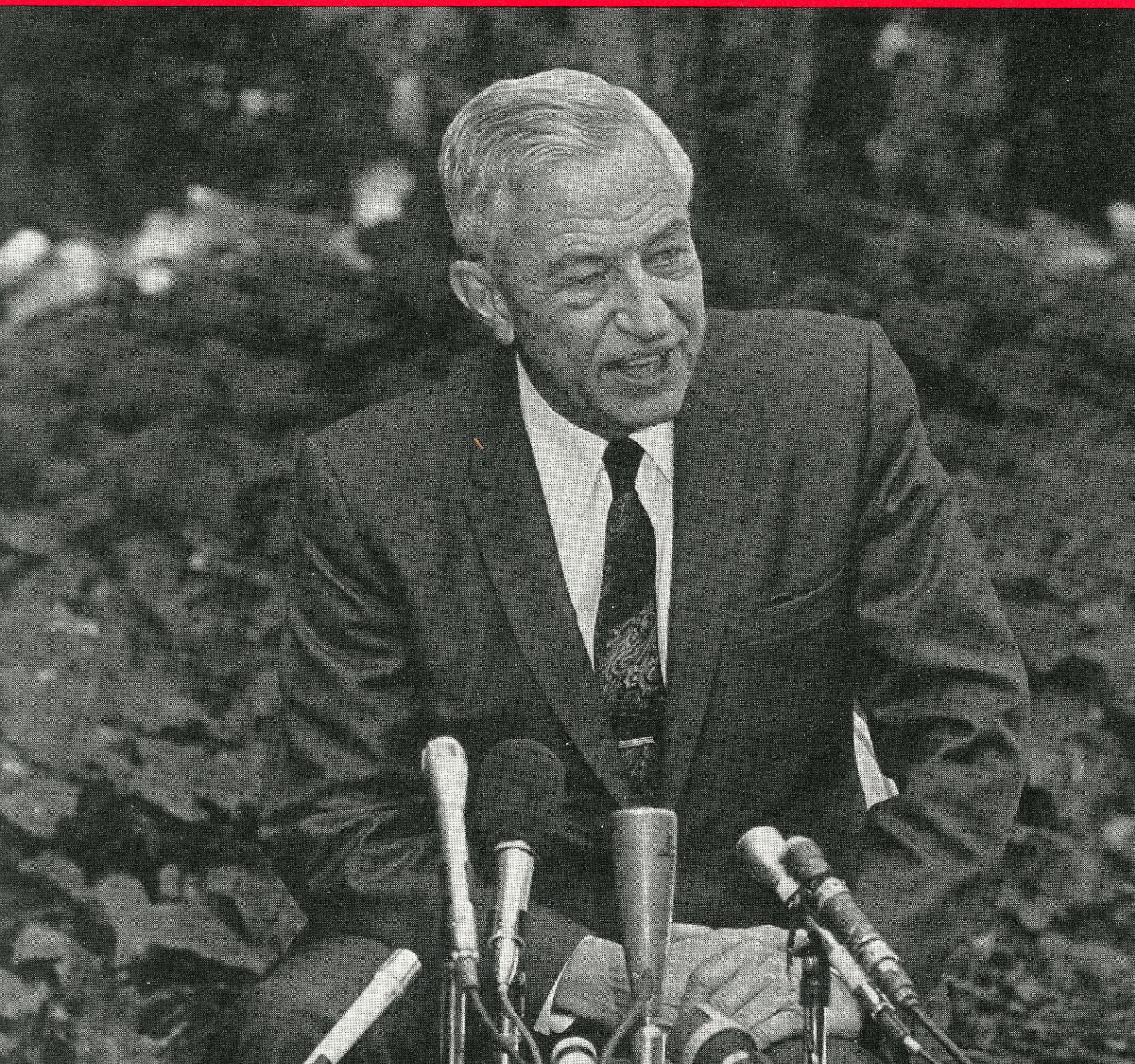
DECEMBER 1968

E&S ENGINEERING AND SCIENCE

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



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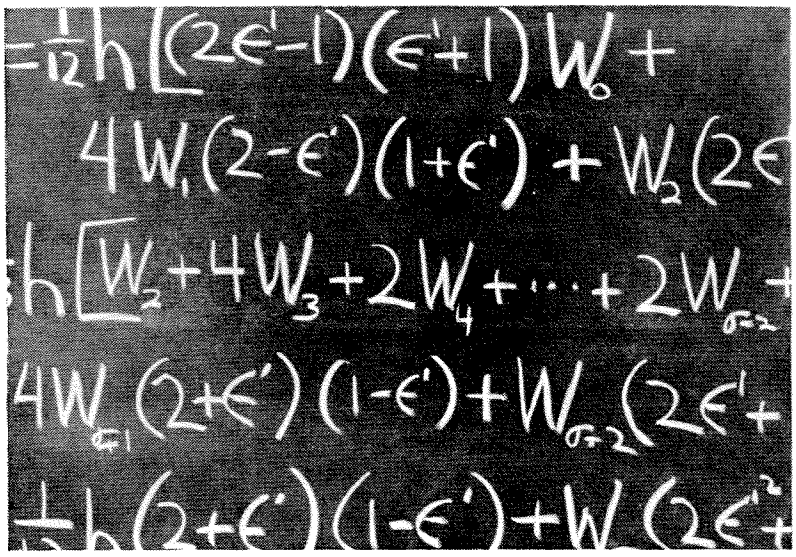
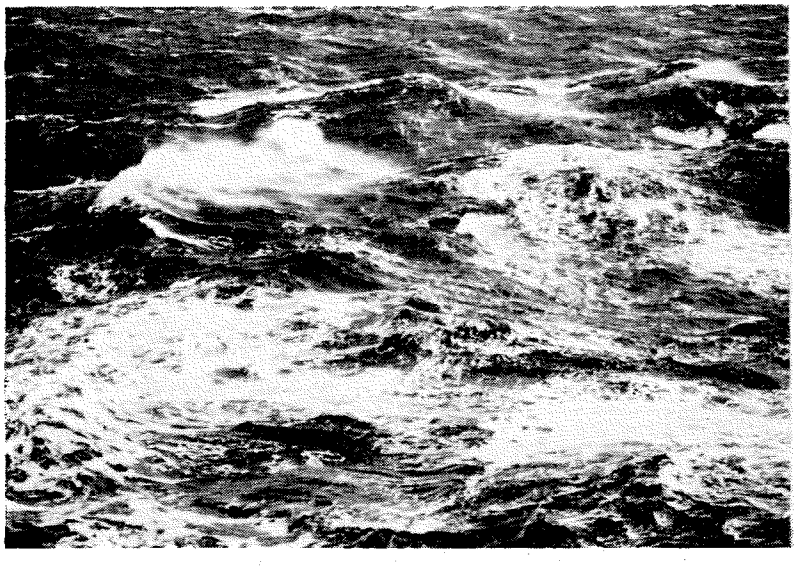


or knowledge of oceans.



