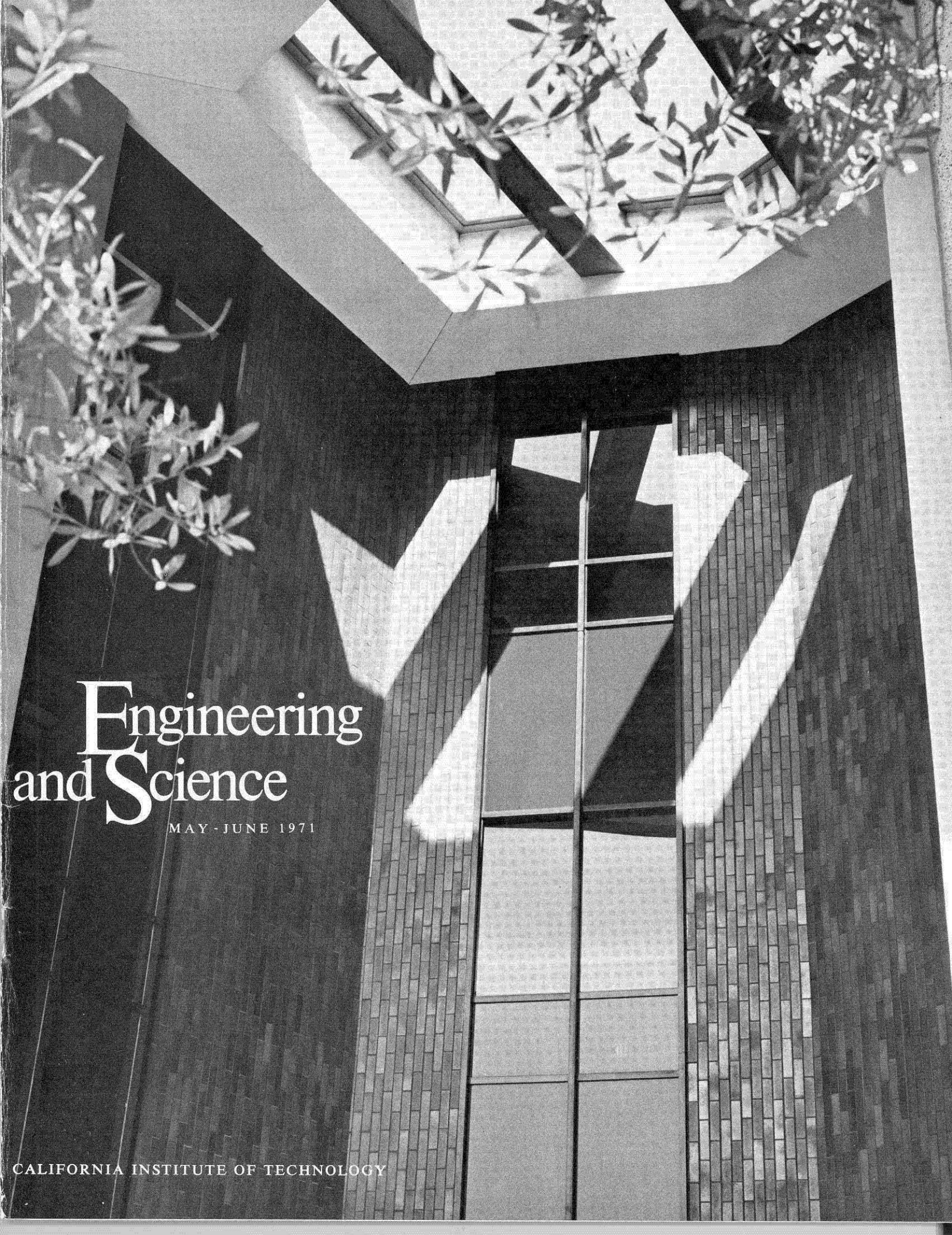

Engineering and Science

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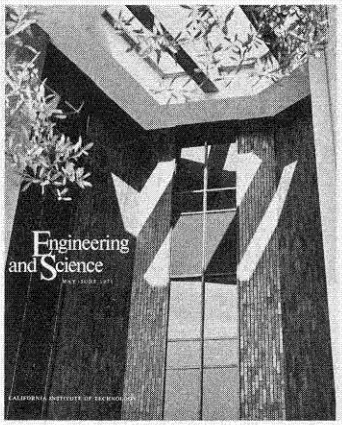

Engineering and Science

In this issue

Humanities and Social Sciences

On the cover—a striking view of the main entrance of the new Donald E. Baxter, M.D., Hall of the Humanities and Social Sciences. This is the work of Susie Tracy, a creative photographer whose interest is in design rather than literal representation. Some other examples of her unique photographic approach to Baxter Hall are on the inside back cover and pages 12, 14-15, and 17.

With the dedication of Baxter Hall on May 10, the Division of the Humanities and Social Sciences not only formally took up residence in new quarters but also implemented its accelerating movement into new areas of research and teaching—exciting reasons for *Engineering and Science* to devote this issue to some aspects of the past, present, and future of the division:

In "Creating the Next Discipline" (page 1), 11 faculty members discuss that future—as they foresee it.

"Baxter Hall—A Laboratory for the Humanities and Social Sciences" (page 12) describes the division's new home and tells something of how it came into being.

"A Time of Metamorphosis" (page 18) is adapted from the talk given at the Baxter dedication by Robert L. Sinsheimer, chairman of the division of biology.

"Energy Unlimited" (page 21), a profile of the division's acting chairman, Robert Huttenback, discloses further facets of Caltech's versatile genial abbot.

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by Robert L. Sinsheimer

We are facing an identity crisis for the species, a rite of passage from life in a world we never made, to life, for better or worse, in a world of human design.

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CREATING THE NEXT DISCIPLINE

The humanities and social sciences at Caltech—as eleven members of the division faculty see them.

The history of the development of the California Institute of Technology and the study of the humanities as a part of the curriculum are inextricably interwoven. For more than 50 years, there has been no wavering from commitment to the principle that the education of scientists and engineers should be a full one in the classical sense—that it should be leavened with a broad program of humanistic and cultural studies.

Over the years, of course, both the Institute and the humanities division have grown and changed in scope and emphasis, but undergraduates have always been required to take from 20 to 25 percent of their course-work in humanities subjects. Since 1965 students have been offered options in English literature, history, and economics. Signalling a new direction, the division added Social Sciences to its name in 1966. Now, in 1971, social science has become an integral part of the curriculum; and the growing faculty and staff of the division are for the first time in many years housed in one building—the beautiful new Baxter Hall.

What role do the humanities and social sciences play in the education of a Caltech student in 1971? What role *should* they play?

A group of undergraduates addressed themselves to these questions recently in a meeting with the visiting committee of the division—an advisory group of trustees, alumni, and other distinguished friends of the division.

Some student comments:

"What's a humanity—and how do you pour it into a scientist to make him more human?"

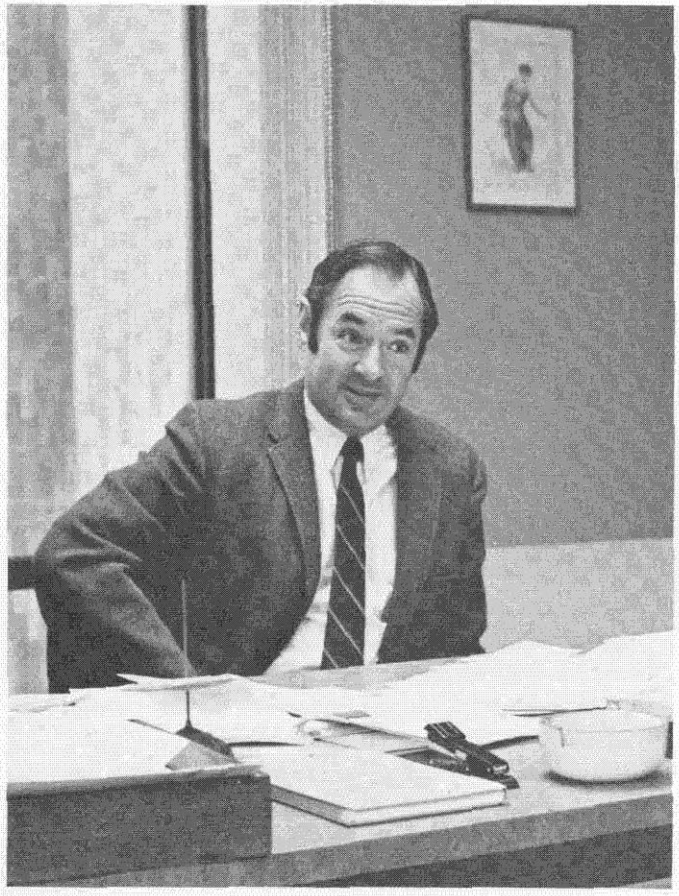
"Tech has given us all a knee-jerk assumption that the faculty in the humanities and social sciences aren't rigorous. But if you talk to those guys, you find out that they are critical, logical, and analytical, even when they're not quantitative—and some of them are that, too."

"Somewhere in the world there has *to be a place where people are interested in both science and the humanities."*

"I'm staying here even though I'm not going into scientific research. We're a technological society, and to effect change you have to understand science."

Such comments indicate the depth of the students' concern with this aspect of their education. It is a concern that is shared by the faculty of the Division of the Humanities and Social Sciences. Their answers to some of these perennial questions are presented on the following pages, in a series of *Engineering and Science* interviews with 11 members of the division.

What is the role of the division?



Robert A. Huttenback

professor of history, dean of students, and acting chairman of the division of humanities and social sciences

Caltech has always been innovative and forward looking, and the Division of the Humanities and Social Sciences, rather than duplicating what is already being done, is concerned now with moving ahead—with creating the next discipline. One new direction lies in social science, viewed not in its traditional guises of economics, political science, sociology, and psychology, but as a truly a-disciplinary and interdisciplinary venture.

We are already heading in this direction. For example, one of our current efforts is attempting to fund a Center for Applied and Theoretical Research in the Social Aspects of Public Needs. The center will consist of a group of faculty—and perhaps eventually graduate students—who will be dealing with questions of social policy and problems at two levels. They will be developing and improving social science theory. And they will provide personnel for the growing number of campus programs concerned with applications of theory to social problems. Some of our economists are now working in the Environmental Quality Laboratory, and other division members—including an anthropologist—are working with the Environmental Engineering Science and the population programs.

In the future we hope to work closely with JPL's section on social problems. If a center is developed on campus, as is hoped, to deal with problems of natural disasters, we will be cooperating with it. I expect that our work will include both the hard and the soft social sciences, although—given the history and strengths of the Institute—a heavy emphasis on analysis and quantification is likely.

The role of the division in the areas of the humanities is somewhat different. We must continue to emphasize undergraduate education and excellence of teaching. We also have a responsibility for the enrichment of the entire campus community. That means increasing our efforts in such affective areas as art, music, and drama. Possibly we should establish a Center for the Creative Arts. Next year we will have two poets-in-residence: Robert Kelly and Diane Wakowski. William Agee, curator of the Pasadena Art Museum, will offer a course in modern art history, and we are particularly happy that Erik Erikson will give the Haynes Foundation Lectures in January 1972. Then in the fall, Professor Erikson will be in residence on the campus and will lead a seminar on the nature of creativity.

In what areas does the division perform?

David C. Elliot

professor of history and executive officer for humanities and social sciences

The division has two areas in which it performs. One is in the humanities, where for many years we have been concerned with giving students an opportunity to talk about values—to understand that things are not always cut and dried mathematically and that even when they are, choices still have to be made.

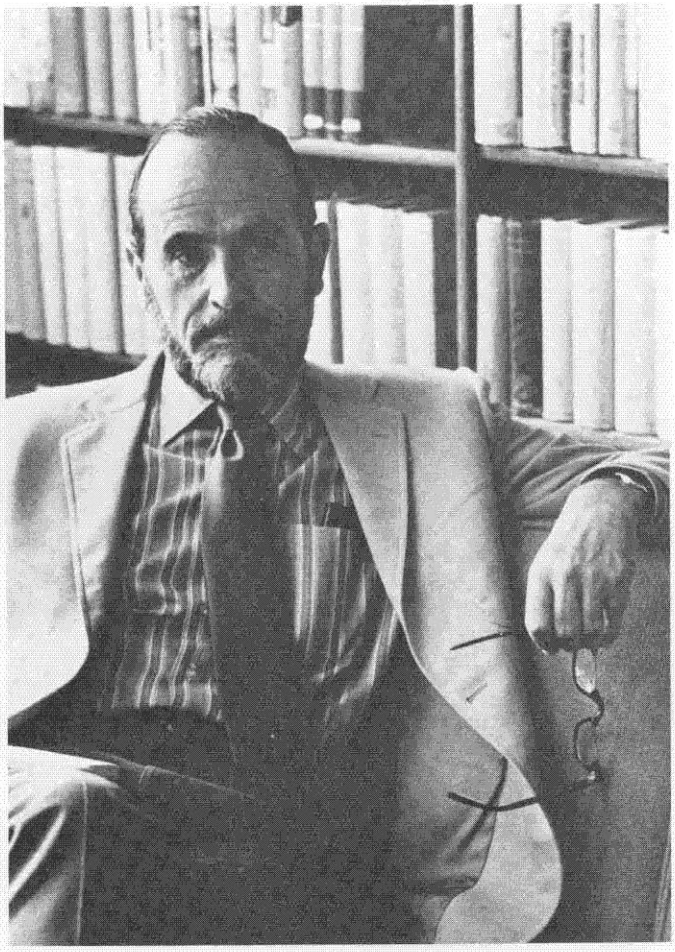
In the social sciences, which is the other area in which we perform, I think it is important that we think about the effects of scientific developments on human life. The problems that arise are social problems.

A classic case is the development of atomic energy and then the atomic bomb, which dramatically changed the whole security picture in this country. Arms control and security problems are examples of the kinds of social problems we at Caltech should try to deal with; and in an environment that is highly skilled technically and scientifically, we ought to be able to get a line on such practical problems.

This particular interest is expressed at present in our connection with the Southern California Arms Control and Foreign Policy Seminar which Caltech and the RAND Corporation jointly sponsor. Last year the Ford Foundation gave a three-year grant of $285,000 to enable RAND and Caltech to bring together people who are interested in these matters. I should hope that we could encourage three or four young guys, graduate students or faculty members, to develop an interest in this field. The ranks of the older generation—the Bachers and the DuBridges, who were involved in the early development and application of atomic energy—are thinning out. It's about time we had some younger people applying their minds to this problem, which is not going to be solved tomorrow. It's going to be a problem for their generation, and the next one, and I think we have a public responsibility to provide the opportunity for some of our young people to become involved.

Right now I think there is some real skepticism about what social science can contribute, because—quite frankly—despite much creative work, there's a lot of guff there. Possibly the most suspicious of all are the humanities people here, especially when they see the obvious or the over-simplified proved with mathematical precision.

Economics tends to be recognized as being more mature than other social sciences, and I suppose it is. Is that because it's more mathematical—because you can add up pounds and shillings and dollars and cents, whereas it's harder to add up human attitudes and beliefs?



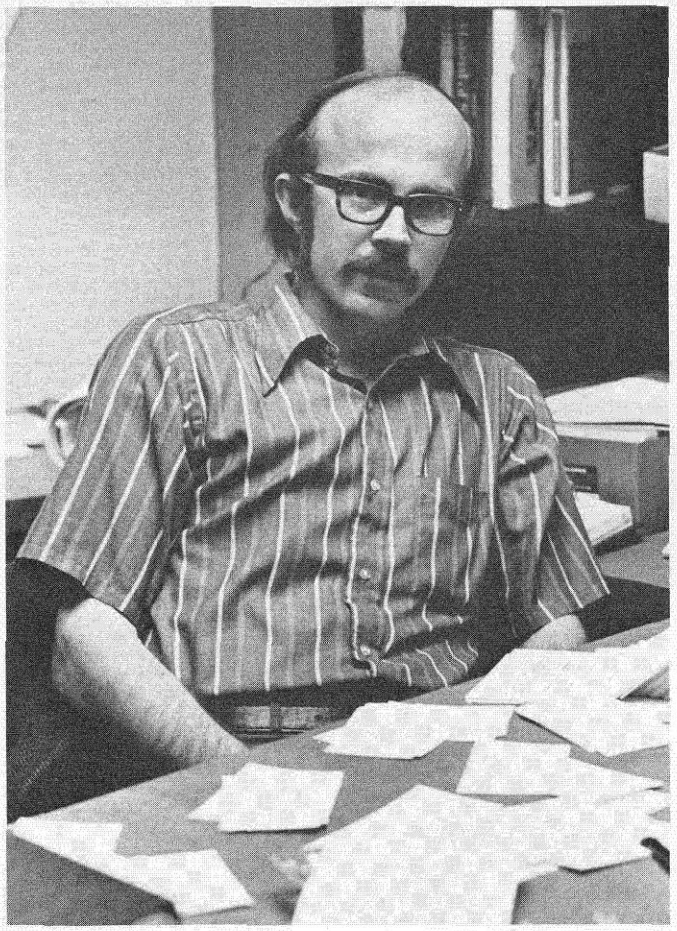
Can one make the rest of the social sciences mathematical in the same way as economics? This is a real question, and I don't think the answer is yet clear. And, anyway, is this what we mean by rigor—making things mathematical?

Where is the division heading?

