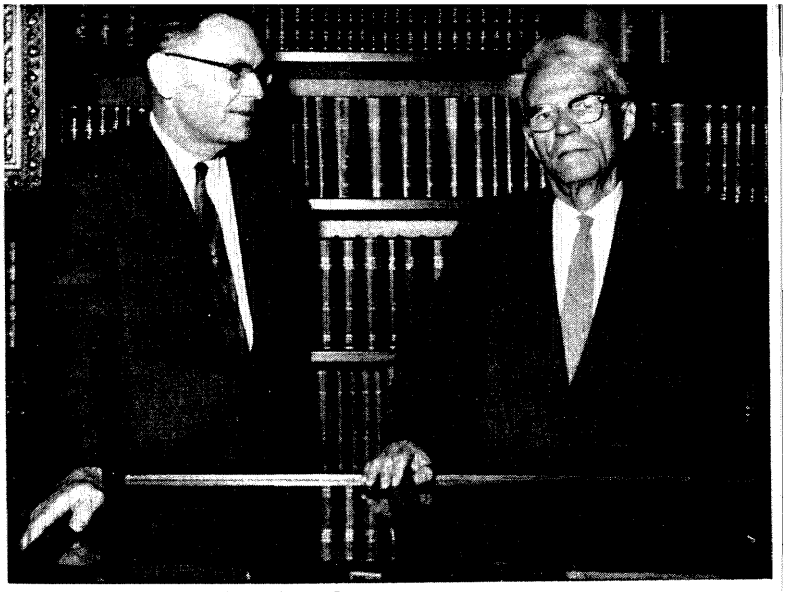
He has also been keenly interested in astronomical instrumentation, and has made improvements in the ruling machine and supervised the ruling of optical diffraction gratings at the observatories, where some of the world's finest gratings have been made. Gratings are used to produce and study spectra of visible light. He has devised a precise automatic guider for the 200-inch Hale Telescope, and has developed integrating exposure meters for spectroscopy.

Dr. Babcock is a member of the American Academy of Arts and Sciences, the National Academy of Sciences, the American Astronomical Society, the Astronomical Society of the Pacific, the International Astronomical Union, the Society of Sigma Xi, and Tau Beta Pi. In 1957 he received the Draper Medal of the National Academy of Sciences, and in 1958 was awarded the Eddington Medal of the Royal Astronomical Society.

Honors and Awards

President Lee A. DuBridge gave the commencement address and received an honorary Doctor of Laws degree at Loyola University's 51st annual commencement on June 9 in Los Angeles.

Frederick C. Lindvall, professor of electrical and mechanical engineering, and chairman of the division of engineering and applied science, will be honored by the Senate of the National University of Ireland on July 11 at the University College in Dublin. He will receive a degree of



Horace W. Babcock and Ira S. Bowen

D.Sc., *Honoris Causa*, in recognition of his distinction in the fields of electrical and mechanical engineering.

Robert B. Leighton, professor of physics, and Roger W. Sperry, Hixon professor of psychobiology, have been elected fellows of the American Academy of Arts and Sciences. Dr. Leighton received the distinction for his highly intricate camera that photographs phenomena on the sun's surface. Dr. Sperry developed the "twin-brain" technique for studying the brain's circuitry and recently confirmed with microphotographs his theory that the nerve fiber circuits in the developing brain grow, assemble, and organize themselves by intricate chemical codes under genetic control.

Robert L. Daugherty, professor of mechanical and hydraulic engineering, emeritus, has been reappointed by the Los Angeles County Board of Supervisors to a fourth 3-year term as a member of the Air Pollution Control Hearing Board.

Caltech Glee Club Record

Men of Science in Song, a new recording by the Caltech Glee Club of 55 men directed by Olaf M. Frodsham, is now available. The record contains a variety of songs by the Glee Club, the Caltech Madrigal Society, and the Caltech Quartet. The Glee Club is well known on the west coast in concerts, on radio, and in television, and was heard nationally in 1960 on TV when it appeared with the U.S. Marine Corps Band in closing ceremonies of the Winter Olympics. The monaural records are available in the Caltech Bookstore for $3.00 or may be ordered by mail from the Caltech Glee Club, Dabney Hall.