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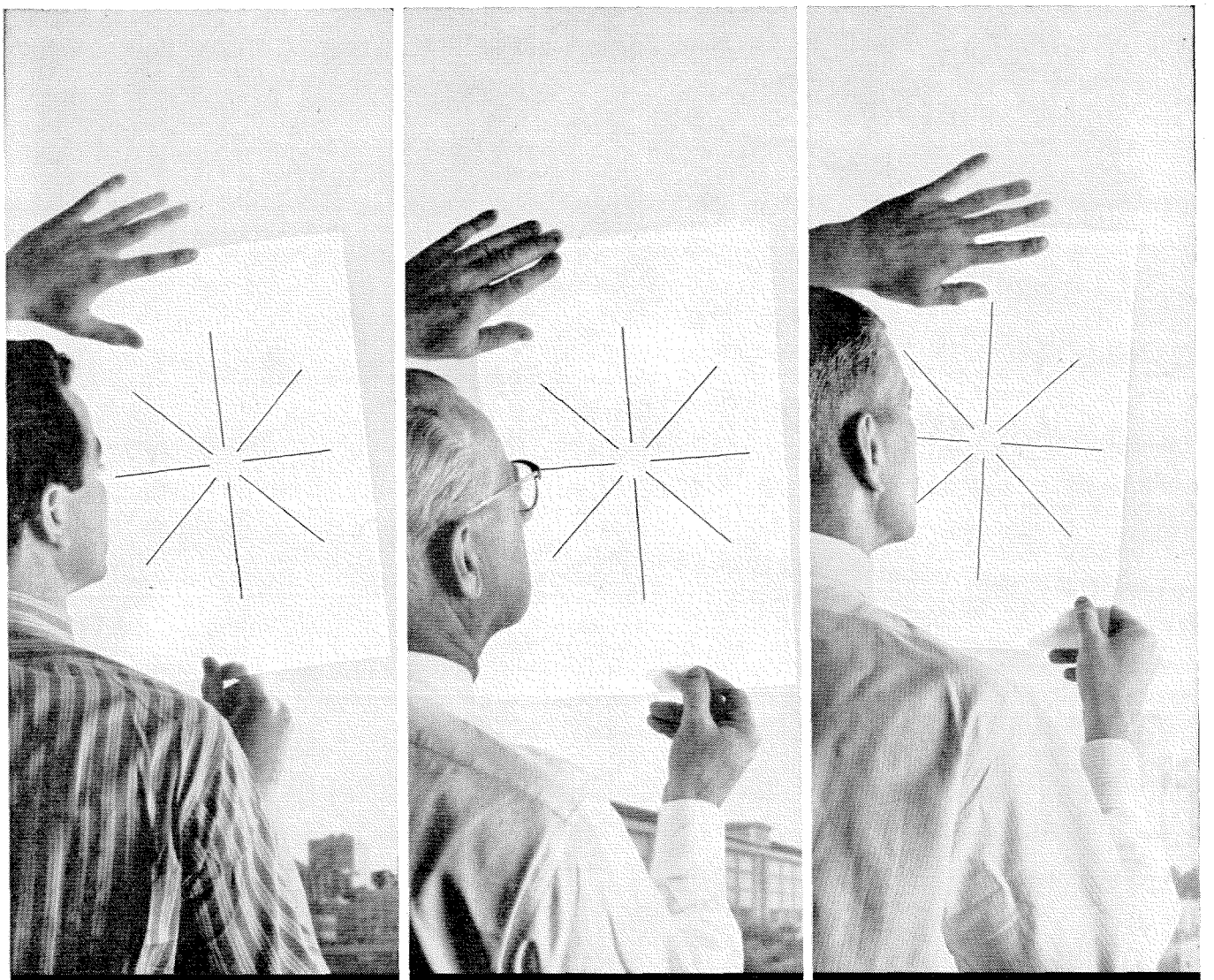

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ENGINEERING AND SCIENCE

DECEMBER 1968 / VOLUME XXXII / NUMBER 3

On The Cover

Lee A. DuBridge makes a public announcement of his retirement as president of the California Institute of Technology to become Science Adviser to the new President of the United States when he takes office on January 20. To the congratulations, good wishes, tributes, and goodbyes that have been pouring in since his surprise announcement on December 3, *E&S* adds its farewell—an issue devoted to a brief review, in pictures and text, of the 22 memorable DuBridge years at Caltech.

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Cover, 8, 16, 19, 21, 25—James McClanahan
12—Ernest Kleinberg / 13—Tom Harvey / 13, 20—*Los Angeles Times*
19—William Zolan / 20—Leigh Wiener

Staff

Editor and Business Manager—Edward Hutchings Jr.; *Associate Editors*—Bruce Abell '62, Phyllis Brewster, Julie Ann Davey, Jacquelyn Hershey, Kathleen Marcum; *Photographer*—James McClanahan.

Published monthly, October through June, at the California Institute of Technology, Pasadena, Calif. 91109. Annual subscription $4.50 domestic, $5.50 foreign, single copies 50 cents. Second class postage paid at Pasadena, Calif., under the Act of August 24, 1912.