Robert Bates

assistant professor of political science

I think the division is headed in a very exciting direction in terms of formal, analytical modeling or theorizing about social, economic, and political processes. By its very nature, Caltech is a place where that can be done in a superior way, and political science will have a strong part to play in it. Political science departments are increasingly turning out people who are very much interested in the modeling of political theories.



There's also room for another kind of political scientist here—the kind concerned with making empirical observations of how people behave politically; getting out and interviewing a lot of people in the field; doing public opinion studies, power analysis, and decision-making analysis. This is more the kind of political scientist I am. One place we might work that in at Caltech is with EQL, doing studies of active decision-making for the regulation of power supplies, population controls, transportation schemes, and things like that.

I say, as do many people in this division, that the talents may be different for these two kinds of political scientists, but the two types are not incompatible. Obviously, in terms of good analysis they can't be incompatible. When you look at empirical reality, you ought to be testing something. When you try to explain what you see, you should be taking recourse to certain kinds of theories. And I don't have an awful lot of respect for theorizing that hasn't been worked against an empirical data base, either.

Caltech offers a social scientist several things. One is an incredible amount of freedom to do whatever it is that he wants to do; he doesn't have to fit into an already rigidified program that has to perpetuate itself. Another thing it offers is very bright and able students. People are doing work for me in freshman courses here that would be highly respectable in some graduate courses. And then there is the material support that the Institute gives the social scientists. In most universities, a young assistant professor couldn't expect to get anything like the kind of support that has been available to me here.

There are disadvantages of course: the small library and lack of a graduate program at the moment. You tend to feel lonely intellectually. You miss having people to talk to who will have an immediate grasp of the field so you won't have to go slugging your way through to an understanding of even why it's important. But this can be overcome to some extent by taking advantage of the tremendous range of professional interests available at other universities in southern California.

This isolation is something that people seriously consider when they think about signing up at Caltech. But the thing is, some of the areas of political science that we will be working in are so new that you'd be equally isolated almost anywhere. A man who is really in the forefront of the field isn't going to be any better off even in a school with a big political science department.

Thayer Scudder

professor of anthropology

I think the most interesting thing about the division is its diversity—which also creates its greatest problem. I doubt if there is another academic division in the country to compare with it. Right here at Caltech, it is certainly more diverse, for example, than the Division of Physics, Mathematics and Astronomy. We run the whole gamut in teaching—from English literature and art, where you are primarily concerned with aesthetics and values, to econometrics and analytical techniques in political science, which is highly quantitative and scientific.

Other prestigious universities have busted up the humanities and social sciences into departments: economics, political science, psychology. I think it would be a great mistake to do that at Caltech. One of our advantages is that we have the opportunity to develop an a-disciplinary program that is interested in intellectual problems involving a wide range of social sciences and humanities.

I'm an anthropologist. As such I'm a behavioral scientist; I'm also a social scientist, but I'm also in the humanities. Other anthropologists are involved in the biological sciences. Those subdivisions met the traditional conveniences of the past, but they will not necessarily be conveniences in the future.

Many of our intellectual and applied problems in the United States and the world today are problems that can be dealt with only through the interdisciplinary approach, utilizing a wide range of social sciences and also bringing in the disciplines which are primarily concerned with questions of values—the humanities.

And I think we will be able to get the kind of people we need to develop the division along these lines. It is true that our reputation as primarily a science school handicaps us in recruiting the kind of people who feel happiest in a large department, and this probably includes the majority of social scientists. Certainly, the best departments in the country in political science or anthropology, for example, are the largest ones. And young people a little uncertain of themselves probably won't want to come to a place where they're going to risk being alone.

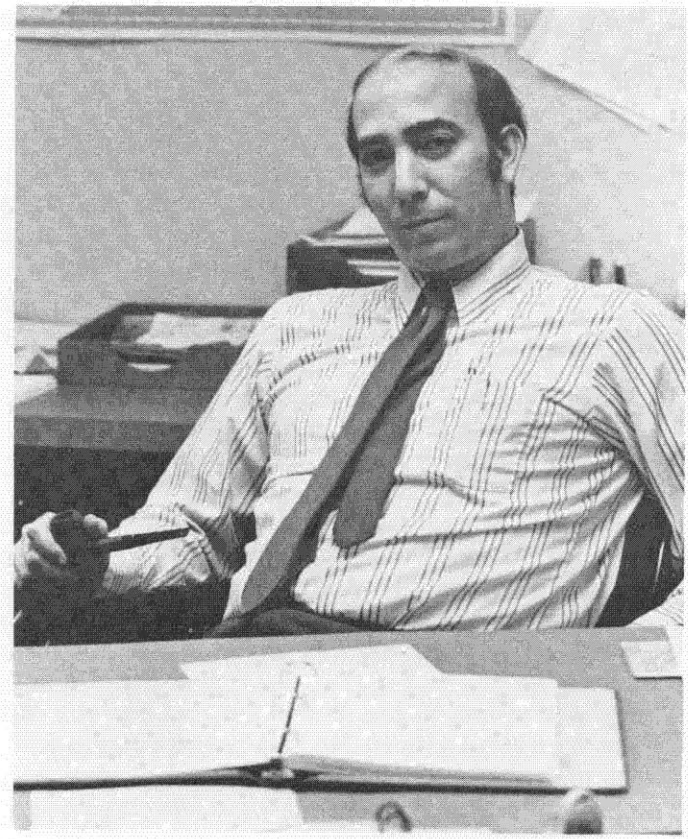
On the other hand, I think we have a tremendous advantage in recruiting brilliant oddballs. When I say "oddballs," I mean people who want to come to a place where they can do their own thing without the security of a long-established structure behind them, where they can have some input into the system no matter how junior they are. I suppose we can automatically eliminate 90 percent of the possible candidates, but the remaining 10 percent—the oddballs—are some of the brightest guys being turned out today.

Similarly, when we get into graduate education, I think the division will attract an unusual kind of graduate student. They are going to be setting up their own programs instead of getting their degrees in the traditional disciplines. The fact that we have no graduate program now means that the dead weight of tradition isn't holding us back.

What should we try to do very well?

Dan Kevles

associate professor of history



Over the years we have been asking ourselves the key question: What are those few things we ought to be trying to do very well? Social science is one obvious choice because contemporary social science is moving increasingly in an analytical and mathematical direction. Given the strong support in other divisions for this approach to the world—and a good deal of expertise and facilities, like computer banks, for helping us to develop it—this seems an appropriate thing for Caltech to do.

Many of us believe that the history of science in the 20th century is another appropriate field to do at Caltech. For one thing, there's the obvious reason that Caltech is a scientific and technological institution. The Institute is relatively young, and accordingly all its work has been done in 20th century science: in physics, quantum mechanics and nuclear physics; in biology, molecular biology and genetics; in geology, geophysics, geochemistry, and, more recently, planetary science. The story of the development of these fields is well worth doing and there aren't any programs anywhere in the United States in the history of 20th century science as such.

Generally, historians of science are centered in the 17th and 18th centuries, and they deal primarily with intellectual history, with the development of scientific ideas. By concentrating on the history of 20th century science, we would be filling an important academic gap. And by including the social, political, institutional, and economic history of science, especially in the United States, we would be doing it in a unique way.

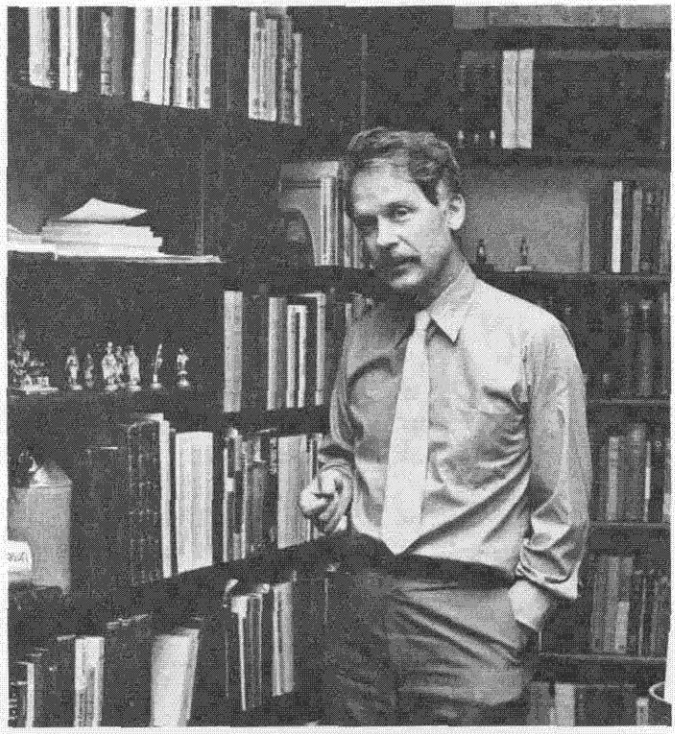
I should add that there is another and quite different reason for doing social science at Caltech. Financially, science in the United States has gone through its golden years and then its lean years in an almost cyclic fashion. In the golden years, the scientific community has managed to argue that what's good for science is *ipso facto* good for society. The public has in general been willing to go along with this notion in the golden years mainly, I think, because at those times it's been more interested in the enlargement of the economic pie than in its distribution. The lean years for science have occurred when the larger public has become concerned with social reform: in coping with the environment, with depressions, with social problems. At such times it has tended to mount something of a revolt against science, and to contend that we should be doing less to advance science and more to assure that the benefits of science are distributed and controlled in an equitable way. In the past the critics have fastened upon the social sciences as an intellectual and managerial instrument to achieve this end. You don't have to be especially well informed to know that they are doing the same thing today.

Considering the contemporary mood, the scientific community—and Caltech in particular—would be doing itself a disservice if it were to dig in against the social sciences. It seems to me that the scientific community would have served itself and the nation better if for the last 40 years, since the depression in short, it had paid more attention to the distribution of the benefits of science. I would be willing to argue that Caltech ought to commit itself to a program in the social sciences at this point in time precisely because the public is suspicious of the natural sciences. By doing so the Institute would be telling the public that it is not merely interested in advancing science at great public cost. It would be telling the public that, parallel and together with advancing science, it is also interested in helping to assure that science is used to good social purpose. In my opinion, that would be in the best interests of Caltech and science, not to mention the republic.

How is the division changing?

Peter Fay

professor of history



I think the division is going to be moving from its traditional middle ground out toward the ends of the scale —in both directions. We're going to be successful in developing quantitative social sciences of the same caliber and much the same kind of interest and specialization that the science and engineering disciplines have. And that's new, because this Institute didn't have any such thing—didn't even have that ambition—until four or five years ago.

On the other end of the scale I think we're going to grow in the "affective" area—the arts. I don't think we're ever going to have a formal course for Institute credit in piano playing or oil painting, but we may well have course work in art history or music theory, and facilities for art activity in the widest sense—visiting artists, practice rooms, and pianos, for example.

What really concerns me is the middle area of the scale, where English and history are. They have the two largest faculties in the division, and measured by either their teaching or their writing they're strong. But their range is narrow. We historians are almost all in either American or European history.

I think we've become so specialized because of the teaching requirement we've had. For years all incoming freshmen had to take European history and English, and all sophomores had to take American history. So we acquired a very large faculty in a very few subjects. If we're going to diversify—and I think a good case can be made for that—we're going to have to let our history and English faculty contract by a gradual process of attrition, and use those slots to widen our range. We could offer Chinese history maybe, or Italian or Latin American history, and some literature that's not English.

We're on our way to some of this because the requirements have been changed. Next year the freshmen will be offered a smorgasbord of courses that will fulfill the humanities requirement. I would define humanities as work which is not expressible in mathematical terms, that must be put into words. A course in which you read prose, in which you write, in which you argue in prose, is a humanities course.

That, of course, excludes the kinds of mathematical social sciences that our social scientists are pushing, and they're the ones who are pushing the show right now. We're hiring analytical political scientists instead of descriptive political scientists, for example; and economists who work with models but regard Galbraith as frivolous because he writes big surveys in prose for the general public. Some of our social scientists think if they can't do their work with mathematics, it isn't worth doing.

At least in the short run, that's the way things are likely to go here, and in some ways that's unfortunate. I'd like to have the descriptive faculty too.

It seems to me that we should have among the political scientists, for instance, someone who is interested in understanding the American or European political systems; and that he should start teaching with a descriptive recreation of past politics related to present politics. I know our students need this. The freshmen I teach simply do not understand, descriptively, how the American—or any other—political system works. They can't describe it.

A descriptive understanding of the whole has to precede analysis of any of the parts. I'm pretty sure that the analytical political scientist can't tackle the whole spectrum of politics, because some of it is too human to be susceptible to mathematical analysis. If you line up their articles—with all their mathematical analysis—in the end they won't, I suspect, give a total view. Educated people ought to have a reasonable understanding of the American political system as a whole, and for this some plain description is indispensable.

David Smith

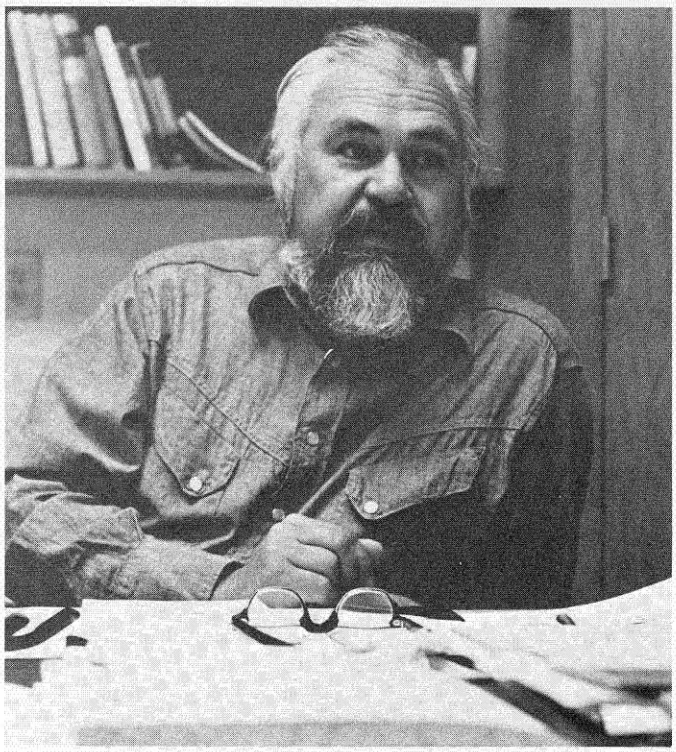
associate professor of English and master of student houses

One of the difficulties with work in the humanities here at Caltech is that it is so different from work in any other field. The social sciences and the sciences are rather alike in that their work is, in a sense, done publicly; it's very often done by groups of people. Humanities are done alone—in a closet thinking.

It's very easy to be a humanist here and to feel isolated, because there are not very many people doing what you are doing, and not many who understand the need for privacy and quiet and the singular effort that goes into it. And, indeed, we *are* somewhat isolated—or at least on the periphery of activities at the Institute.

What that sense of isolation—and lack of worth—can lead to is the loss of good faculty in the humanities. We have very, very fine scholars in the English and history departments right now—two or three of world reputation and several others of sound national reputation. We have to fight against losing people like that.

But we in humanities have to do something to establish a sense of activity on our own part, and we have to feel a sense of commitment by the Institute that humanities are really worth doing. I don't really feel that we need graduate students as much as we need support for our research and for leaves of absence. It's very difficult to get an outside grant if you're in humanities, no matter how good you may be, so the help the Institute does give is very much appreciated.



The tradition of the sabbatical has reasons, you know. At some point you have to have a means of getting out to get some perspective. I taught a course at Cal State, Los Angeles, and that did more good for my teaching here than anything that's happened in a long time.

The students at Cal State weren't the greatest in the world, but some of them were surprisingly good. They were mostly English majors. They were all seniors, but the class was evenly divided between men and women. I had a middle-aged nun, an old lady who was finding something to do with her time since her children were grown up, a couple of housewives, and some young students. That kind of change is really very exciting.

One thing we could do here is to admit a few people who are going to actually do humanities—in effect make the English major more a real major than it is. Now, it's for people who came here thinking they were going into the sciences, and defected. They say we're turning out a special kind of English major, one who can take a heavy load of science in his junior and senior year. But you can't really train an English major if he's spending half his time in the sciences any more than you could train a scientist if he was spending half his time in English. One kind of arrogance in a scientific institution is the assumption that it doesn't matter whether you're a good English major or not.

Two areas in which we ought to do more work are in the history and philosophy of science. So many kids come here accepting science as an absolute in itself—and even the scientists don't accept it as an absolute. Science is a cultural phenomenon, a product of the civilization and vastly influenced by all kinds of ideas.