Jesse W. M. DuMond

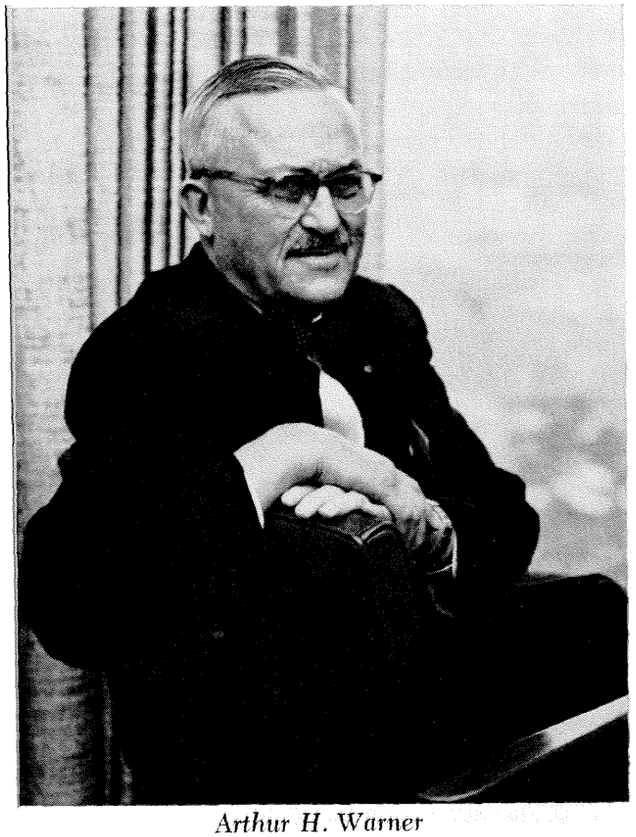
Retiring

Retiring this month: Jesse W. M. DuMond, professor of physics; Paul D. V. Manning, professor of chemical engineering and Arthur H. Warner, executive director of Caltech's Industrial Associates.

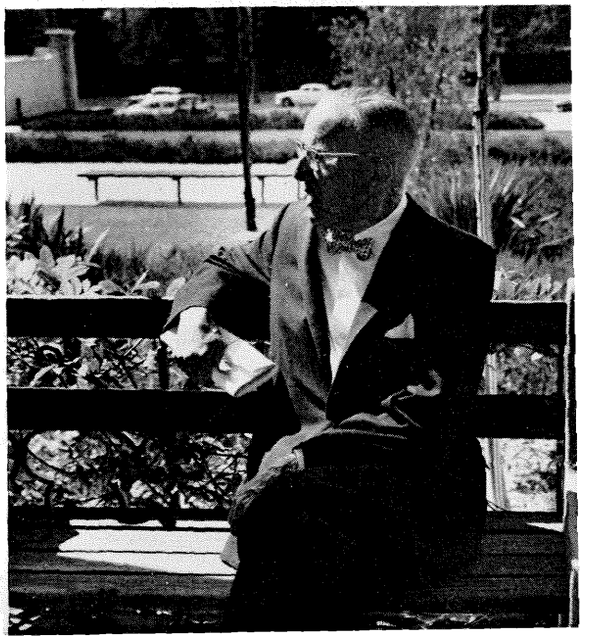
Dr. DuMond, who received his BS from Caltech in 1916 and his PhD in 1929, is a leading authority on the precise value of the physical constants and in the field of x-ray and gamma-ray spectra. He began his career as an electrical engineer in industry, and at the National Bureau of Standards, and soon became interested in fundamental physics. One of his early contributions concerned the analysis and theory of powerful x-ray spectrometers. He has built several such instruments and used them to make accurate measurements and precision studies of x-rays.

Paul D. V. Manning received his MS from Caltech in 1917, the first man from Caltech to earn a degree higher than the bachelor's. A specialist in the fields of chemical engineering and research administration, he joined the Caltech faculty in 1958 after retirement from his position as senior technical vice president of International Minerals and Chemical Corporation in Chicago.

Dr. Warner came to Caltech in 1962 from the Aerospace Corporation, after having established that firm's Atlantic Missile Range Office at Cape Canaveral. A graduate of the University of Colorado, he received his PhD in physics from Caltech in 1927 and for 28 years was on the UCLA faculty.



Arthur H. Warner



Paul D. V. Manning

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Alumni News

Throop University Graduate

RICHARD W. SHOEMAKER, '03, one of the three earliest graduates of Throop University, was honored in the spring of 1962 by the Engineering Council of Sacramento Valley for his contribution to the growth and development of the electrical power industry and the engineering profession. Born in Germantown, Pennsylvania, 81 years ago, Mr. Shoemaker has lived in California since he was one year old, and received his entire education here. While still in college he sent California's first wireless message to Catalina Island. He later installed the first trackless trolley in this country in Laurel Canyon, near Hollywood. He then spent some time in Asia where he negotiated for the electrical railways in Harbin, Manchuria. Upon his return to California, he made an accurate estimate of the power potential of the Hoover Dam, and designed the drop for the All-American Canal in the Imperial Valley.