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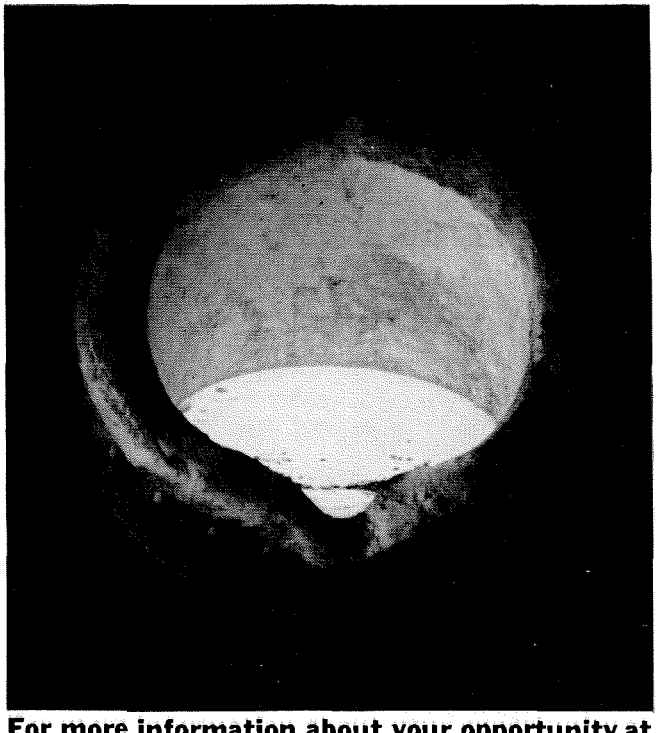

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An Invitation to the Faculty

On the assumption that we could all enjoy the pedagogical nuances of teaching and the subtleties of research into fundamental physical laws better in an atmosphere that permitted respiration—I would like to invite the faculty to join in a smog action program.

We are all aware of the outstanding contributions of some individual members of the Caltech faculty. For example, Dr. A. J. Haagen-Smit's discovery of the photochemical reactions of smog and his present leadership of the Air Resources Board are well known. But I wonder what the faculty as a whole has done to back up the efforts of individual members, to insure that the simple technical steps which should have been taken ten years ago will in fact be taken today.

For just one example, the public knows practically nothing of C. C. Patterson's research showing the dangerously high lead levels in the blood of average urban dwellers. Have we, as Patterson's colleagues, made sufficient effort to insure that the legislature faces the problem of the lead content of gasoline? About eight million gallons are burned every day in Los Angeles County—the home of the California Institute of Technology, an institution which has just embarked on a program of "Science for Mankind."

The core problem today is that there are about four million cars in the Los Angeles area. They produce *12,000 tons of pollutants per day.* Each car on the average will go on producing this pollution for a period on the order of ten years. No matter what kind of new-car emission standards are passed, these cars already on the road will continue to put out this enormous amount of pollution unless we actually, in operational fact, do something about it.

There are simple, inexpensive repairs and adjustments that can be made on some cars which will cut their smog emission by a large amount, some more expensive repairs that will cut pollution by a smaller amount, and so on. There is an obvious cost-benefit criterion of action to be taken. This cost-benefit approach is an important part of the study undertaken by Associated Students of Caltech in their research project and continuing studies on smog.

The Caltech student project will shortly produce a report on the completion of this work, a project which I have heard characterized by professional smog experts as one of the best analyses produced by any group so far. Part of that ASCIT report will be a proposal for diagnostic stations that would prescribe corrective remedies for cars currently in use and insure the maintenance of low new-car emission levels. Will the Caltech faculty support this very fine piece of work? Will the faculty communicate it to the community? Will we mobilize support for obvious actions which need to be taken to alleviate smog now?

Here is my invitation:

Will some of the faculty volunteer to come together, discuss and agree on a few technical, engineering actions which should be taken in the immediate future to alleviate smog contribution from cars?

Will they make one trip to Sacramento to get the legislature moving on these measures?

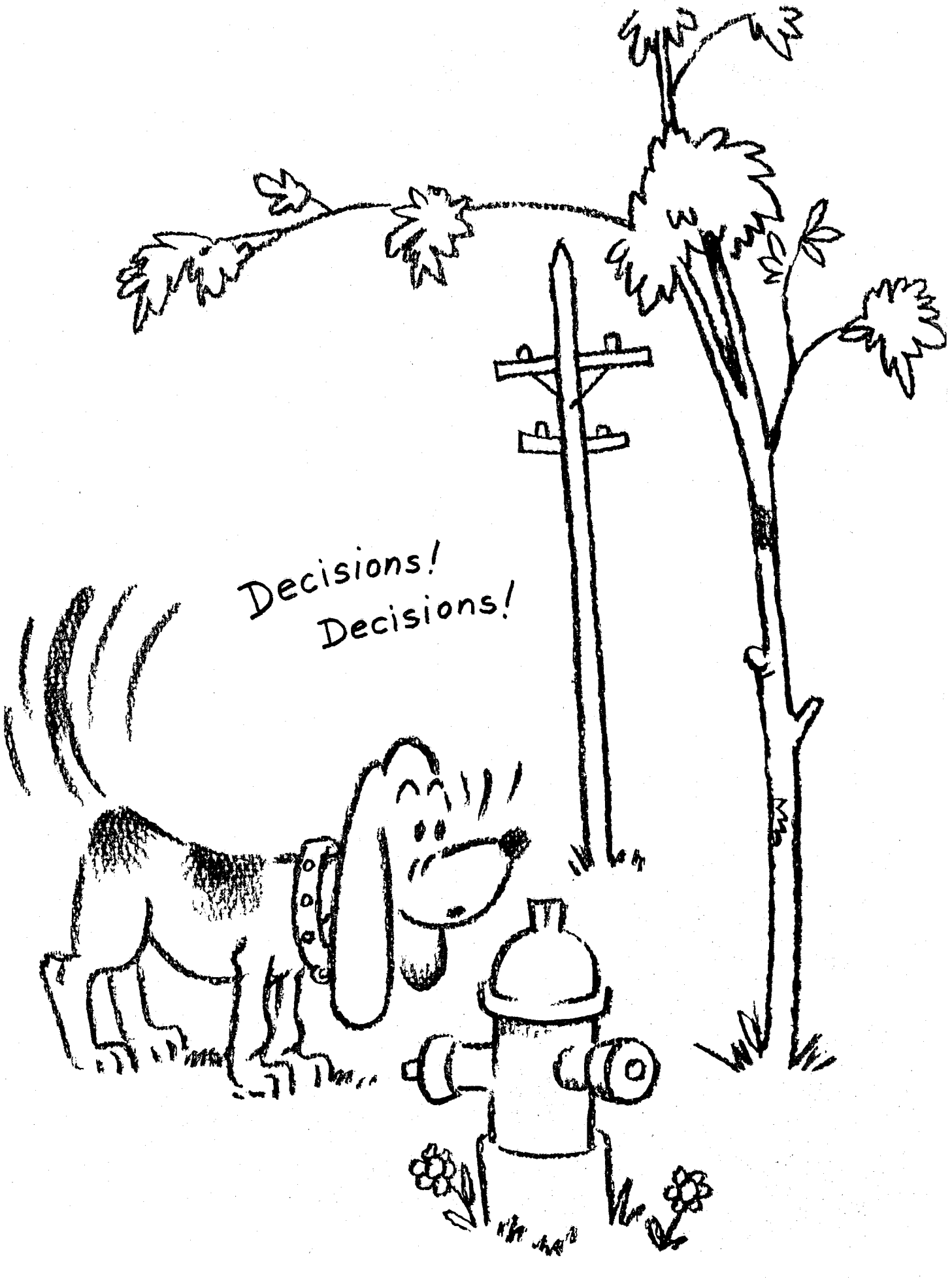
Would they talk to the local radio and TV once or twice, the newspapers occasionally?