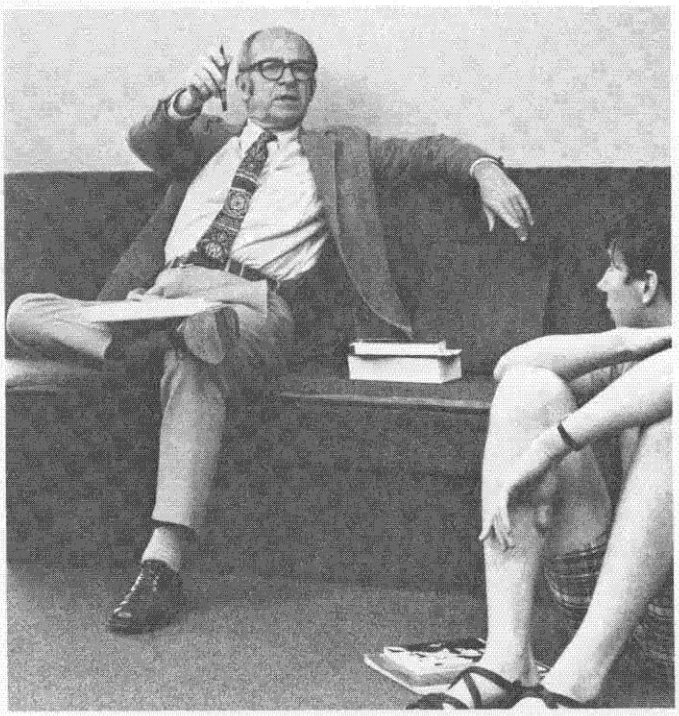
The "affective" areas at the Institute are pretty marginal right now, but there's a good deal of talk about enlarging them. Bob Huttenback is trying to move the division in this direction. Next year we will have two poets-in-residence, and I wish we could bring in an occasional novelist or musician. This is a grandiose dream, but why not increase our offerings in music—just a bit? Perhaps we could get instructors who are performing artists as well. With a little imagination, some shifting of priorities in the division, and a little additional money, we could begin to make this a more lively place.

As for the arts program, which is three years old now, unless we get some more funding, quick, it's going to fall apart. But there is a core—an exhibitions program, which I've been doing—and some artists-in-residence actually working here, and we ought to get more mileage out of them. They, along with the exhibitions program—to which we're absolutely committed—can be most useful in interesting community people in the Institute.

literature and the arts?

Charles Newton

lecturer in English



One area where we will encourage students to experiment is that of making films. The cost has been underwritten for three years by a gift from Frank Capra, who is an alumnus and a member of the humanities visiting committee.

Administratively, we don't expect this project to take a place in the curriculum, but several of us regard ourselves as contributing volunteer time to the supervision and organization of a student activity. The first year will probably be one of exploration—finding out what we need to know. This summer we want to decide what kind of professional help we need.

Some students are interested in film as an artistic creation; others want to use it as a means of communication. About 15 students have indicated an interest so far, and a few of them think they can put together a project that can qualify for independent studies credit—as students did at Harvard.

I think we are going to see surprising originality in some of these projects. Not long ago one of the undergraduates shot a time-delay sequence of the sun rising over Millikan Library, and then edited it together with some tape-recorded music so that when the sun's rays struck refraction angles in the lens, the music hit a big chord. It was good.

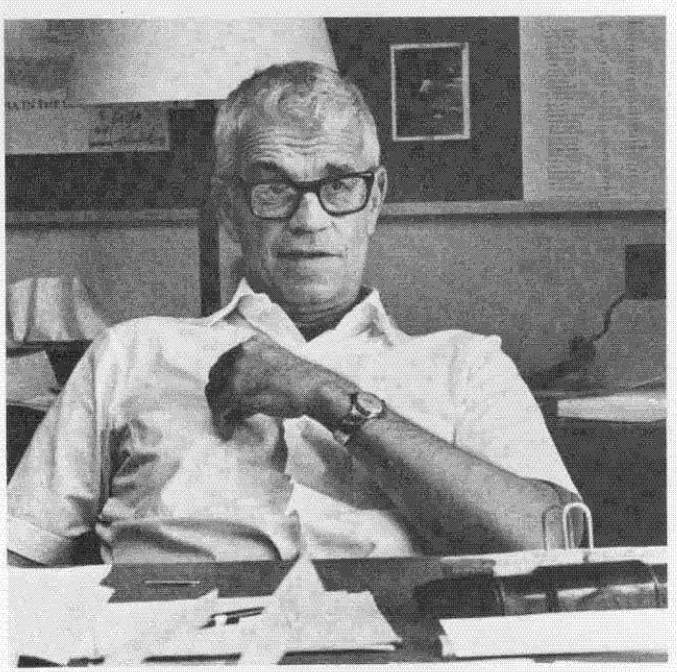
J. Kent Clark

professor of English

There is going to be a new emphasis on the visual and performing arts at Caltech, and we in humanities think it is going to help us do a better job of teaching. Forms of art like dance, drama, and film are creative and more immediately available to our students than some of the great literary art; they require less sophistication for an initial kind of appreciation and response. The visual and performing arts are valuable in themselves, of course, and they should also be useful in leading students from the simple to the more complex forms of expression.

In our age there is an intense and increasing involvement with morals and values. Combine this with the constant need for beauty, significance, and self-expression, and you get a natural concern with the humanities in general and the arts in particular. Here great literature is extremely important, because literature is an attempt to deal with values and behavior; with the intricacies of the human soul. This is, of course, why Dostoevsky, Shakespeare, Joyce, and Eliot, for instance, are so interesting and discussable today—and permanently important. Great art of this kind is always relevant and is to be distinguished from temporary flashes and fashion.

But literature usually requires a good deal of sophistication, both in reading and in experience. That is its great difference from, say, mathematics: Once you master a difficult abstract principle of math, you've got it; no richness of personal experience of feeling is required. It is humanities' job to help people become capable of dealing with complexity and sophistication in artistic and intellectual values.



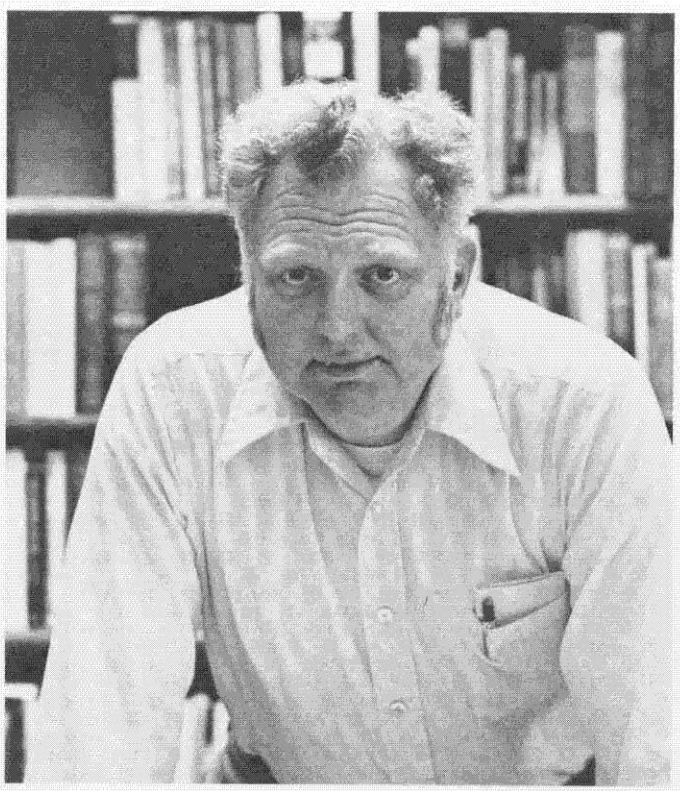
Why should Caltech get into the social sciences?

Lance Davis

professor of economics

Why should Caltech get into the social sciences? Well, a part of the answer is that we have some very, very fine undergraduate students who are beginning to find that the scientific world may not be just what they want. It seems too narrow, too confining, and not really relevant to some of the major problems that face the world. Secondly, we have already gathered a damn good social sciences faculty; with the additions we've made in the last two years we have a very powerful capability in the area that falls between economics and political science—what I call public choice.

Finally, and most important, many of the most pressing problems around the world today—while they frequently have an important scientific and engineering component—are basically social science problems. Caltech could go on doing first-class science forever, but if we want to do the stuff in the next 10 years that's as exciting as biology was 15 years ago, and as physics was 30 years ago, we'd darn well better get into social science. All the environmental problems clearly have a major social science orientation; and the same thing is true of population, of poverty, of the ghetto. Science can offer something, but social science is the major area concerned.



I want to see Caltech have a major role in the formulation of some really predictive theory in social science—theory that can be used to formulate rational public policy. Just as science attempts to structure theories that make sense of phenomena and allow you to predict what will happen, analytical social science needs to build theories that will be useful and relevant for handling problems. It's only through reasonable prediction that you can get any measure of control of your environment.

Economic and mathematical academic theory have had fantastic impact in the past 20 years. But in the political world, as yet there are fewer important uses of theory. That's principally because the theory has been so lousy. It's only been since the late fifties that we have had the beginnings of some very simple-minded analytical theory in political science. Now the work has become more useful in the sense of being able to predict in a reasonable fashion some behavior of a government institution. There's been a lot of work on things like the actions of congressional committees, or on small-group decision-making in such things as zoning boards—all of which has led to the beginnings of some sensible policy. If I were going to start over again, I'd be a political scientist. I think that's where the action's going to be over the next 10 years.

Some of the new people coming to the division are interested, and very competent, in applying this analytical methodology to problems that fall between economics and politics. Another group here says: "Look, economics hasn't been concerned enough with psychological aspects of problems. You'll have to modify some of your theories on the basis of personality and individual behavior." And the third leg of our program is provided by people who are interested in laboratory simulation of small-group behavior, or in field work in real-world situations—men who are attempting to bridge the gap between theory and the problems of the world.

So we have within the same operation quite different groups, which I think will interact with each other in ways that will provide us with a well-rounded program: the formulation of theory; the application and testing of that theory in the light of what happens in the world; and then modifications necessary to make that theory cope with the fact that you're dealing with individuals, not computers; and, finally, useful policy recommendations.

What will be the impact of social sciences on the humanities?

Rodman Paul

professor of history

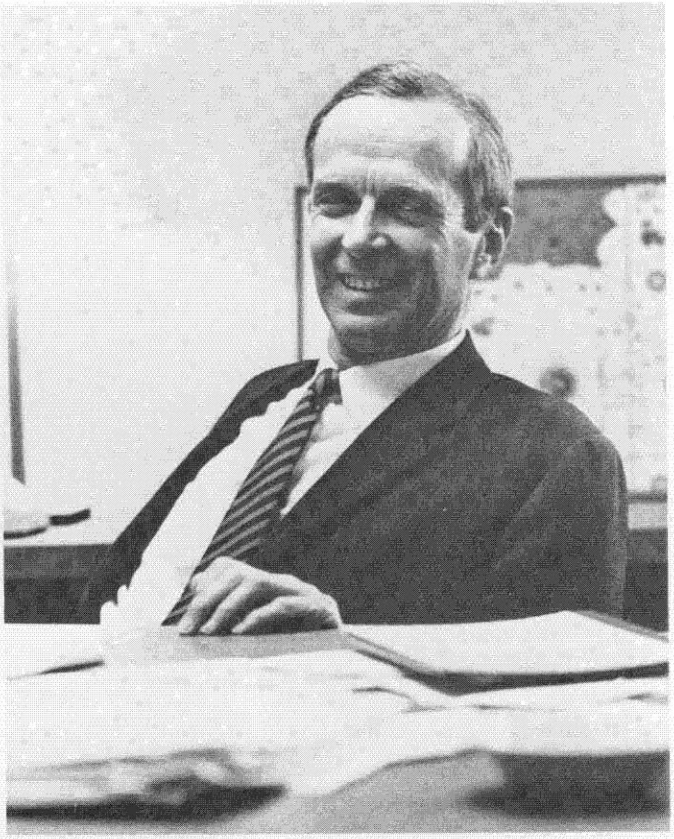
I'm not at all sure the social sciences, which are at last getting started, will really have a deep impact on most of the humanities. Indeed, in a superficial sense they will be competitive. We all know that; and yet, as a matter of faith, I believe the social sciences should be cultivated. But in the process I don't want to see history, literature, and philosophy neglected. Nor do I want us to neglect music, the fine arts, and drama—things we haven't ever done a great deal with here.

If this place remains small and in one nice building so that we can share students, lunches, and bull sessions, I think there's a fair possibility for fruitful interchange on an individual basis between the social sciences and the humanities. But a handsome building is not in itself a guarantee of that. At Harvard the chairman of one department complained to me that his new little sky-scraper kept his scholars vertically fragmented; and at the University of Pennsylvania another said that their brand new sprawling headquarters made for horizontal fragmentation. Maybe we need a cube.

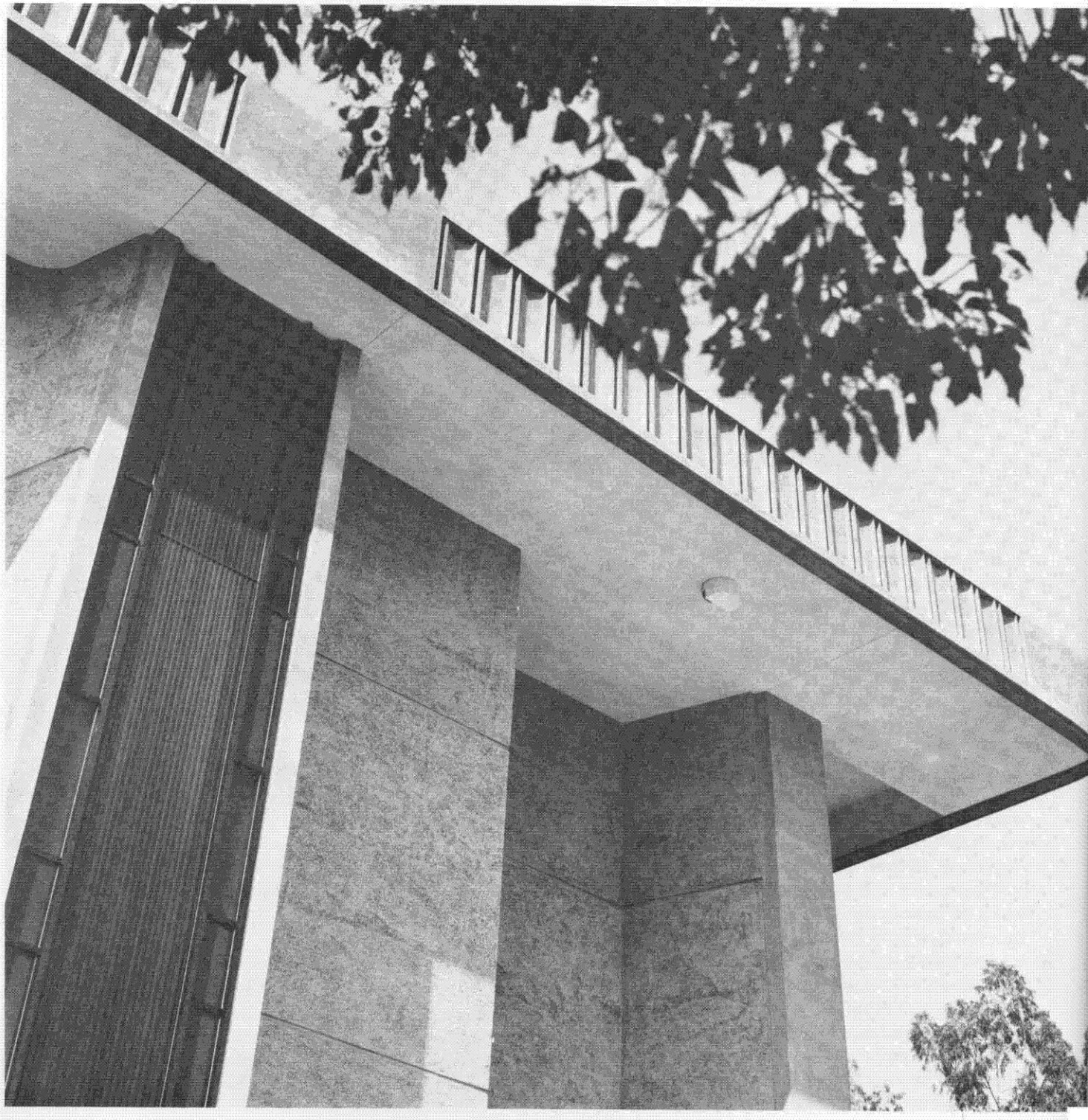
Graduate work in the division will no doubt always be very selective, and it should be. I think graduate work in the social sciences will come very quickly; and graduate work in a few highly selective areas of history might be quite logical. But there will never be a broad-scale attack on the social sciences; we would have to change the whole nature of the place, increase it to an unmanageable size, to do that.

There's a lot of debate as to the function of humanities, and it's harder to define that than it is to define the function of the social sciences. Ask yourself, for instance, why we have historians around this place. Well, I've been here since 1947 teaching undergraduates, and I've long since outgrown the notion that it was to make cultivated gentlemen out of them. We do help give them a more rounded outlook, so that their education will not be hopelessly one-sided. But we in the humanities have a chance to offer them not only useful information, but subjects that lead to a consideration of values, which may lead them to form their own values. And we can help them get fun out of life—a sense of beauty, a sense of pleasure.

The key to the whole thing is to get first-rate people. Many of the first-quality people in the nonscientific areas are reluctant to come to Caltech because it seems an alien environment. A great many are afraid to come to a place where so many of their colleagues speak another



language and think in an unfamiliar way. So, there have been a great many difficulties over the years in recruiting the best people. To a great extent the only people who have stayed and have been productive in their fields have been the loners, people who don't need to be surrounded by a crew of admiring graduate students, research assistants, and colleagues; people who aren't afraid to be in a community where many people won't understand them. I've often said that Caltech should pay bigger salaries to nonscientists than the national going rate, and provide better research support than is available elsewhere, in order to increase the material attractions of teaching here.



BAXTER HALL– A LABORATORY FOR THE HUMANITIES AND SOCIAL SCIENCES

"We visualize the humanities building as a setting for courses focusing on the enormously complex problems of being a man—a creature who feels and dreams, loves and hates, hopes and despairs. Life is not confined to equations and laboratory experiments."