Mr. Shoemaker, who holds some 25 patents, is the author of *Radiant Heating* (McGraw-Hill), a text that is used worldwide. Although he retired in 1946 from the Chase Brass & Copper Company, he has been active on projects for the Oakdale and Turlock Irrigation Districts, and is presently serving on the technical papers committee of the Sacramento Section of the American Institute of Electrical Engineers.

Tau Beta Pi President

DONALD S. CLARK, professor of mechanical engineering and director of placements at Caltech, is the new president of Tau Beta Pi, national engineering honor society.

He is also chairman of the five-man executive council, the governing body of the society which serves for four years. Other members of the council are Hallan N. Marsh, who received his BS from Caltech in 1922; David R. Stern, research manager for the American Potash and Chemical Corporation; Robert L. Mannes, professor of mechanical engineering at USC; and Edward P. Coleman, professor of engineering at UCLA, who serves as the council's vice president.

Dr. Clark, who received his BS, MS, and PhD degrees from Caltech, has been on the faculty since 1934 and is widely known for his research on the dynamic behavior of metals.

A basic problem facing the designers of submersible, sea-going, air-cushion, flying or space-seeking vehicles is the resistance of the liquid or gaseous fluids through which these craft must pass. The shape of the vehicle becomes critical in determining its speed and efficiency. Research on fluid dynamic shapes at Douglas Aircraft Division laboratories is among the most advanced in the world. Included are studies and experimental work relating to submarines, ships, subsonic, supersonic and hypersonic aircraft, and manned re-entry space-planes. Also under present development are new computer-oriented methods of calculating the potential flow and heat about arbitrary bodies throughout the speed spectrum and solving the various configuration problems which are involved.

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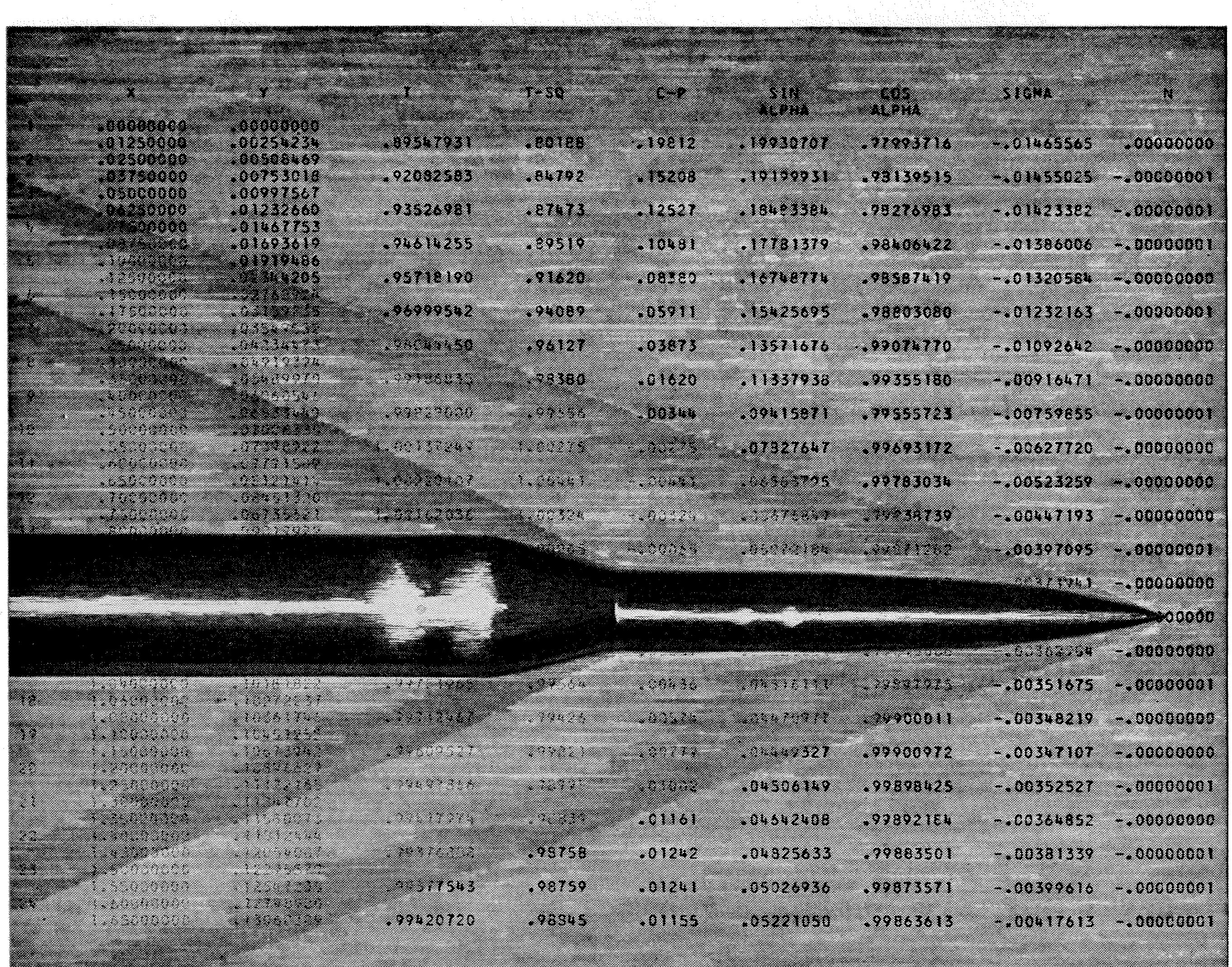