Depending on how they felt they could be most effective, I would suggest they do this either in the name of an ad hoc faculty committee, as a subcommittee of the Los Angeles Chapter of the Federation of American Scientists, or under the auspices of the Southern California Clean Air Council.

Halton Arp
Staff Member, Mount Wilson and Palomar Observatories

Board member, Southern California Clean Air Council

Chairman, Los Angeles Chapter Federation of American Scientists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Decisions!

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A Farewell From Lee DuBridge

I have had over 22 wonderful years at the California Institute of Technology, and I have been pleased and proud to be a part of such a great institution. I leave my friends and colleagues here with feelings of great sadness. However, now that the President-elect of the United States has called on me to assume an important place in the new administration, I feel that as a loyal American I cannot refuse.

Even as I agreed to accept this post I knew that the search for my successor at Caltech was nearing its culmination. I am now delighted that so distinguished a scientist-administrator as Dr. Harold Brown will lead our beloved Institute to higher achievements in the years to come. Pending his arrival my long-time friend and colleague, Dr. Robert Bacher will be serving as acting president. Caltech will be in good hands.

I want to thank the board of trustees, the faculty, the students, and all employees and friends of Caltech for their great support over these many years, and I trust that all of them will continue their devoted loyalty to a great institution.

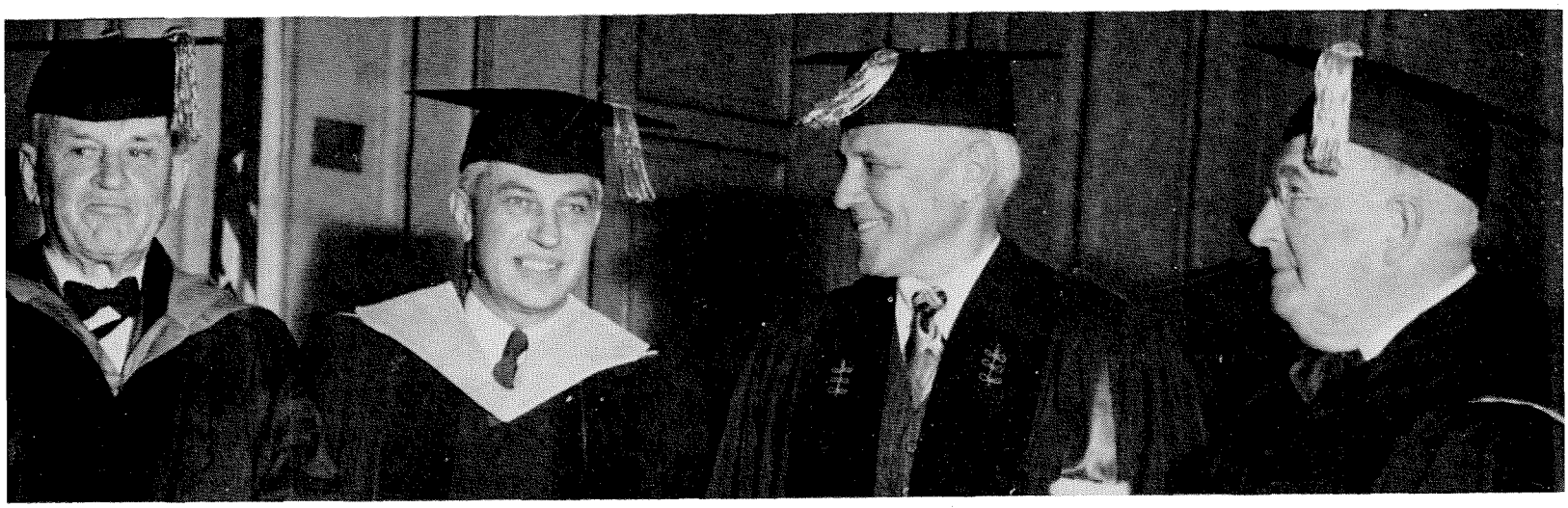
THE DuBRIDGE YEARS

FROM THE BEGINNING

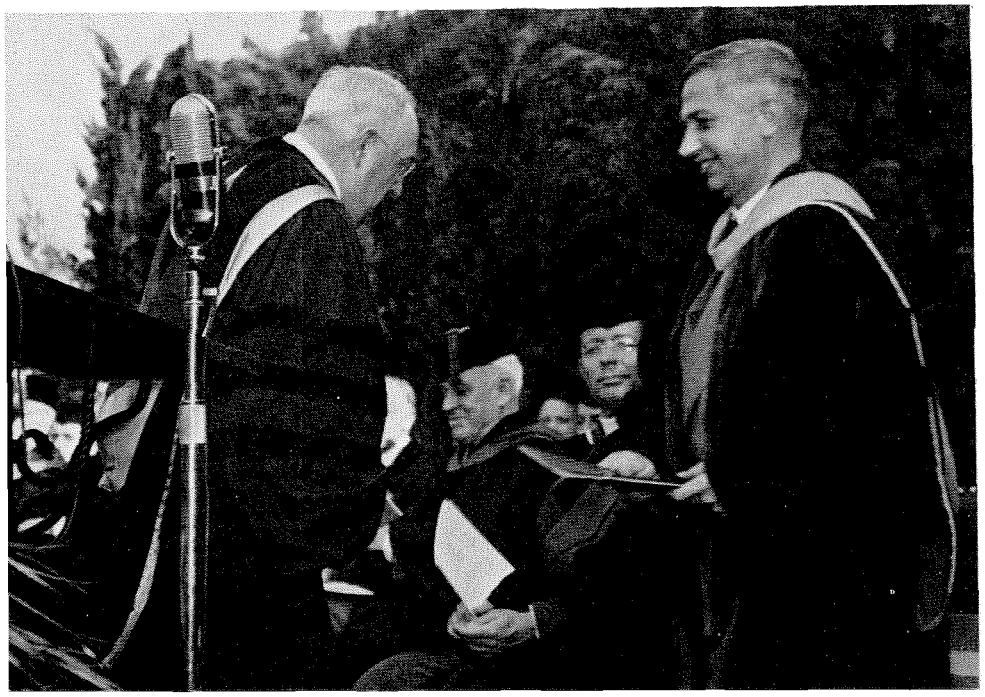
"As I take on these new duties, with humility and trepidation, I wonder if any man can help but be appalled at the task of running any educational institution these days."

Lee A. DuBridge was speaking from the stage of the Pasadena Civic Auditorium on November 12, 1946, at the first presidential inauguration ever held by the California Institute of Technology—his own.