Hallett Smith, chairman of the division of humanities, was writing to Arnold Beckman, president of Caltech's board of trustees, in 1966, to describe the kind of home his faculty wanted for the humanities and social sciences.

The letter continued: "A building which houses these activities should symbolize the spirit in which they are pursued. It should not be stark or austere. It should have dignity and beauty. It should be spacious enough to encourage thought and contemplation. Let nobody ask of it what a passing tourist once asked about another Caltech building: 'What do they make here?' In the ideal humanities building, people make thoughts and insights and value judgments. The building should give that impression, even to a tourist."

The years between that letter and its culmination in the dedication of the Donald E. Baxter, M.D., Hall of the Humanities and Social Sciences on May 10, 1971, were a time of much thought and planning, hard work, and generosity. And they saw the continuation and enlargement of an idea with a 50-year-long tradition in Caltech's history: the idea that the humanities must be an integral part of the education of every Caltech undergraduate.

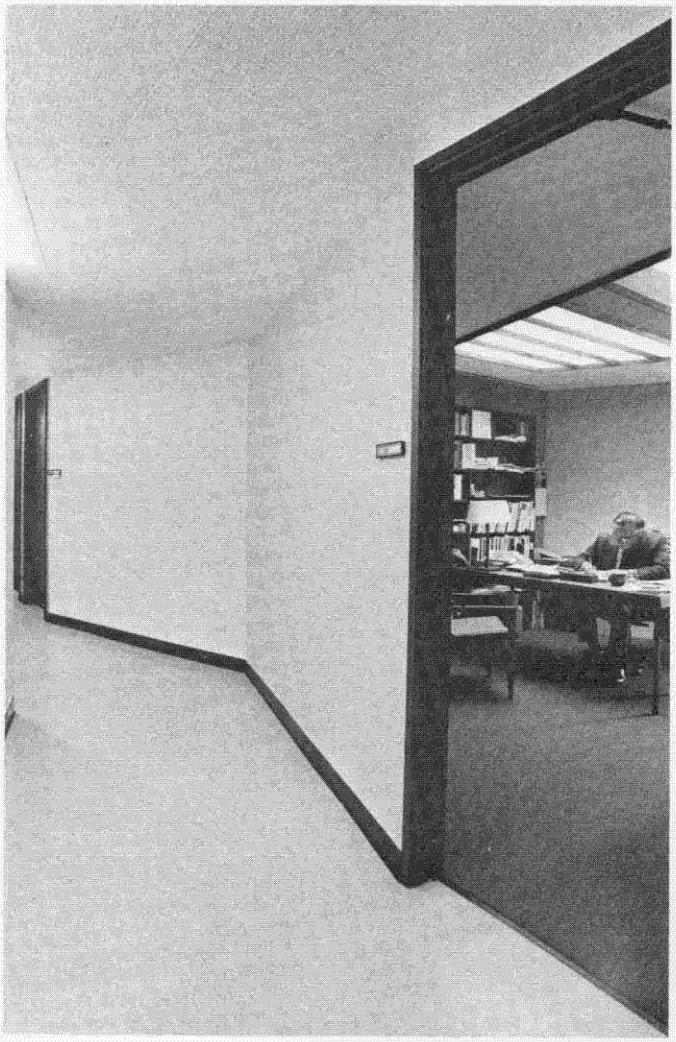
The first home for the division of humanities was provided by Mr. and Mrs. Joseph Dabney in 1928. At that time, tuition at Caltech was $250 a year, the graduating class numbered 69, and there were 10 men on the humanities faculty. For them, Dabney Hall must have been spacious, but as the number of humanities courses and faculty grew, the building seemed to shrink. Finally, in 1962, the campus building committee allocated space to replace Dabney with a larger building on the north side of San Pasqual Street.

Robert Alexander, a Los Angeles architect and a fellow of the American Institute of Architects, was chosen to create the building described in Hallett Smith's letter—possibly because he saw it as every bit as much a laboratory for the humanities and social sciences people as a physics or chemistry laboratory is to *its* occupants.

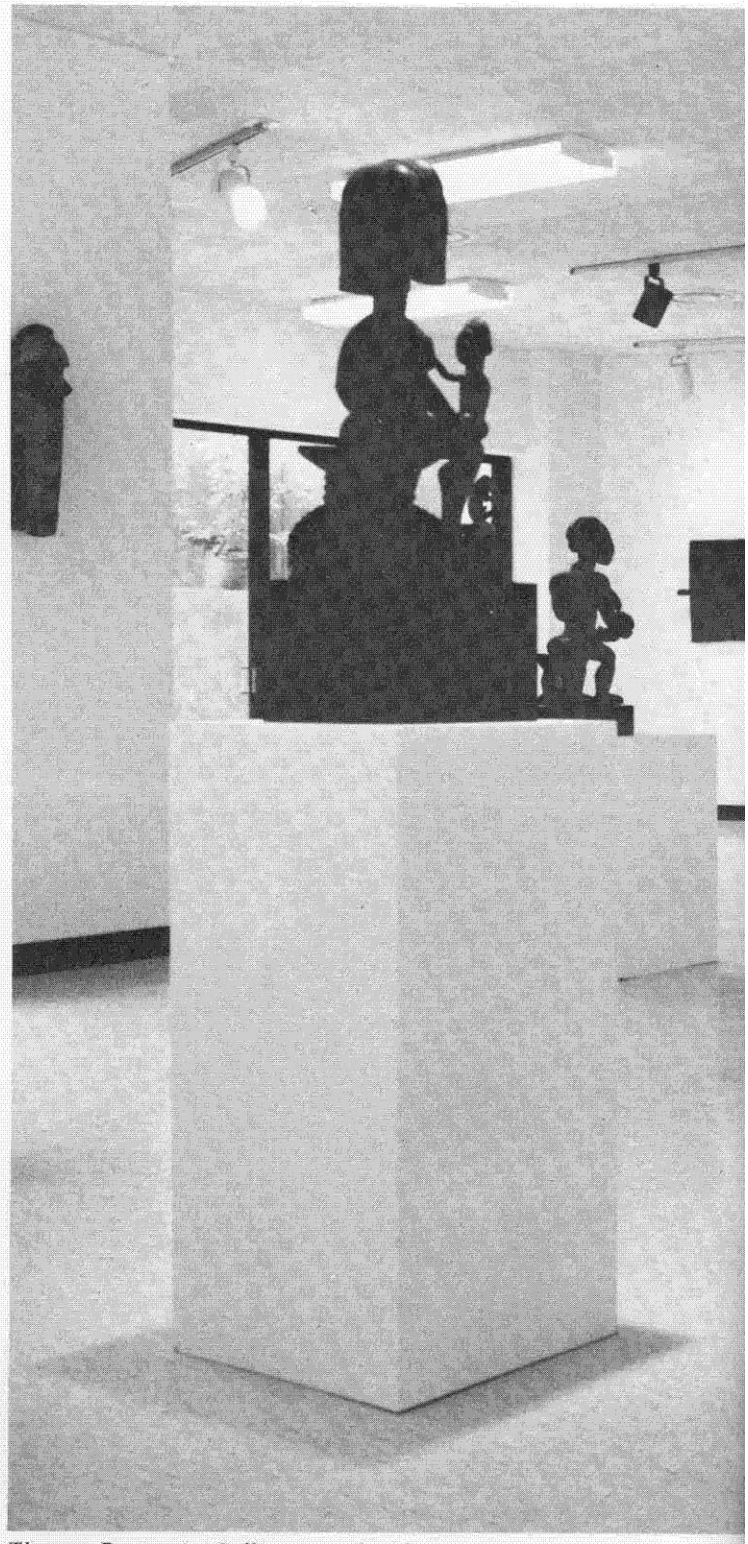
Although Alexander signed the contract to start the building plans in 1966, its reality was not assured until November of the following year when Mrs. Delia B. Baxter of Atherton, California, made the largest single gift ever presented to Caltech—$2.8 million—with the suggestion that it be used "to build, equip, and maintain" a humanities and social sciences building. It was to be named in honor of her late husband, Donald E. Baxter, M.D., who pioneered in the development and production of solutions and associated medical equipment for intravenous therapy, and who founded the American Hospital Supply Corporation.

The Baxter family had a longtime interest in Caltech, going back to before Dr. Baxter's death in 1931 at the age of 53. The Baxters at one time lived on California Boulevard two blocks east of Caltech, and their children viewed the campus as the place with the biggest yard in the neighborhood.

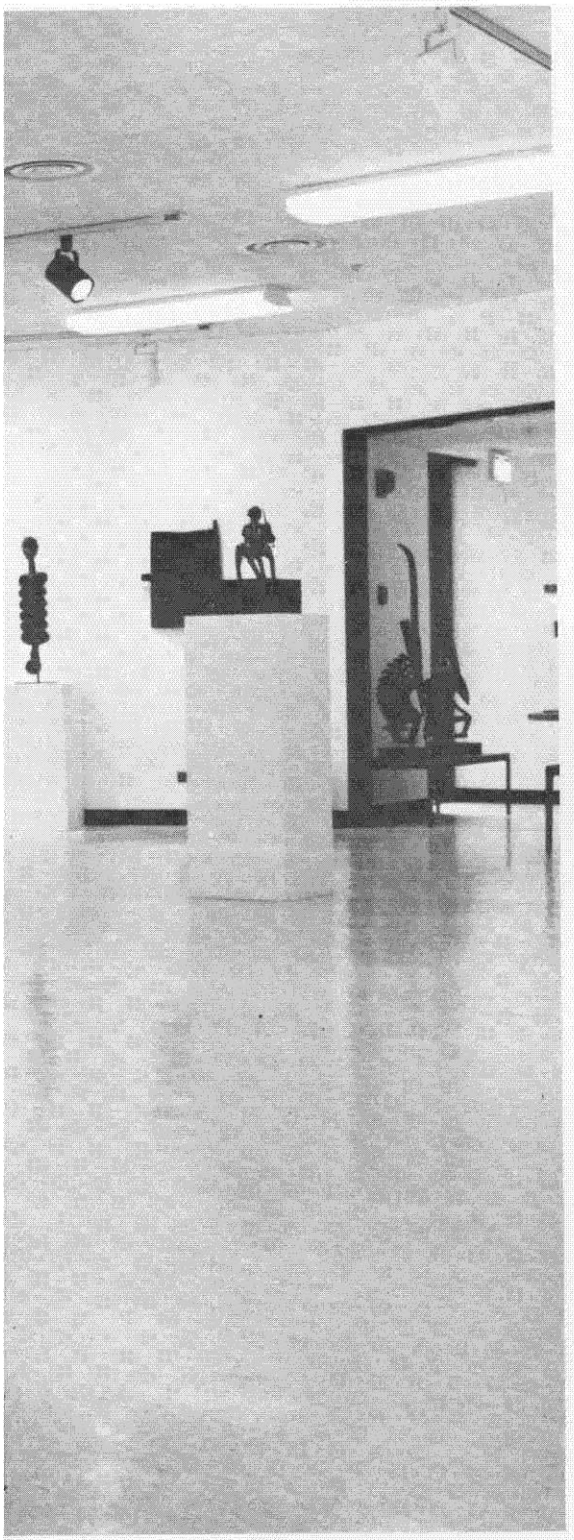
The formal announcement of the Baxter gift was made by Governor Ronald Reagan at a November 8, 1967, dinner heralding the start of Caltech's $85 million development campaign. By the time of the groundbreaking ceremonies in May 1969, Simon Ramo, a Caltech alumnus and trustee, and his wife, Virginia, had given

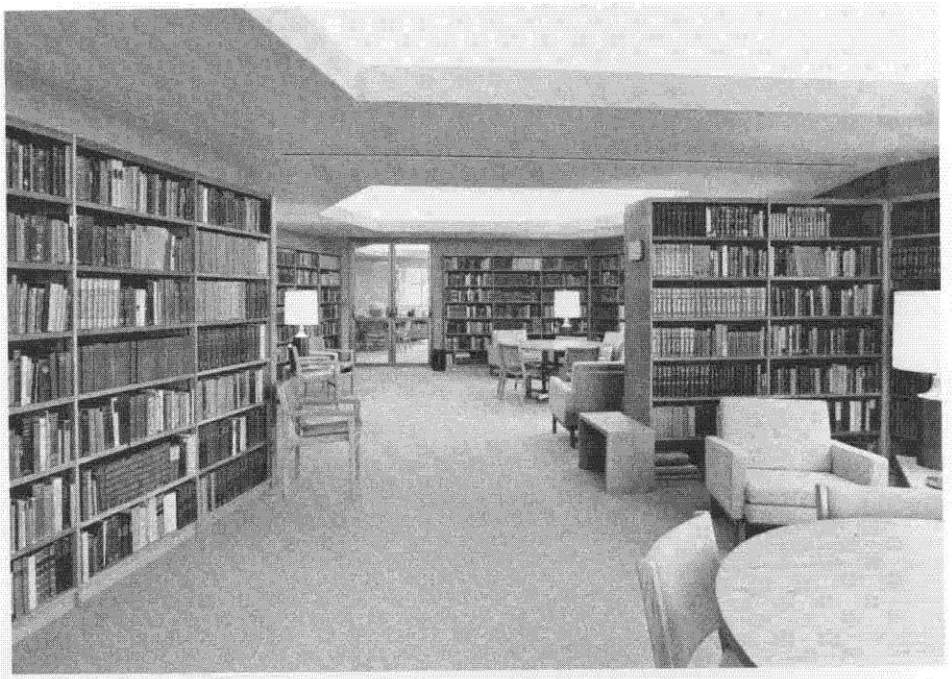


Angled corridors and hexagonal offices are a Baxter trademark. They are designed to counteract the monotony and formality of long straight lines and cubicle rooms.



The new Baxter Art Gallery opened with a show devoted to the Victor DuBois Collection of West African Art. From 100 to 300 people visited it every day for five weeks.





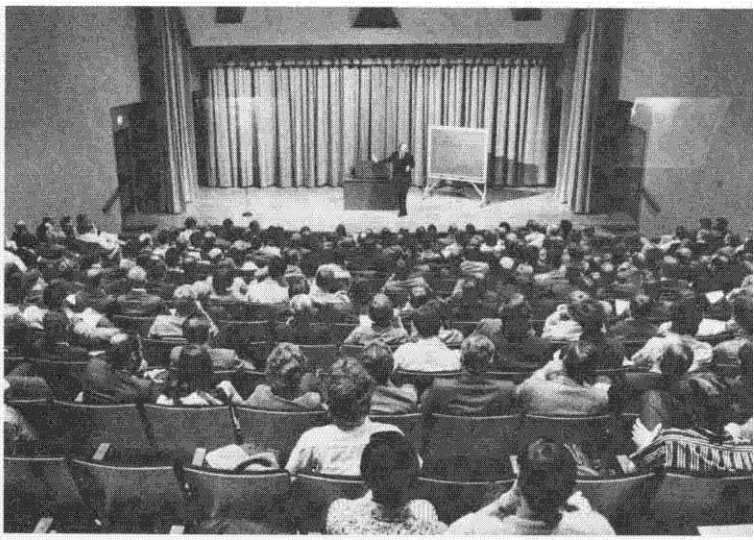
Spacious and inviting for browsers or serious readers, the Clinton K. Judy Memorial Library is housed in Baxter Hall.

money for an auditorium inside the Baxter building—Ramo Auditorium. The U.S. Department of Health, Education, and Welfare gave funds for additional facilities.

Caltech's new humanities and social sciences "laboratory" expresses an entirely different concept from that of any other building on campus. In 1962 the specifications suggested 36,000 square feet, but the actual structure has 62,513, designed on the principle of the hexagon—three hexagons across, and with interacting subdivisions of hexagons. Even the foyer floor tiles are hexagonal, and the wall lighting fixtures also carry out that shape. The study-offices are long hexagons, and the smaller offices are half that. Hexagon-shaped rooms and double-sized offices had been tried out in the old library section of Dabney Hall, following the removal of the humanities library to Millikan. The consensus was that they helped communicate a warm and informal quality hard to come by in the conventional square.

Baxter's hallways are angled, which banishes the sterile aspect of long, straight corridors. They also incorporate conversation areas with groupings of furniture that encourage casual meetings among faculty and students.

Among the other features of Baxter Hall are a large art gallery and an expanded Public Affairs Room. Two special book collections are also housed in Baxter. One is a browsing library of English and French literature with its concurrent history. These books are from the library of Clinton Judy, chairman of the humanities division from 1923 to 1949. The other special library is the Africana collection belonging to Edwin S. Munger, professor of geography.