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DOUGLAS

ALUMNI FUND PROGRESS REPORT

	This Year	Last Year
Number of donors:	1510	1608
Participation percentage:	18.8%	20.6%
Number of dollars:	$70,480	$62,880

How many of you have said to yourselves, "I can't help the Alumni Fund because I can only make a *small* contribution?"

We hope you are aware that *any size* contribution is appreciated. Your interest and your active participation is equally as important as your generosity.

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

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How Industry Tempers Theory with Practice to Get Good Design

An Interview with G.E.'s F. K. McCune, Vice President, Engineering

As Vice President—Engineering, Francis K. McCune is charged with ensuring the effective development, use and direction of General Electric's engineering talent. Mr. McCune holds a degree in electrical engineering and began his career with the Company as a student engineer.

For complete information on opportunities for engineers at General Electric, write to: Personalized Career Planning, General Electric Company, Section 699-07, Schenectady 5, N. Y.

Q. Mr. McCune, how do you define engineering design?

A. First let's look at what engineering really is. The National Society of Professional Engineers calls it "the creation of technical things and services useful to man." I would paraphrase that to add an industry emphasis: engineering is linking an *ability to do* with specific customer *needs and wants*. The link is an engineering design of a useful product or service.

Q. In the light of this definition, how can the young engineer prepare himself for industry?

A. In college he should absorb as much theory as possible and begin to develop certain attitudes that will help him later in his profession. The raw material for a design, information, flows from three general funds: Scientific Knowledge of Nature; Engineering Technology; and what I call simply Other Relevant Information. Academic training places heavy emphasis on the first two areas, as it should. Engineers in industry draw heavily on theorems, codified information, and significant recorded experience basic to engineering disciplines taught in college. The undergraduate must become knowledgeable in these areas and skilled in the ways of using this information, because he will have little time to learn this after graduation. He also must develop a responsive attitude toward the third fund.

Q. As you say, we learn theory in college, but where do we get the "Other Relevant Information"—the third fund you mentioned?

A. This knowledge is obtained for the most part by actually doing engineering work. This is information that *must* be applied to a design to make sure that it not only works, but that it also meets the needs and wants that prompted its consideration in the first place. For example, we can design refrigerators, turbines, computers, or missile guidance systems using only information from the first two funds of knowledge—heat flow, vibration, electronic theory, etc.—and they will work! But what about cost, reliability, appearance, size—will the prospective customer buy them? The answers to these important design questions are to be found in the third fund; for example the information to determine optimum temperature ranges, to provide the features that appeal to users, or to select the best manufacturing processes. In college you can precondition yourself to seek and accept this sort of information, but only experience in industry can give you specific knowledge applicable to a given product.

Q. Could you suggest other helpful attitudes we might develop?

A. Remember, industry exists to serve the needs and wants of the market place, and the reasons for doing things a certain way arise from the whole spread of conditions which a given design has to satisfy. Learn how to enter into good working relationships with people. Much of the Other Relevant Information can be picked up only from others. Also train yourself to be alert and open-minded about your professional interests. In industry you'll be expected to learn quickly, keep abreast in your field, and to grow from assignment to assignment. Industry will give you the opportunity. Your inherent abilities and attitudes will largely decide your progress.

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