It was not Lee DuBridge's first association with Caltech. In 1926 he had come here as a National Research Council Fellow to work for two years with the great physicist Robert A. Millikan—the man he was now replacing as chief administrator of the Institute.



1946—Lee DuBridge is inducted as Caltech president on November 12. With him are his predecessor (1921-46) Robert A. Millikan; MIT President Karl T. Compton; and James R. Page, chairman (1943-54) of Caltech's board of trustees.



1947—Chairman of the Board James Page turns the podium over to DuBridge at his first Caltech commencement.

The years between had been productive. In 1928 DuBridge joined the physics faculty of Washington University in St. Louis; in 1934 he became chairman of the department of physics at the University of Rochester; and just before the outbreak of World War II, in 1940, he was chosen to serve as director of the new Radiation Laboratory being established at MIT to develop radar for the military—a project that played a crucial role in the successful outcome of the war.

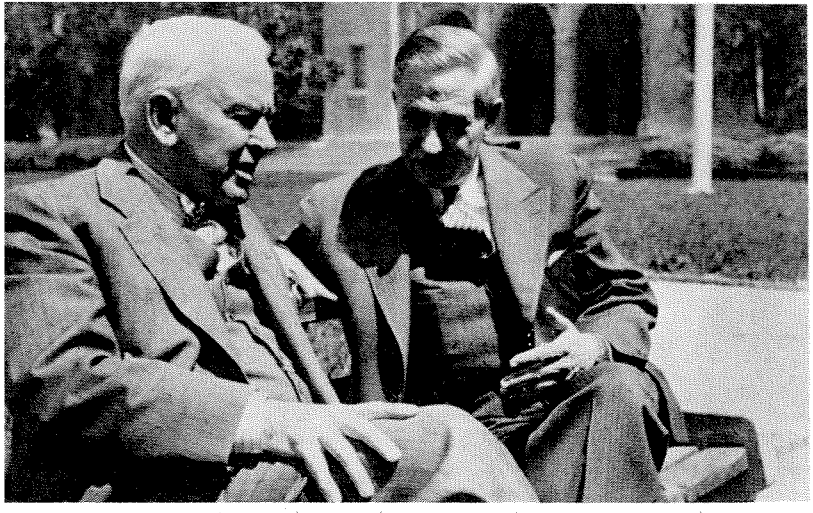
When DuBridge came back to head Caltech in 1946, his immediate task was to move the Institute out of its war-oriented program of secret military projects back to its fundamental scientific interest. He had to face the problems of an unprecedented enrollment (from 962 before the war to 1,391 after), overcrowded classrooms, insufficient housing, and overtaxed instructors. And the funds had to be raised "to build on existing foundations an institution which will more perfectly serve the needs of a changing world."

From the beginning—and all through his 22-year presidency—Lee DuBridge stated his commitment to the concept of a small, select institution offering excellence in education. Facts and figures are only part of the story, but the statistical record of change during the DuBridge administration is an impressive indication of how he has held to that concept.

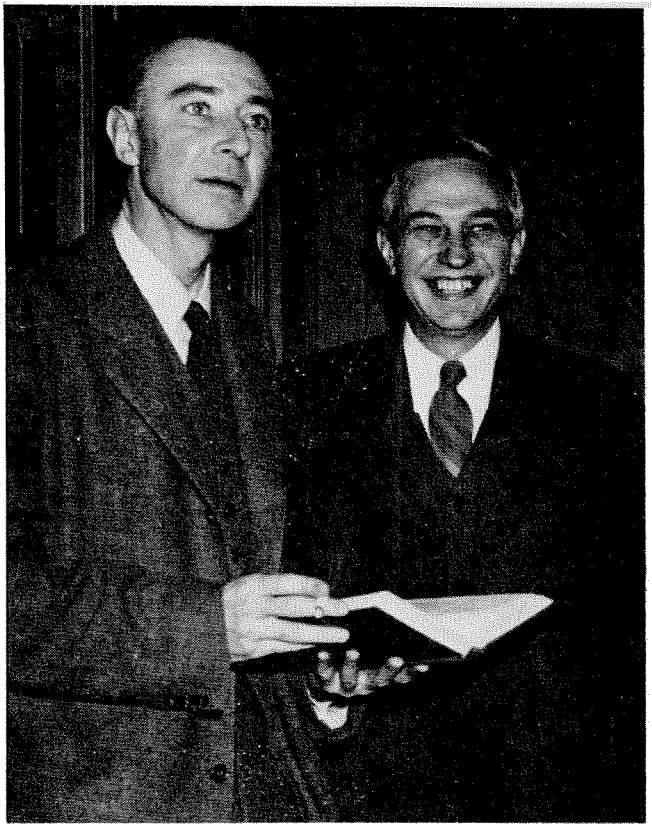
The 30-acre campus of 1946 has grown to 90 acres; the $17 million endowment is now over $100 million; the faculty of 260 is now 550; the number of campus buildings has increased from 20 to 64; and the budget has gone from something under $8 million to $30 million. But enrollment has remained relatively constant. In 1946 the total number of students, graduate and undergraduate, was 1,391. Today it is 1,492.