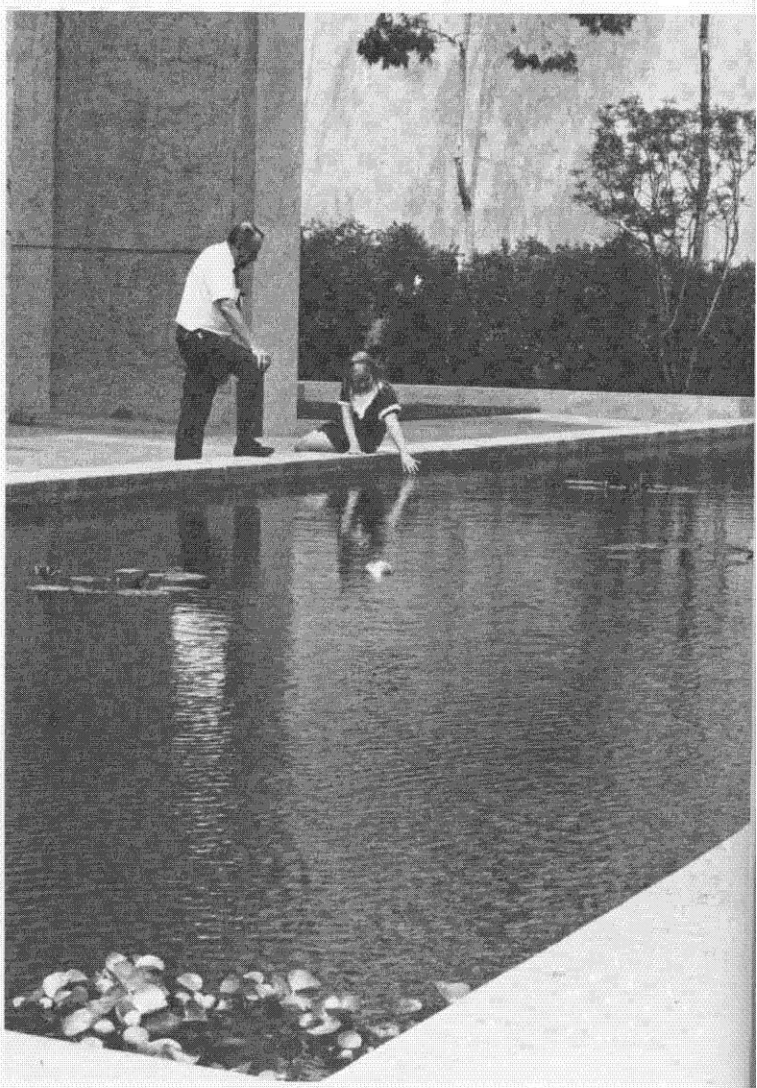
Ramo Hall on the first floor of Baxter is a 435-seat auditorium—the gift of Caltech trustee and alumnus Simon Ramo and his wife.

Almost 9,000 people visited the art gallery's first exhibit, which opened on April 6. On display were African artifacts, collected over a 12-year period of travel and study by Victor DuBois, a member of the American Universities Field Staff.

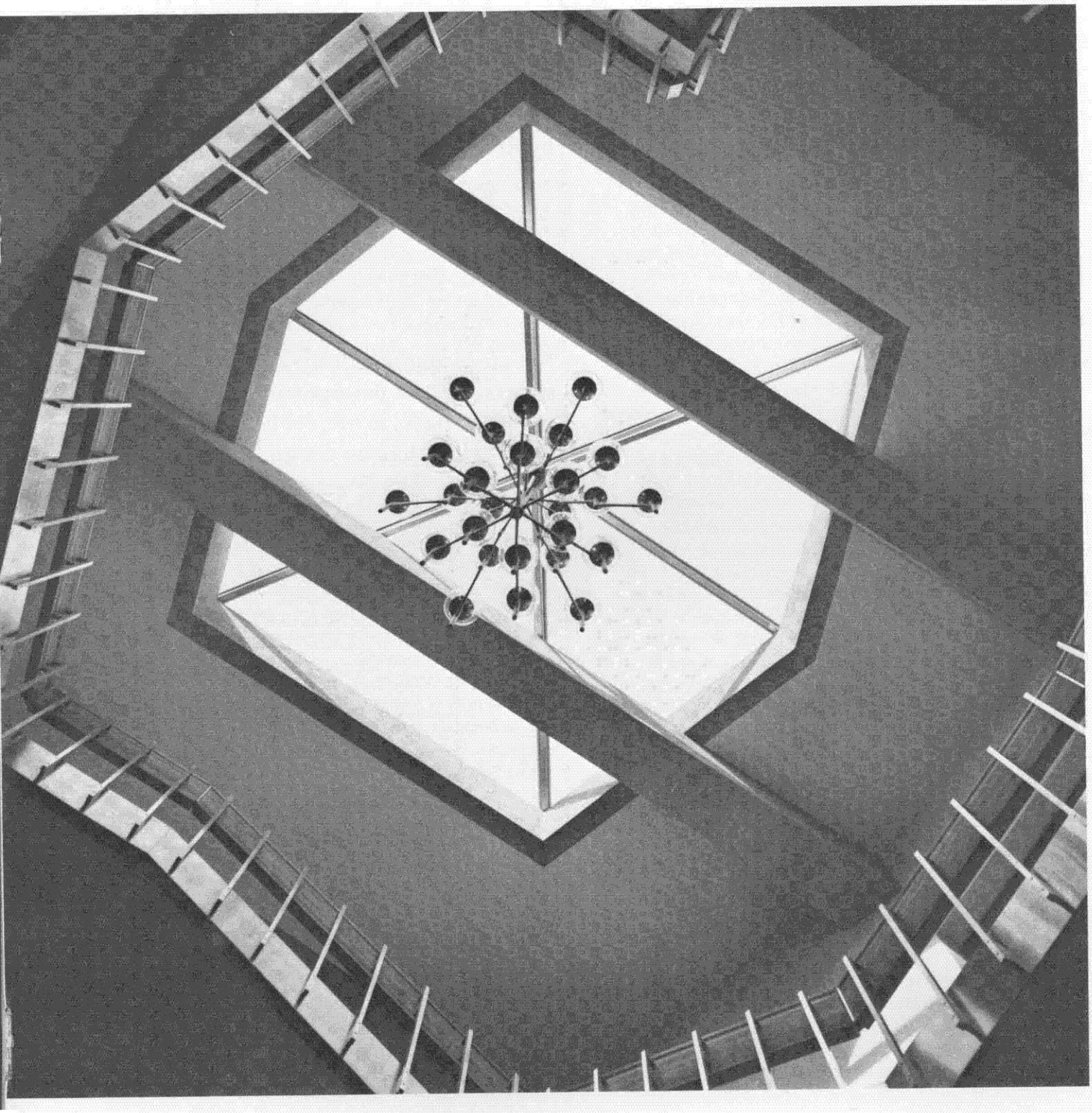
Ramo Auditorium is a sorely needed middle ground between the larger, more formal, Beckman Auditorium and the shabby discomforts of Culbertson Hall. The handsome 435-seat theater-like auditorium is already booked far ahead for lectures, intimate musical and theatrical presentations, and film showings. Baxter also has a 297-seat lecture hall.

Since the 54 members of the faculty and staff moved into Baxter at the end of March, they have found the building itself a good teacher. Architect Alexander, who says it is the best building he has ever done, is pleased when he hears a faculty member's report that students talk more in seminar classes in Baxter than they did in Dabney. Some of the faculty insist they can get far more done in their new offices than they could across the street—an idea confirmed by one of the secretaries who said: "I go home exhausted every day. Moving into this building has acted like pep pills on everybody!"

Not quite everybody all of the time, of course. Symbolizing fulfillment of some of Hallett Smith's original thoughts about the function of a humanities building is the pool along the south side of Baxter. Often a quiet few people are there—leaning over the edge to watch the carp gliding in and out among the water lilies and demonstrating that "life is not confined to equations and laboratory experiments."



Pools are places for reflections—of buildings and trees and thoughtful people. The Baxter pool includes water lilies and golden carp.



A TIME OF METAMORPHOSIS

by Robert L. Sinsheimer

We are facing an identity crisis for the species, a rite of passage from life in a world we never made, to life, for better or worse, in a world of human design.

I expect that I have been invited to speak here as the spirit of buildings future. As you know, we hope to construct a phenocopy of the Baxter building—a laboratory of behavioral biology—across the mall. In fact, I am pleased to invite everyone here to its dedication —date to be announced.

When completed, these two buildings with Beckman Auditorium will form the Court of Man—a giant tuning fork to resonate with the deepest human and social vibrations. Good vibes, we hope.

I had thought of writing a little scenario in which the Caltech citizen of the future is wandering up the mall, on his way to Beckman Auditorium, to hear a lecture on the plans for the new 500 TEV (trillion electron-volt) accelerator—designed to utilize the magnetic field of the planet Jupiter—a joint project of our Divisions of Physics, Planetary Science, and the JPPL (that's the Jupiter Particle Propulsion Laboratory), when said future citizen becomes aware he is running a gauntlet. On the right he is subject to the hard-eyed scrutiny of the economists and social scientists, who view him as a sort of aberrant social molecule in an unstable excited state; while from the left he receives the covetous glances of the psychobiologists, who see him as the somewhat hapless but complex integral of his genes and his experience *and* as a potential experimental subject. Fortunately, there will still remain the humanists, who will simply accept him with eloquent affection and admiration.

But I could not continue this sanguine scenario, for in truth I do not see the future—at Caltech or elsewhere—to be any linear projection of the present. I know that a dedication is customarily an occasion for self-congratulation and euphoric prediction, and I believe it *is* particularly

"A Time of Metamorphosis" is adapted from a talk given at the dedication of Baxter Hall on May 10, 1971, by the chairman of Caltech's biology division.

significant that we are dedicating a hall of humanities and social sciences at a great institute of technology in this peculiar and pregnant period in history.

But there is today a growing apocalyptic mood. It becomes ever more clear that as we approach the beginning of the third millennium A.D., we are hurtling through the closing decades of a very long era, that we are caught up in the tide of an inexorable period of change in human goals and values, on a global scale, without precedent in all human history.

That we face successive waves of confrontation: between western man's persistent urge for material wealth and physical power, and the finite resources of the planet; between the familiar values—hallowed by success—that have brought us out of an age of helpless scarcity, and the strange values—tentative and awkward in their newness—appropriate to an age unchained from want. Confrontation between our increasing need for knowledge and our increasing hesitance to bear its responsibility; between the dream realized and the reality achieved, as for example between the very human wish for immortality and the staggering consequence of its possible approximation. Confrontation between our treasured but often rigid and egocentric conception of individual human rights and our ever increasing human interdependence. Confrontation between the rational on which our very lives must henceforth rely and the intuitive and irrational—so deeply imbedded in our nature—on which, in our impotence, we have for so long depended.

In brief, we are entering into a time of metamorphosis for man, of dissolution of the old in the creation of the new. As a result we are facing an identity crisis for the species, a rite of passage from life in a world we never made, to life, for better or worse, in a world of human design.

Man has evolved through millions of years into a creature adapted to his planet; sustained by its web of life, favored to be increasingly preeminent among its forms. Whatever mistakes man made (and surely there were many) were never collectively fatal because of the resilience of the web and the growing security of his place in it.

Now with our exponential increase in numbers and in power we have come to our Rubicon. The ancient sustaining web is tearing, and we must soon choose. We may retrench, and it will heal, at the psychic cost of profound human restraint; or we may deliberately undertake to design a new web of support—to human specifications—literally to engineer the planet for man. The cost again will be psychic: the knowledge that we are truly on our own *and* that we are fallible. Again, a confrontation—of diffidence and daring or, some may say, of humility and hubris.

Few, if any, can foresee the shape of the civilization that will emerge from the years of turmoil. Or, more pertinent, what will be the role of science and technology?

For five decades this Institute has built upon the academic legacy and vision of Millikan, Noyes, and Hale, and it has built well. We have gathered here the finest concentration of scientific and technological talent on earth. We attract annually the most brilliant students from the schools and the colleges of America.

But we must not assume that the inspired vision of the founders will never need a re-vision, an adaptation to the light of the time. After 50 years, in a time with new insights and new shadows we should reexamine our course, neither shackled by success nor contemptuous of continuity. How should we prepare our students for this time of metamorphosis? It merits much thought. I would suggest now three, admittedly partial, answers:

First, to continue to do well that which we have done well—to transmit and expand scientific knowledge. Man must still have need of science and technology. The principles of quantum mechanics and thermodynamics, the theorems of Fourier and Gödel, the laws of Newton and Maxwell, the rules of valence and the genetic code—these are not about to be repealed or become obsolete.

Our insights into the nature of matter and life, our vision of the dimmest past and the farthest space, our recognition of the continuity of life and the universality of natural law, our dawning perception of the biology of mind—these are the illuminations that science has brought to man. They extend the human horizon, and they will be an enduring part of any civilization.

But we must remember that in science to continue to do well is to continue to change and change again as the unknown unfolds and the human perspective evolves.

Second, to enlarge greatly our educative mission, to accept a far wider role in the creation of scientific literacy. The scientific illiteracy of the bulk of the population, in a society obviously dependent upon technology, can lead only to fear and mistrust, to apathy, to erosion of self-confidence and of self-government. In a recent literary magazine, one may read: "For the first time the forward-vaulting intelligence of our species, so intricate yet so vulnerable, a piece of systematic evolution, finds itself in front of doors it may be best to leave unopened; on pain of life."

On a dimension of good and evil, fear lies well toward the latter. And the worst fear, the impenetrable fear, is the fear of knowledge itself. This is a plague of the spirit, and we must prepare to meet it.

The fault lies with the schools, with the media, and above all with us who have the knowledge but have not been concerned with its diffusion. Fortunately, today the means exist if we are equal to the task.

In a quieter day Santayana wrote, "He who does not know history is condemned to repeat it." The analog for today should be, "He who does not comprehend technology is condemned to serve it."

And third, we will need to learn to infuse our technical education with ethical concern. Those words sound curiously old-fashioned, with images of stained glass and stagnant rhetoric. But in a time of metamorphosis new purposes and new values are needed to inspire new enterprises. To focus upon scientific excellence but neglect ethical concern is to lower the sights of humanity. Such a practice must also breed scorn and ultimate frustration for science, in the denial of its own values.

We can no longer rely upon the inherited framework of values to shelter us from the harsh burdens of decision. Science and technology have created, irreversibly, a highly interactive society. The principles governing such interaction have long been the concerns of morality, but the novelty and intensity of these interactions and the consequent depth of their impact upon each individual have grievously strained the fabric of the accepted morality. We can no longer optimize subsystems without concern for the whole. The values of the past are inadequate to the present and if undeveloped are helpless to contain the future.

If scientists wish to serve fully in the formulation of the new age to come, if we wish to be more than the "political eunuchs" and "servile automatons" our critics decry, then we must indeed be well prepared to shoulder our share of the burdens of decision. Our students will need practice and experiment in the realization of the values implicit in their acts, in the clarification of alternatives and the calculations of consequence, in the achievement of decision and its continued reflux—and thus, in the conscious, heuristic, and humane formulation of values for a new time. Just as we educate in the laboratories of science, so I believe we should educate by exposure to and experience in the laboratories of human decision, wherein judgments of social value are made every day—in the courts and in the hospitals; in the nursery schools and in the planned parenthood clinics; in the prisons and the asylums; in the regulatory agencies and the legislatures and the executive offices.

Our values must change to match the new reality, the new freedoms and the new constraints, as we emerge, collectively, from the childhood of the race.

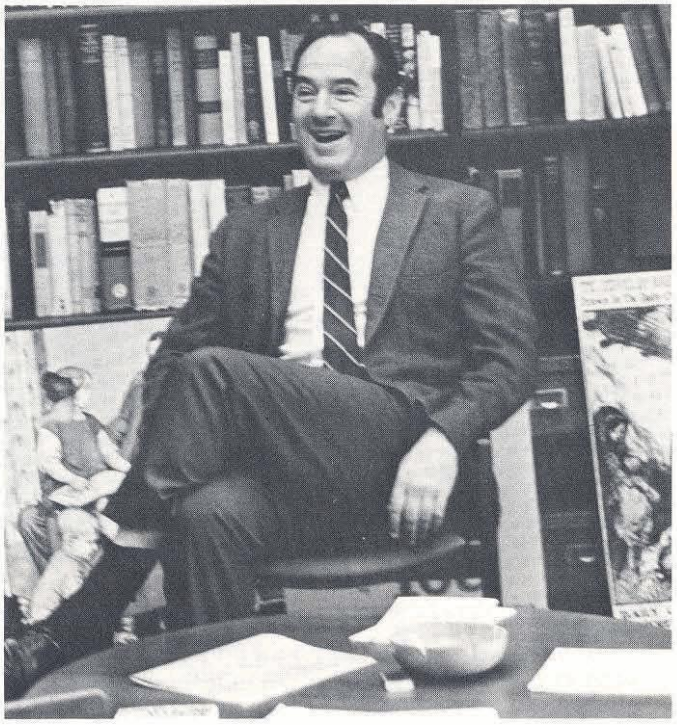
What I have said is not new, it is only more urgent.

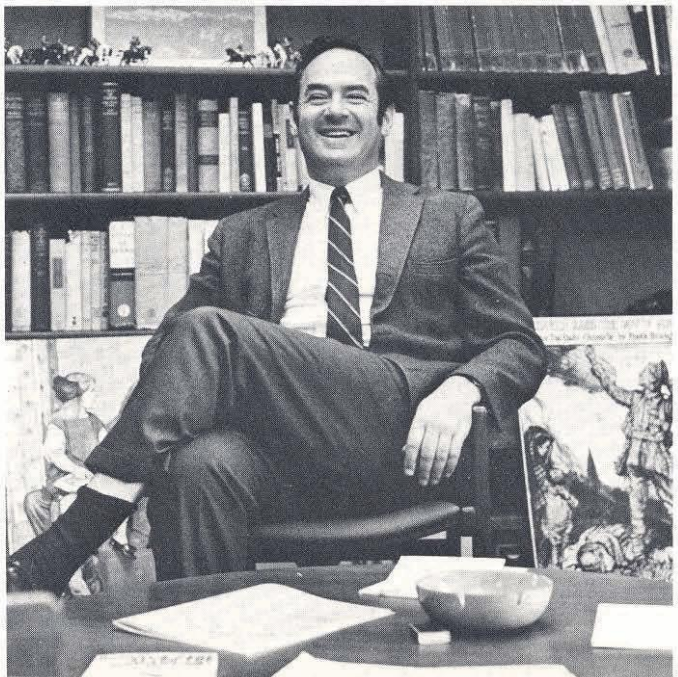
To look at MIT is often to see ourselves in a somewhat distorted, but surprisingly faithful, mirror. In the recent report of the Commission on MIT Education we may read: "Despite all the changes of the past decade there remains at MIT a decided bias against humanistic learning . . . Too many faculty members and students continue to think of the humanities, the social sciences, and the arts as unimportant, irrelevant, and methodologically soft. The structure of the curriculum encourages students to relegate such studies to a minor, secondary role . . . We must encourage a broader view of learning and a deeper engagement with questions of value in the scientific and technical disciplines themselves."