1947—The new president poses for his first official portrait.

1947—For incoming freshmen (then, as now) this is the high point of New Student Camp—a chance to talk to the president.



1951—Millikan and DuBridge have an informal conference. Millikan died in 1953, six years after DuBridge became president.



1950—Robert Oppenheimer, director of the Institute for Advanced Study in Princeton and a former Caltech professor, returns to the campus to lecture on the elementary particles of physics.

1954—DuBridge, Chairman of the President's Science Advisory Committee (just one of the major jobs he will do for President Nixon), meets with Ike in Washington.

SPOKESMAN FOR SCIENCE

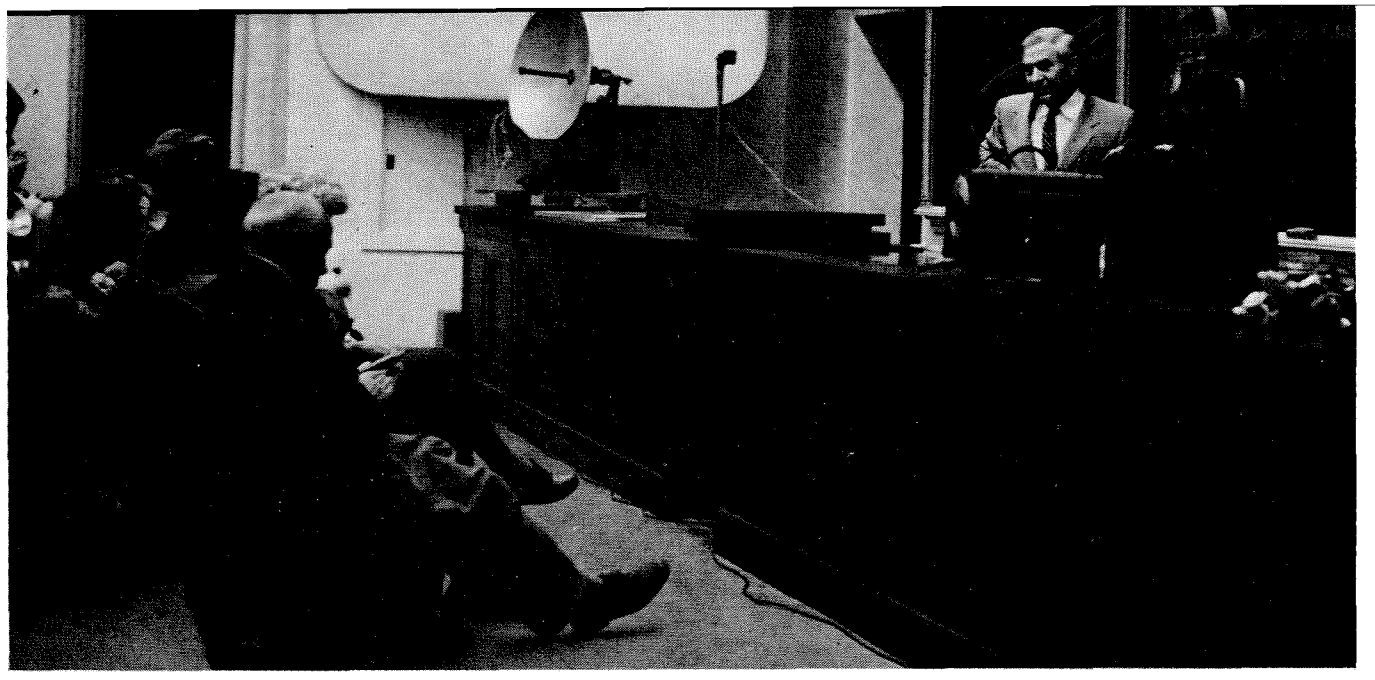
"It is tragic that the goals of science are so little understood . . . that it is regarded as a mysterious category. Science is merely one path to greater understanding."

Lee DuBridge has spent much of his life trying to dispel the public misconception of the role of science in the overall human endeavor.

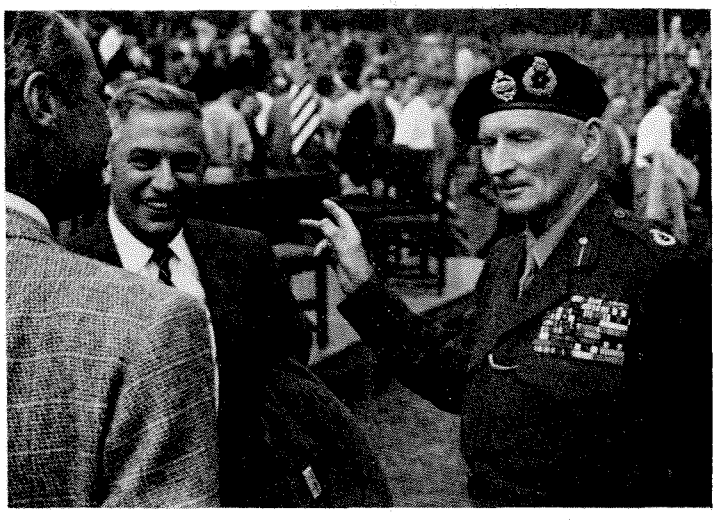
He has been the champion of science and technology at every opportunity. And his opportunities have been many. He has carried the word to industry, to the government, to the business community, and to the people—to civic groups, institutions, committees, commissions, and boards. In his 22 years at Caltech he has made more than 500 formal speeches, served on 32 boards and 31 committees, and traveled by air a distance roughly equal to three and one-half round trips to the moon.

Some Milestones

1946	Lee A. DuBridge inaugurated as president of Caltech.
1948	200" Hale telescope dedicated at Palomar Earhart Plant Research Laboratory completed Graduate program in astronomy initiated Tournament Park bought
1949	Guggenheim Jet Propulsion Center opens Tuition raised from $500 to $600
1950	Thomas Engineering Laboratory completed Merrill Wind Tunnel dedicated Air Force ROTC unit established on campus
1951	60th anniversary of Caltech Industrial Associates formed Billion-volt synchrotron goes into operation Edwin M. McMillan, '28, MS '29, receives the Nobel Prize in Physics President Truman appoints DuBridge to the Science Advisory Committee
1952	Geochemistry established as a field of research
1953	Robert A. Millikan dies



1955—DuBridge gives a Friday Evening Demonstration Lecture on radar. During World War II he led the development of radar at MIT.



1954—Field Marshal Viscount Montgomery, British World War II hero, visits Caltech to address the faculty and students in Tournament Park.

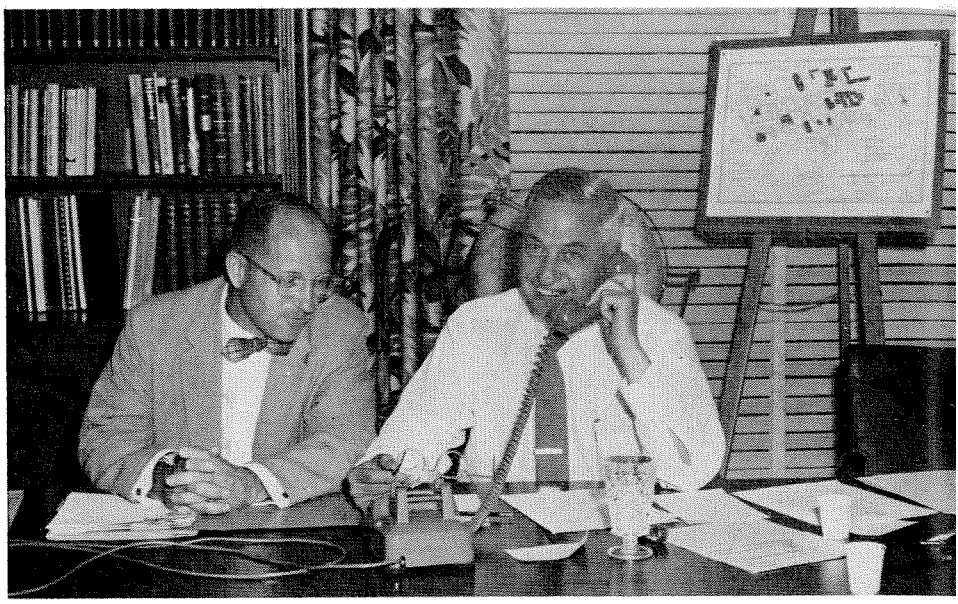
IN DEFENSE OF ACADEMIC FREEDOM

"If there is any area of human activity which flourishes only in an atmosphere of freedom, it is the area of creative science and technology . . . . Freedom—private initiative—that is the first prerequisite for a virile technology."

When Lee DuBridge moved from wartime research back to the academic world, he carried his convictions about academic freedom into the era when Joseph McCarthy and his supporters were extinguishing it wherever they could—and university faculties were among their chief targets. DuBridge consistently championed this freedom, and most particularly on his own campus.

In 1953 he wrote: "Academic freedom is a privilege granted to a teacher by his university . . . (the privilege) to retain his position in the university even though he expresses opinions or beliefs, or makes statements, or engages in activities which are unpopular with the public or at variance with opinions of his colleagues, or of the university administration, or its governing board . . . . Every leading university in the United States has assured its faculty of this privilege. Thereby the progress of learning has been accelerated and assured—to the eternal benefit of civilized living."

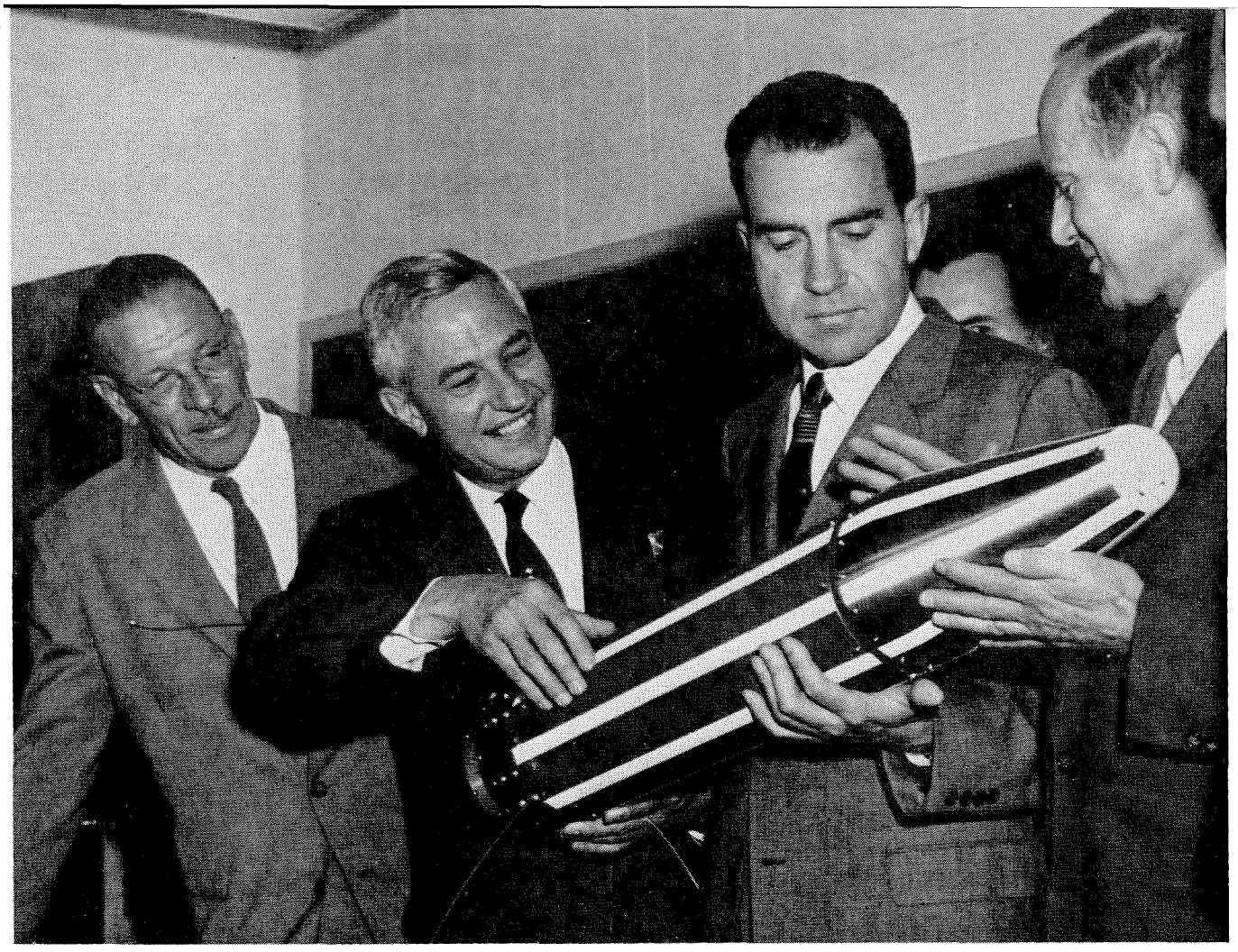
He gave even more specific voice to these beliefs in April 1954 when he testified in Washington before the Personnel Security Board of the United States Atomic Energy Commission in support of his colleague Robert Oppenheimer. And, during the long years when the chairman of Caltech's chemistry division, Linus Pauling, was under fire for his political convictions, DuBridge—against a growing storm of criticism—solidly defended Pauling's right to that freedom.