Forty years ago, Albert Einstein spoke to the students on this campus. In his brief talk he said: "It is not enough that you should understand about applied science in order that your work may increase man's blessings. Concern for man himself and his fate must always form the chief interest of all technical endeavors . . . in order that the creations of our mind shall be a blessing and not a curse to mankind . . . Never forget this in the midst of your diagrams and equations."

In ancient Egypt the jagged shapes carved on the horizon were the pyramidal tombs of personal glory; in medieval Europe, the holy cathedrals of a common human hope; in the twentieth century, the skyscrapers of impersonal, corporate commerce. What forms shall shape the horizons of the future society?

At this dedication of Baxter Hall I would ask those who will dwell here always to remind us of what we in science are coming slowly to see, but they have always known: that the proper study of mankind is man—that the ultimate challenge is man—and thus that the ultimate goal of science must be to explain man as a product of nature and thereby to set him free.





Energy Unlimited

Huttenback's Law says that energy begets energy; it also produces a lot of solid achievement.

Those to whom Robert Huttenback is only a name may wonder how a Caltech faculty member can simultaneously teach, manage a constant flow of research, run the division of humanities and social sciences, and be dean of students. Those who observe the torrential Huttenback energy at work don't wonder at all. It is the hallmark of the man.

Huttenback's Law says that energy begets energy. He starts his mornings with either a couple of sets of tennis or a two-mile jog through the quiet streets of San Marino, where buses of school-bound children watch for and wave to the man in the old blue sweat suit.

His energy also floods out into a passion for games, and his life style is reminiscent of the often unorthodox way he plays and coaches them—an unorthodoxy based on a grand impatience with red tape, and on a good-natured conviction that people don't always use common sense. If, as player and coach, he shows a strong self-confidence, imagination, and an ability to make and execute decisions, it is equally true that he is insistent on seeing that details are attended to and that differences in personalities are recognized and respected. These qualities that have brought him loyalty and respect on the playing field are also descriptive of his handling of the successive jobs as house master, dean, and acting division chairman.

A coaching job brought him to Caltech in the first place. Back in 1950, when he was a UCLA senior and captain of its soccer team, he happened to be in the gym office when a call came from Caltech's athletic director, Harold Musselman, wanting somebody to coach soccer here. Huttenback volunteered.

To toughen up the Techers who unwittingly turned out for soccer under the new coach, he immediately ran them

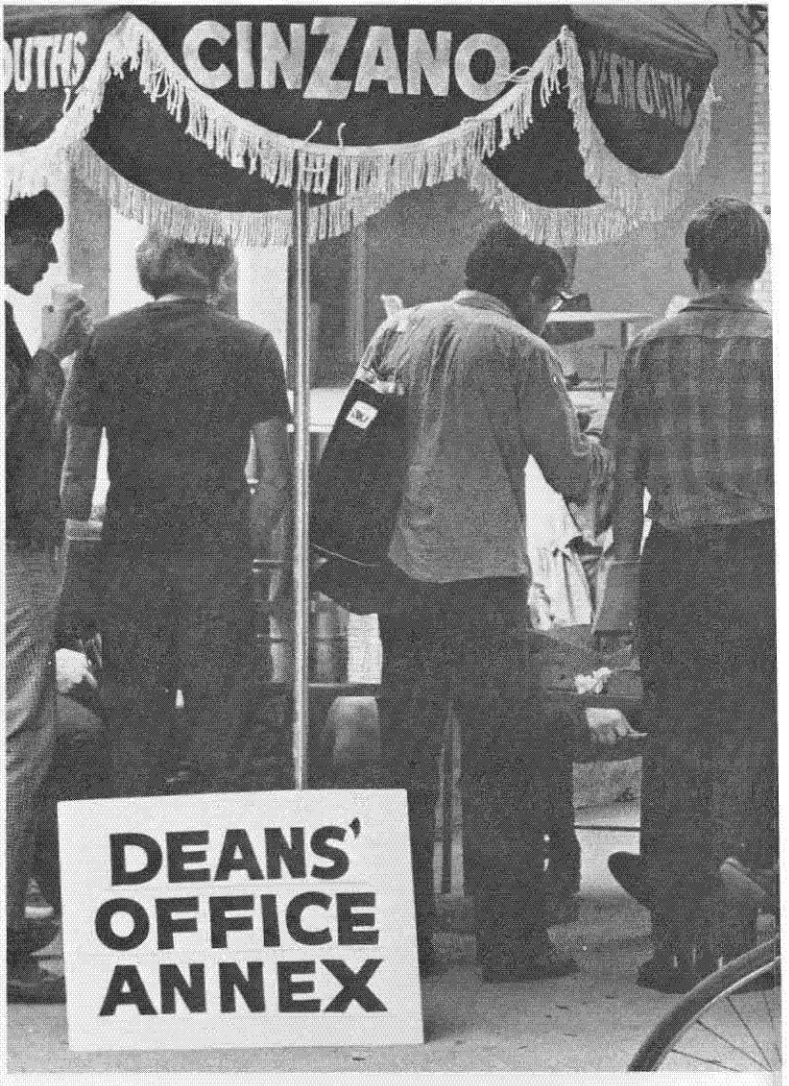
for several miles. This coaching method cost soccer some participants, but it winnowed those who had dedication and stamina. It also seemed to pay off, because the team had a magnificent record of achievement and eventually even beat UCLA.

Huttenback's introduction to football as a freshman at UCLA delighted him, not only because it was fun, but because he discovered team membership also meant clean socks every day and an occasional free meal. He also played rugby, cricket, and soccer, and ran a flourishing intramural touch football league that flattened all but the Bruin Nisei Club.

His liking for such sports as rugby, cricket, and soccer dated back to early childhood years spent in the games-playing English school system. His mother had been a child piano prodigy from San Francisco who spent several years studying with Europe's top teachers. She cut a concert career short to marry Otto Huttenback, a member of a wealthy old Jewish family in Frankfurt, where Bob Huttenback was born. The Huttenbacks were among the many families who fled Germany during Hitler's rise to power.

Otto and Dorothy Huttenback, with Bob and his older sister Peggy, settled in London; and Bob, who had been registered at birth for the famous old public school of Harrow, spent his prep school years at Highfield School in Hampshire. At the age of eight, he was the youngest boy there, having—in the traditional English manner—been bundled off with a trunk full of newly tailored gray flannels, Eton jackets, blazers, and a boater hat.

At Highfield he endured the standard inconveniences

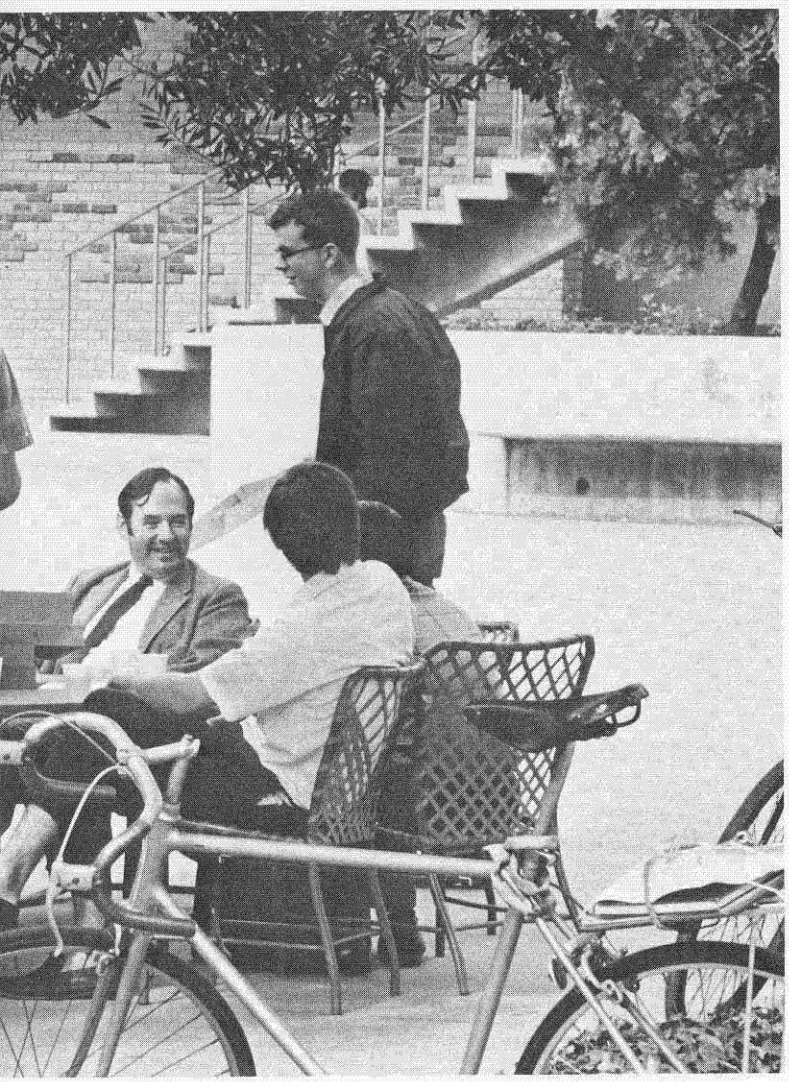


of canings and early morning cold showers, along with the classic rigors of Latin, Greek, and mathematics. But of course there were always those games to play.

The family was visiting in the United States when World War II enflamed Europe. Since they had no deep ties in England, they settled in Los Angeles with no plans to return, and for Bob Huttenback, Beverly Hills High School became a substitute Harrow.

He had always been allowed a free rein to develop in his own way, which contributed to a certain maturity of attitudes. As a teen-ager he chafed under high school's stringent rules and enforced social activities. He never saw the necessity of following the flock.

His ensuing four years at UCLA were a revelation. The big school was made to order for him—with the freedom and anonymity one could have if one chose. He says this environment influenced him as master of Caltech's student houses and still marks his philosophy as a dean. Every student has what he terms the God-given right to flunk out, and one of the foundation stones of his beliefs about adults, young and old, is that they



The deans' office in Throop and the chairman's office in Baxter are too far out of student orbits to suit the ex-master of the student houses. So, every now and then, Bob Huttenback sets up a branch office in Winnett Plaza.

should be able to choose not to be saved from their own errors and shortcomings.

At UCLA he was not a big-man-on-campus. Fraternity life didn't interest him, and he considered campus politics an exercise in futility, since students had no real power. He is much more inclined to favor campus politics today, now that students have acquired more control over their academic environments.

Huttenback's academic preferences at UCLA were history, political science, and economics. As might be expected, his minor was physical education, and he thought he might like to be a professional coach—an ambition that waned when he joined the army after graduation in 1951, and found himself running an athletic program in the vast khaki world of Ft. Bliss, Texas.

After his army year he returned to UCLA and graduate school, where he soon realized that he thoroughly enjoyed the academic environment and the challenge of graduate school subject matter—particularly British imperial history, with emphasis on the history of India.

Halfway through graduate school—in July 1954—he married a fellow UCLA student, Freda Braginsky. He met her when he audited an undergraduate history class and happened to sit next to her.

His Caltech coaching continued through his graduate school days, and in addition to soccer he assumed responsibility for the freshman baseball team. He claims that the team's success came about because his ignorance of the subtleties of the game drove him to some outrageous and exotic coaching methods, which paid off. However, students he coached say that one of the strongest reasons for his success was his ability to take a bunch of oddly assorted people and weld them into a cohesive, smoothly working group.

His popularity with the students became so widespread that he was eventually offered the job of master of student houses. The administration wanted him to take it on as a full-time position, so it came as a bombshell when he pointed out that he was a serious scholar of British imperial history, for whom teaching and research had number one priority. Since he was about to receive his PhD, he didn't want to be master unless he could also be a faculty member.

The compromise he worked out with the Institute allowed him to teach "at the discretion of the division." This delicately turned phrase didn't bother him. Hallett Smith, the humanities division chairman, gave a sympathetic ear to his academic plans, and his active scholarship and demonstrated teaching ability kept him moving up the professorial escalator—until he received his full professorship in 1966.

Huttenback's colleagues describe him as a dedicated and effective scholar whose work has reflected a steady maturing in depth of insight. His latest book, recently published by the Cornell University Press, is *Gandhi in South Africa.* The important London *Times Literary Supplement* spoke of the author's meticulous documentation and close reasoning and doubted that Huttenback's detailed and critical study of this period of Gandhi's career will be superseded.

Most of the material for his studies has been gathered during research trips to India, Africa, London, and other places where there are major archival collections relating to the old British Empire and the modern Commonwealth. As one would expect of so busy a man, he has to do the Pasadena part of his research and writing in small

patches during the academic year—"ten minutes here, ten minutes there" is the way he describes it. The results of his notes, writings, and a voluminous correspondence come together during the summer.

During the academic year he tosses up all his activities in the same blanket, being division chairman one minute, a researcher the next, and a dean the next. Except for a brief look-in every morning, he is hardly ever in the deans' office on the first floor of Throop Hall, but the door to his Baxter office is seldom closed, because Bob Huttenback is the most accessible of men.

If he isn't in there, he is probably making the rounds of his faculty's offices—which he sometimes manages to do twice a day. Students wanting to see him about leaves of absence, dropping courses, or occasionally some complicated infraction of the honor system that needs a word from a present-day Solomon drop in frequently. His approach to students with worrisome personal problems is rational and nonjudgmental, which results in a minimum of embarrassment for everyone concerned.

Huttenback likes being dean better than being master of the houses—at least partly because he has fewer occasions for imposing discipline. As master of student houses he found it taxing "to have to hit somebody between the eyes and be Big Daddy simultaneously."

He sees the role of the dean of students as being sympathetic and supportive but he also believes in "inflicting new ideas on students now and then." He feels this is particularly necessary at Caltech because he's never seen much evidence that the student body is very innovative. Those few who are, he thinks, are atypical. "I looked on Joe Rhodes from the outset as an aberration." (Rhodes, Caltech's first sophomore ASCIT president, became nationally known even before his graduation, and later became the youngest member of President Nixon's panel on student unrest last year.)

As a teacher, his students find him tough, and for the old reason that is a bugaboo to many Techers—lack of obvious structure in the course. Instead of telling them one-two-three the reasons for the rise or fall of the British Empire, he throws them into a mass of material and expects them to strike out for themselves.

One student complained that Huttenback further clutters up his material by tossing out myriads of anecdotes about the people involved in the events being studied. What he has missed is Huttenback's basic belief that history is made up of the irrationality of individuals, and not tidy trends.

Racial problems within the British Empire absorb him as current and planned research. His next book, *Kashmir as an Imperial Factor*, is at the Cornell University Press now, and he will finish *The Quest for a White Australia* this summer. His ideas for future research and writing stretch to the horizon.

Such energy and output make it easy to understand the delight in his voice when he called his office during a research trip to Canada last summer, and announced with great glee: "There's a museum here that's open 24 hours a day!"

When one has worn for so long and with such flare the garb of the genial abbot of the student houses, it is not easily discarded, no matter what other roles he may assume. Occasionally a few people have even mistaken for superficiality the Huttenback *joie de vivre*, versatility, and graceful handling of many sticky wickets.

As one faculty friend recently said, "His solid achievements and his administrative skills can't be denied, so maybe it's time to recognize the real Bob."

The suggestion would undoubtedly be seconded by hundreds of Caltech alumni who, through him, saw the first indication that there's a lot of life going on out there beyond the lab.

Robert B. Corey
1897–1971

Robert B. Corey, 73, professor of structural chemistry emeritus, died on April 23 in Pasadena. He had been a member of the Institute staff for 34 years.

Robert Corey was born in Springfield, Massachusetts, in 1897. He received his BChem from the University of Pittsburgh in 1919 and his PhD from Cornell University in 1924 for work in inorganic chemistry. He was an instructor in chemistry at Cornell for five years. In 1928 he joined the staff of the Rockefeller Institute for Medical Research, and it was there that he became interested in the structure of molecules—the focus of his work for the next 30 years.

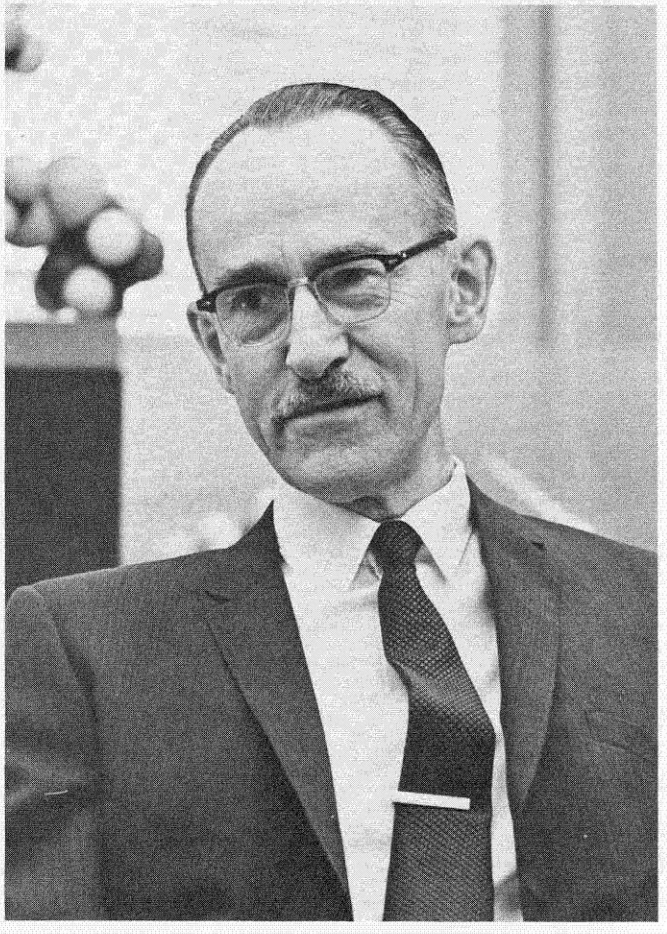
Because Caltech had the equipment necessary for his studies in X-ray crystallography, in 1937 Corey came to the Institute as a senior research fellow. Linus Pauling, then chairman of the division of chemistry and chemical engineering, had been working for some time on the structure of proteins, but he needed more information about the dimensions of the bonds and bond angles and the radius of the atom in the polypeptide chains—a project that Corey agreed to undertake. In rapid succession he determined the structure of several peptides, and within a dozen years he had laid the foundation for work on the detailed structure of proteins.

From 1942 to 1946 Corey was on leave to work with the Office of Scientific Research and Development on the analysis, composition, and stability of propellant powders for rockets, and in 1947 he was awarded a joint War and Navy Department Certificate of Appreciation for his services to the nation during World War II.

After the end of the war Corey worked for several years on the development and improvement of precise space-filling molecular models for use in the study of proteins. Today's molecular models are in all essential features identical with those that were first made under his direction, and they have become an indispensable part of present-day chemistry and molecular biology.

The early 1950's were exciting years in this field. The Corey-Pauling model for biological macromolecules was being formulated and information about it was being disseminated. While Corey was usually not enthusiastic about participating in the dissemination process, in 1955 he made a round-the-world speaking tour—and left a wake of people who suddenly understood and believed in the models he explained: the alpha-helix, the antiparallel chain pleated sheet, and other structures of proteins to whose development he had so greatly contributed.

After 1956 Corey turned his attention from the fibrous



repeating type of protein and focused on crystalline proteins and enzymes. His studies in this area had a profound effect on the development of protein crystallography at Caltech and throughout the world.

Corey was awarded a Guggenheim fellowship in 1951, and the University of Pittsburgh honored him with a DSc degree in 1964. He was a fellow of the American Chemical Society and of the American Association for the Advancement of Science, and a member of the National Academy of Sciences.

A memorial service was held in Dabney Lounge on the campus on May 5 with George Hammond, chairman of the division of chemistry and chemical engineering, presiding. Tributes to Corey were given by three of his long-time friends and colleagues: Linus Pauling, professor of chemistry emeritus; Richard Marsh, senior research fellow in chemistry; and Ernest Swift, professor of analytical chemistry emeritus.

SHOCK-WAVE ALCHEMY

For the first time, the gemstone garnet has been compressed by a laboratory-generated shock wave into a denser material—a new form that seems to have a crystal structure similar to the titanium ore called ilemenite. The shock wave, which subjects the garnet—of the variety almandine—to the same enormous pressures that rocks undergo at about 375 miles beneath the earth's surface, is produced by a research cannon designed by Thomas Ahrens, associate professor of geophysics. The cannon was constructed using the breech from a three-inch Navy weapon from a destroyer escort but with a 24-foot-long barrel. Unlike the Navy version, this barrel is smooth bored and kept straight to within three-thousandths of an inch over its entire length.

This unique cannon is located at bedrock level in Caltech's shock-wave laboratory. With it, Ahrens is gaining new insight into how the behavior and crystalline structure of minerals change with increasing temperatures and pressures down to 600 miles in the mantle —the 1,800-mile-thick layer of rock between the earth's crust and core. Garnet is a good material for the experiment because there is a considerable amount of it in the mantle.

The cannon fires flat tungsten bullets 1½ inches in diameter into a 120-cubic-foot vacuum tank, and even though the atoms and chemical composition of the garnet remain the same, the shock wave produced by the impact rearranges the atoms so that they are more tightly packed together. The rearrangement of atoms is called a phase change.

Ahrens and his colleagues, research fellow Earl Graham and research engineer John Lower, find it surprising that so dense and hard a mineral as garnet (which has a density of 4.2) is so readily transformed into a more closely packed structure. The resulting mineral has a new structure with specific gravity of about 4.4, which represents an increase of about 5 percent.

Attempts are being made with X-ray diffraction techniques to delineate the new pattern of the atoms, but this is difficult because much of this new phase—which seems structurally similar to ilemenite—is unstable in the laboratory and transforms back into garnet.

The gun used in the Ahrens experiments is instrumented to determine the tungsten bullet's velocity and the speed of the shock wave through the 1/6-inch-thick sample of the garnet. The bullets can travel up to four times faster than those from ordinary rifles, so a typical experiment doesn't last long—about a millionth of a second.

In about half of a recent series of 14 shots fired at increasing bullet velocities, Ahrens and Graham observed the garnet undergoing a complete change of phase. At first the velocity of the shock wave increased with an increase in bullet velocity. However, as bullet velocities continued to increase, the shock-wave velocity first decreased and then increased again. This was the clue that a phase change had occurred.

By using minerals and metals such as garnet as targets, the experimenters can determine what effects the extreme pressure deep in the interior of the earth (and of other planets) has on their mechanical properties and crystalline structure. They can also study effects such as melting and shock-induced phase changes similar to those produced by meteorites impacting the earth, moon, and other celestial bodies. In earlier experiments Ahrens and his group used the gun to transform the mineral enstatite into what was thought to be the garnet structure. They chose to carry out experimentation on enstatite because other researchers had found that it had been transformed into garnet structure in a meteorite, presumably by shock waves induced by a violent impact at some time in its history.

Ahrens and his co-workers have also used the gun technique to produce shock waves in various kinds of glass to change their ability to bend and refract light, and to erase fission tracks on rocks that are produced by radioactive particles. His research is sponsored by the National Science Foundation and the National Aeronautics and Space Administration.

Thomas Ahrens, associate professor of geophysics, loads his converted Navy cannon. At the end of its 24-foot-long barrel is a 120-cubic-foot vacuum tank in which the target mineral is suspended.

The Month at Caltech

New Members of the National Academies

Membership in the 108-year-old National Academy of Sciences or the National Academy of Engineering, established in 1964 as an outgrowth of NAS, is one of the highest honors that can be accorded to an American scientist or engineer. The list of Caltech faculty members who have been elected is long and distinguished. At their annual meetings this year the academies added four more Institute scientists to the NAS roster (bringing Caltech's membership to 40), and two engineers to NAE (making a total of 11).

The new NAS members are Harry B. Gray, professor of chemistry; A. J. Haagen-Smit, professor of bio-organic chemistry emeritus; Hans W. Liepmann, professor of aeronautics (and a member of NAE since 1965); and Gerald J. Wasserburg, professor of geology and geophysics. NAE's new members are Lester Lees, professor of environmental engineering and aeronautics; and Roy W. Gould, professor of electrical engineering and physics.

Gray

Haagen-Smit

Liepmann

Wasserburg

Gould

Lees

New Trustees

Two new members have been elected to Caltech's board of trustees, bringing the total current membership to 44. The new members are R. Stanton Avery, founder, chairman, and chief executive officer of Avery Products Corporation of San Marino, California, and Lew R. Wasserman, president and chief executive officer of MCA Inc.

Recently named the California Manufacturer of the Year by the California Manufacturers' Association, Avery started his company three years after his graduation from Pomona College in 1932. It is now a leading manufacturer of self-adhesive products, with 27 factories and sales operations in over 20 countries around the world.

Avery is chairman of the Claremont University Center board of fellows, and is a trustee of the Claremont Graduate School and of the Athenian School of Danville, California. In 1968 Pomona College awarded him an honorary Doctor of Laws degree. He is a member of the board of trustees of the Huntington Library and Art Gallery and of the Los Angeles County Museum of Art, is also on the governing board of the Performing Arts Council of the Los Angeles Music Center, and is a director of the Los Angeles World Affairs Council.

Wasserman, who has been associated with the Institute through membership on the President's Council, joined MCA in 1936 and was named president of the corporation in 1946. Founded in 1924 as Music Corporation of America, MCA became the world's largest theatrical talent agency. It abandoned talent representation when it acquired Universal Studios and entered motion picture production. MCA is now also in the recordings and television business and has other financial interests both inside and outside the entertainment industry.

In addition to his business interests, Wasserman is chairman of the board of the Center Theater Group of Los Angeles, a member of the board of governors of the Performing Arts Council of the Music Center and of the Radio Free Europe Committee, and a trustee of the Hollywood Canteen Foundation. He is also a trustee of the John Fitzgerald Kennedy Library in Boston, and of the John F. Kennedy Center in Washington, D.C.

Industrialist of the Year

Arnold O. Beckman, chairman of Caltech's board of trustees, has received the 1971 Industrialist of the Year Award of the California Museum of Science and Industry. In presenting the bronze plaque, Samuel B. Stewart, president of the Greater San Francisco Chamber of Commerce, commended Beckman for his accomplishments in three related fields—industry, education, and public service. "Taken individually," Stewart said, "Dr. Beckman's efforts in any one of these fields might well merit the award. However, it is in contributing to the progress of each, and the effective interrelationship of all, that he has made lasting contributions to the progress of our state and the nation as a whole."

A Caltech alumnus, Beckman received his PhD in photochemistry in 1928, and he was on the faculty of the Institute from then until 1940. While at Caltech he became interested in applying electronic techniques to problems of chemical analysis and subsequently founded Beckman Instruments, Inc., to develop and manufacture scientific instruments. This company has become one of the world's leading manufacturers of precision instruments and a major force in the growth of the instrument industry in California.

California Museum of Science and Industry Awards for the industrialist and the scientist of the year have been made for the last 14 years "to give recognition and inspiration to the richly creative men and women of science and industry in our state." The Scientist of the Year Award for 1971 was presented to Peter Duesberg of UC Berkeley by Caltech's president, Harold Brown, who was chairman of the science award jury.

Five men who are now—or were at the time they received the award—members of Caltech's faculty have received Scientist of the Year Awards: William A. Fowler in 1958, Frank Press in 1961, Jesse Greenstein and Maarten Schmidt in 1965, and Robert Sinsheimer in 1968. In addition three alumni have been recipients: Saul Winstein, PhD '38, in 1963; Wolfgang K. H. Panofsky, PhD '42, in 1967; and Walter H. Munk, BS '39, MS '40, in 1969. In 1966 a special trustees' award was given to William H. Pickering, director of the Jet Propulsion Laboratory and also a Caltech alumnus, BS '32, MS '33, and PhD '36. The Industrialist of the Year Award has gone to one other trustee of the Institute: Stephen D. Bechtel Jr. received it in 1968.

Rumford Award

Marshall H. Cohen, professor of radio astronomy and staff member of the Owens Valley Radio Observatory, is one of 21 scientists who received the 1971 Rumford Award of the American Academy of Arts and Sciences.

The Rumford Award, established in 1796 to encourage research in the fields of heat and light, is the oldest scientific prize in the Western Hemisphere, and until now it has always been awarded to individuals. This year the academy changed its tradition to recognize work done by three outstanding teams whose membership totals 21—a 9-member team in Canada, 8 men at MIT, and 4 affiliated with the National Radio Astronomy Observatory and Cornell University. Cohen's work was done with the NRAO-Cornell group, two other members of which are Caltech alumni: Barry Clark (BS '59, PhD '64) and Kenneth Kellermann (PhD '63).

All three teams have contributed to development of very-long-baseline interferometry—a new technique of radio astronomy that uses two radio antennae separated by many thousands of miles, both simultaneously observing the same small radio source. Carefully synchronized atomic clocks are used to time the instant of simultaneous observation, and the interference fringes are created in a computer by comparing the magnetic-tape output of the two antennae. The result is resolution 1,000 times better than that obtainable with the largest optical telescope. "The Great Soviet-American Extragalactic Investigation," published in the March 1970 issue of *Engineering and Science* magazine, is an account furnished by Clark and Kellermann of some of the unexpected practical difficulties they encountered in carrying out one phase of their research.

Cohen, who first came to Caltech in 1965 as a visiting associate professor, received his BEE in 1948, his MS in 1949, and his PhD in physics in 1952—all from The Ohio State University. He spent 12 years on the faculty at Cornell University, first in electrical engineering and then in astronomy. For the two years before he came to Caltech in 1968, he was at UC San Diego as professor of applied electrophysics.

Bruce Medal

Jesse L. Greenstein, professor of astrophysics, executive officer for astronomy, and staff member of the Hale Observatories and the Owens Valley Radio Observatory, is this year's recipient of the Bruce Medal, which is the highest honor of the Astronomical Society of the Pacific. It has been awarded annually since 1898 "in recognition of distinguished services to astronomy" and goes to nominees proposed by six major observatories and selected by the directors of the society.

Greenstein, who received the honor in Hawaii on June 24 at the society's annual meeting, came to Caltech in 1948 to set up the graduate school of astronomy. The American Council on Education now rates it as the top graduate program in astronomy in the country.

An expert in the discovery of peculiar stars and the study of their composition from their spectra, Greenstein collaborated with Caltech physicists in developing the theory connecting differences in the composition of stars with the nuclear energy-producing processes occurring in their interiors. He has studied the spectra of low-luminosity white dwarf stars and the spectra and physical properties of the quasi-stellar radio sources.

Several Institute astronomers have won the Bruce Medal previously. George Ellery Hale, a solar astronomer and one of the founders of Caltech, was the recipient in 1916. The winner in 1969 was Horace Babcock, director of the Hale Observatories; and last year the medal was awarded to Fred Hoyle of the Institute of Theoretical Astronomy of Cambridge, England, and visiting associate in physics at Caltech.

Professor Emeritus

Paul C. Eaton

Paul C. Eaton—dean of students at Caltech for 22 years—came to the Institute in 1946 as a visiting lecturer in English, and the following year he was appointed associate professor of English and associate dean of students. In 1953 he became dean of students. He gave up his duties as dean in 1969 but has continued to teach English full time for the last two years. In July he becomes professor of English emeritus.

In his final annual report, Eaton reminisced: "In this report, my twenty-second and last, I have difficulty in resisting the temptation to point to marble halls which have replaced the brick edifices or empty spaces supporting student life in 1947-48, *Anno DuBridgensis II*. For these monuments, look about you. The Scott Brown Gymnasium, the Alumni Swimming Pool, the health center, three new undergraduate student houses, Winnett Center, and the Beckman Auditorium have all been built and put to use during the past two decades. Complementing the added facilities for instruction, research, and nonacademic administration, they symbolize as well as support the California Institute's interest in the totality of education. I am gratified that I have had the opportunity to participate in the planning, programming, staffing, and on-going activities of these extracurricular centers.

"At the start, along the course, and at the finish of these 22 years I have enjoyed the help and friendship of some fine people. From the beginning there was the counsel of my more experienced colleagues, Deans Franklin Thomas, Winch Jones, and Foster Strong, of senior faculty and administrators of the Millikan era, and of Dr. Millikan's successor—Lee DuBridge. Nobody brought up under the aegis of these wise and devoted men could go wrong all the time.

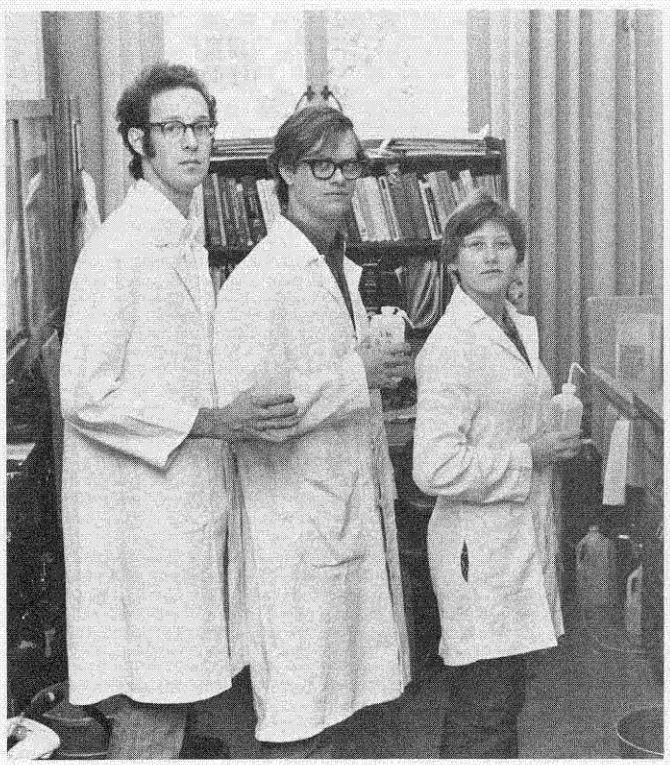
"At the end, it is gratifying to see responsibilities taken over by others, cast in the same mold but ably adapting to changing conditions, men like Lyman Bonner, Robert Huttenback, David Wood, Peter Miller, and David Smith, under Dr. DuBridge's successor—Harold Brown.

"Between September of 1947 and June of 1969 very little of what I was able to accomplish was the sole result of my own efforts or abilities. Most of what can be recalled with satisfaction was achieved through the whole-hearted cooperation not only of those named above but of a host of students, professors, administrators, trustees, coaches, doctors, secretaries, resident associates, business officers, and others of the campus community.

"This is the spirit in which the Caltech student, whether he realizes its value at the time or not, lives and has his being during his undergraduate years. It makes possible the continued success of the Honor System, the student houses, the ASCIT Research Center, student participation in the general governance, the athletic, service, and cultural programs, and—one continually confides—the absence of the need to adopt disruptive means for redress of grievance."

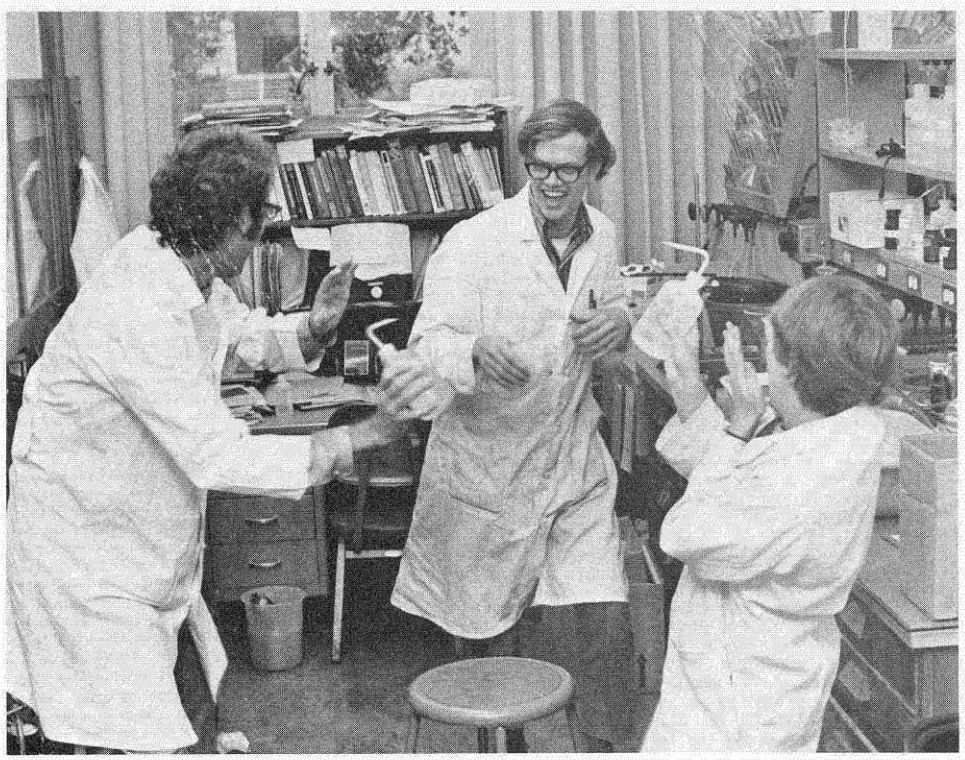
Now that he has retired from both of his Caltech roles, Eaton—a native New Englander—looks forward to spending more of each year "down east" than has been possible during the years of his residence in California, though he has managed to spend most summers in Maine. He was born in Nashua, New Hampshire, took his SB at MIT in 1927 and his AM at Harvard in 1930, and taught in New England until 1946—first at Phillips Exeter Academy and then for 13 years at MIT.

During World War II Eaton was a lieutenant commander in the U.S. Naval Reserve and saw sea duty in both the Atlantic and the Pacific with the Third, Fifth, and Tenth fleets. For duty from 1944 to 1945 he earned a letter of commendation from the Navy, and in 1945 he was awarded the Navy Commendation Medal. His interest in maritime activities continues; he is a member of a yacht club in Islesford, Maine; of the Marine Associates of the Peabody Museum of Salem, Massachusetts; and of the Bath (Maine) Marine Research Society.



Laboratory Exercise

The end of the academic year seems like a good time for us to reveal a guilty secret. Simply stated, it is that all scientists do not spend 24 hours a day totally absorbed in science—as we found out recently when our photographer was assigned to photograph a group of typical young researchers. He chose three earnest and dedicated chemistry graduate students—Bill Beranek, Larry Mohr, and Ellen Elliott—and he was diligently photographing them in their laboratory when one dedicated researcher, overcome by the solemnity of the occasion, squeezed his prop squirt bottle——thereby →



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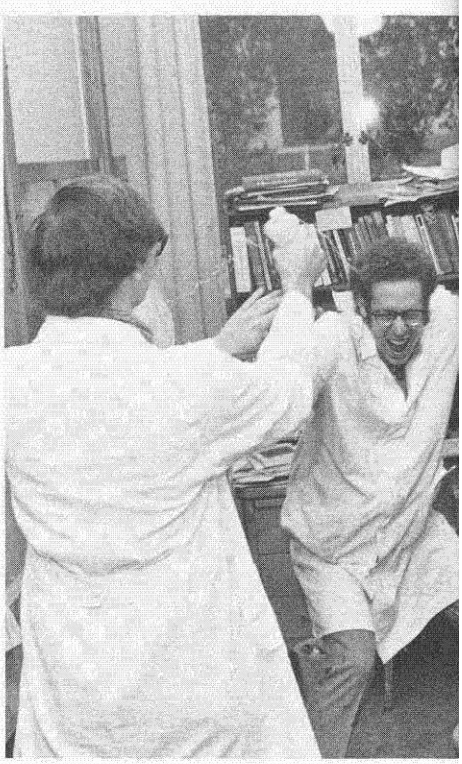

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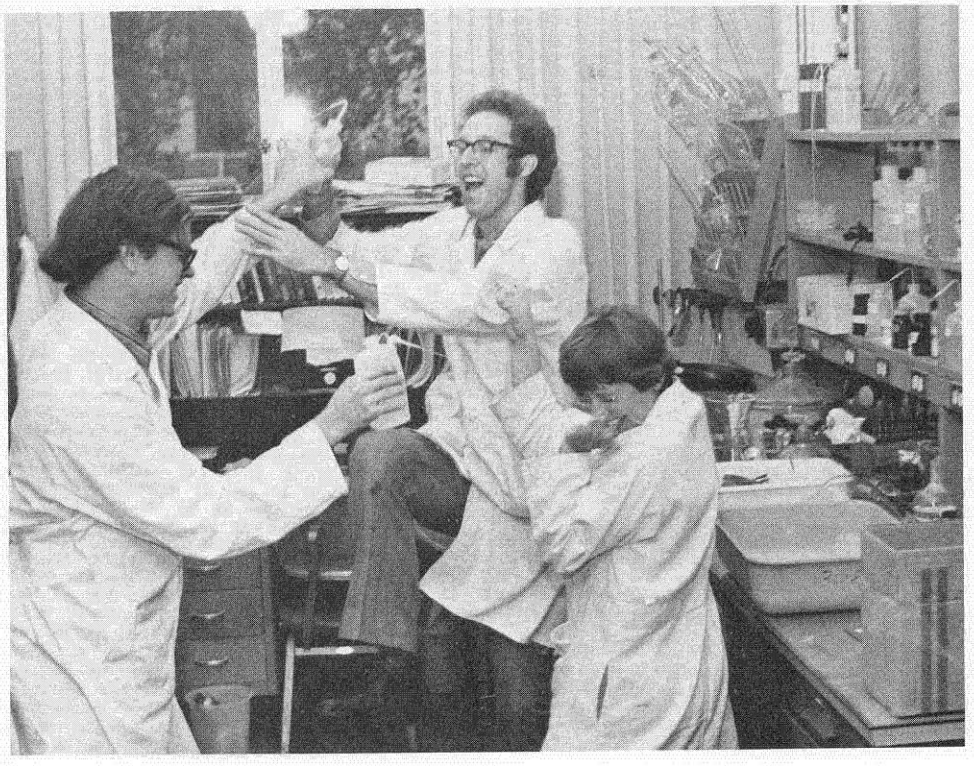


and hazards of the scientific life.

Books

THE FRONTIER CHALLENGE

Responses to the Trans-Mississippi West

Edited by John G. Clark
The University Press of Kansas . . . $10.00

This is a book of ten essays by eminent historians of the American West. The essays focus on how the inhabitants of the area—American settlers, Spanish-Americans, and Indians—developed and accommodated themselves to an environment which was itself constantly altered by the presence of a society in flux. Rodman Paul, professor of history at Caltech, contributes "The Spanish-Americans in the Southwest, 1848-1900" to the volume. The editor, John G. Clark, is a member of the faculty of the University of Kansas.

COMPLEX VARIABLES APPLIED IN SCIENCE AND ENGINEERING

By Harold Wayland
Van Nostrand Reinhold Company . $9.50

This is a basic text on the theory and functions of a complex variable for the senior undergraduate or graduate student in the fields of physics, engineering, chemistry, or applied mathematics. Its author, Harold Wayland, is professor of engineering science at Caltech. In the book he brings the power of analytic function theory to bear on the solution of the common second-order linear differential equations of mathematical physics and the special functions associated with them. Of special interest is the inclusion of summaries—featuring those for solution of ordinary differential equations.

CAVITATION

By Robert T. Knapp, James W. Daily, and Frederick G. Hammitt
McGraw-Hill Book Company . . . $25.00

Using a strong physical approach as its framework, this book discusses: (1) the genesis and occurrence of cavitation as a hydrodynamic phenomenon; (2) its effects on flow properties; and (3) its effects on equipment performance. Both mathematical analysis and experimental information are used. A main feature of the book is its careful examination of the physical characteristics of cavitation as it is observed, the supporting analytical descriptions, and the discussion of particular practical experimental situations in terms of the basic mechanics of the phenomenon.

Robert T. Knapp, professor of hydraulic engineering at Caltech, was working on a manuscript on cavitation at the time of his death in 1957. James Daily, professor of engineering mechanics, and Frederick Hammitt, professor of mechanical engineering—both of the University of Michigan—used Knapp's notes and their own records of subsequent research to complete this volume.

DISCOVERY, INVENTION, RESEARCH, THROUGH THE MORPHOLOGICAL APPROACH

By Fritz Zwicky
The Macmillan Company $6.95

Reviewed by Albert G. Wilson

This is a translation of the author's *Entdecken, Erfinden, Forschen im morphologischen Weltbild*, first published by Droemer Knaur in 1966. It makes available in English the most comprehensive description to date of many of Zwicky's highly original epistemological ideas, including the methodologies of negation and construction, systematic field coverage, and the morphological box, but only cursorily mentions Zwicky's theory of marks. The several types of morphological analysis are developed with illustrations that come mostly from Zwicky's own specialties, but since these are many, there is something for almost everyone.

The reactions to Zwicky's attempts to popularize the morphological method 30 years ago were highly polarized. On the one hand, morphology was regarded as an almost tautological way of thinking that every rational person used but did not bother to formalize. On the other hand, morphology was considered to be a formalization, but a sub-set, of the total analytical process that Zwicky used to make his inventions and discoveries. Unless one were equipped with an insightful intuition, deep knowledge in several specialties, and broad general knowledge, morphology could not be made to work.

Albert G. Wilson is an associate director at the Advanced Research Laboratory, McDonnell Douglas Corporation, in Huntington Beach, California. He is a Caltech alumnus (MS '42, PhD '47) and was a staff member of the Hale Observatories from 1947 to 1953.

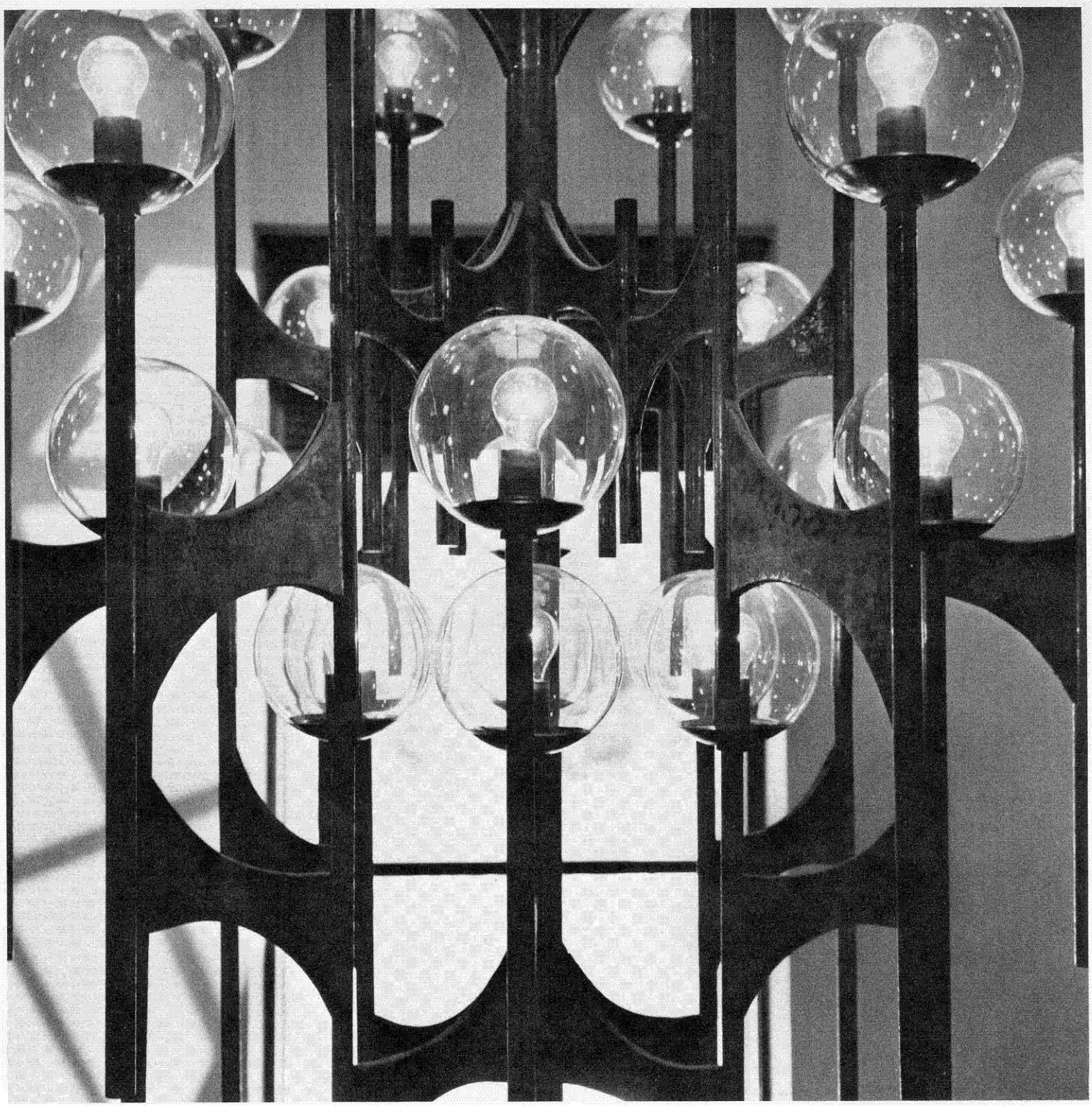
In other words, in addition to the formal steps given by Zwicky for the morphological process, the step "first, become a genius" should be added. But Zwicky feels everyone *is* a genius, and therefore the morphological method could be used by anyone.

His faith in the intellects of his fellow men may yet prove warranted. Recently the morphological method has been discovered by forecasters and long-range planners and is being fruitfully applied in many problem areas. Most recent texts on forecasting include chapters describing the use of Zwicky's morphological matrices in futuribles. With increasing evidence that morphology is a useful tool in many hands, *Discovery, Invention, Research* should be read by all who anticipate they might have a problem of some sort to solve in the next few years. The book may be read eclectically with profit by those wishing an introduction to morphological methods; or may be read in its entirety with enjoyment by those who would like a behind-the-scenes glimpse into the thinking processes and personality of one of the 20th century's most original thinkers.

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

By Leon Lapidus and John Seinfeld
Academic Press $16.50

The authors of this book have three objectives: first, to bridge theory and practice; second, to provide definite recommendations on which methods to use in specific situations; and finally, to prepare the reader for the published literature on numerical integration of ordinary differential equations. They consider in detail problems of current interest, for example, hybrid methods, extrapolation methods, the generation of highly stable algorithms, and the numerical integration of stiff ordinary differential equations. The book is designed for engineers, computer scientists, and workers in industrial research laboratories. It can also be used in upperclass or first-year graduate courses in numerical analysis. Lapidus is professor of chemical engineering and chairman of the department at Princeton University, and Seinfeld is associate professor of chemical engineering at Caltech.



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When was the last time you went out for a breath of fresh air and got it? How long has it been since the sky looked really blue?

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Rapid transit is one. In many cities, the automobile causes more than half the air pollution. In some cities, as much as 90%. But engineers at GE are designing new equipment for rapid-transit systems, encouraging more people to leave their cars in the garage.

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