1958—DuBridge and Alumni Secretary Donald S. Clark kick off Caltech's first big ($19 million) development campaign with phone calls to alumni all over the country.

1955—*Time* thinks DuBridge, at 53, can "justly claim the title, Senior Statesman of Science."

1957—Dubridge with undergraduates on the campus. In 1957 there were 676 of them; today there are 722.



1958—Vice President Nixon, on a five-day visit to California, inspects a model of an Explorer satellite—the USA's first spacecraft—along with Clark Millikan, DuBridge, and JPL chief William Pickering.

IN SUPPORT OF SCIENCE

"The exploration and the support of science for its own sake is not being adequately—certainly not generously—supported . . . . Billions are being spent on military and industrial technology, but the amount spent on science can be measured in a small number of millions per year."

This was the plea that Lee DuBridge took with him everyhere in seeking support for the Institute.

Caltech's first fund-raising drive was launched in 1958—a $19.5 million development program—and its success accounted for 18 new buildings, a faculty salary increase, and other improvements.

In 1959 President DuBridge expressed the hope that the sources of support for education and research would retain the relative positions of 30 percent from endowments, 30 percent from gifts, 30 percent from government, and 10 percent from tuition. While always explicit about the importance of this balance, he continually stressed that the total amount of support must be increased. With this conviction as an impetus, a second campaign was initiated in 1967, with a goal of $85 million to be raised over a five-year period. As DuBridge leaves, the campaign has reached 36 percent of its goal.

Some Milestones

1954	Linus Pauling receives the Nobel Prize in Chemistry
1955	Scott Brown Gym and Alumni Swimming Pool open
	Norman Church Laboratory for Chemical Biology completed
	Tuition raised from $600 to $750
1956	William Shockley, '32, receives the Nobel Prize in Physics
1957	Eudora Hull Spalding Laboratory of Engineering opens
	Archibald Young Health Center completed
	$19.5 million development program launched
	Donnelley Seismological Laboratory opens
	Tuition raised from $750 to $900
1958	George W. Beadle receives the Nobel Prize in Medicine
	Explorer I launched

1959—DuBridge reminisces with Orrin Smith, the Cornell College professor who inspired him to become a physicist.

1962—DuBridge leads Theodore von Karman, Clark Millikan, and former Secretary of the Navy Dan Kimball through Caltech's newly dedicated Karman Laboratory of Fluid Dynamics and Jet Propulsion.

WHERE THE ACTION IS

"Remember that you are a part of a glorious institution. Caltech is really a fabulous place. Caltech is at the center of what is going on; it is where the action is."

Lee DuBridge was speaking to the brand new freshman class of '72 at New Student Camp this fall. And he was saying what he has always believed —that Caltech is a great place to be. He said it when he first came here, and he was still saying it with undiminished pride and enthusiasm in what now turns out to have been his final formal talk to Caltech freshmen.

"You name the field," he said, "and Caltech is there. Caltech is not only there, but Caltech may have pioneered that field. Basic supersonic aerodynamics started here. The study of cosmic rays started here. The discovery of the alpha-helix of the protein molecule started here. Modern rockets began here. Molecular genetics started here. Modern seismology started here.

"The 200-inch telescope is here, and so are a dozen other unique astronomical instruments. For 60 years Pasadena has never had only the *second* largest telescope; at one time it had the largest, the second largest, and the third largest!

"Nuclear structure, the nature of DNA, the biological role of proteins and enzymes, the structure of the center of the earth are all concepts and subjects which have been pioneered here. What makes a star shine? How were the elements created? What is a quasar? A pulsar? Who saw the first positron? the first meson? Who proposed the expanding universe? Ask someone at Caltech.

"But this is all past history: Are we just sitting on the glories of past achievements? Let's look around.

"Does anyone know any more about nuclear reactions in stars, or has anyone added so much to our knowledge, as William Fowler? Carl Anderson still heads the physics division though he earned the Nobel Prize over 30 years ago for discovering the positron. If anyone knows any more about nuclear theory, gravitation, quantum electrodynamics, color vision, or freshman physics than Richard Feynman, no one has found him.

"The founders of molecular genetics were George Beadle and Max Delbrück. Max is still here and has been joined by Robert Sinsheimer, James Bonner, Ray Owen, and a few others.

1962—Richard Nixon, running for Governor of California, makes a campaign appearance at Caltech.

"Linus Pauling proposed the modern theory of the chemical bond, and he and Robert Corey discovered the basic protein structure, the alpha-helix. Pauling has gone and Corey has just retired, but their students and followers, John Roberts, Richard Dickerson, Harry Gray, and George Hammond, keep Caltech in the chemical forefront of the world.

"Beno Gutenberg founded modern seismology. Charles Richter learned how to put numbers on earthquakes. Some younger followers, Clarence Allen and Don Anderson and others, keep the seismo lab a lively place. Gerald Wasserburg and Leon Silver elucidate the earth's history, and Robert Sharp tells us of the geology of glaciers and of Mars.

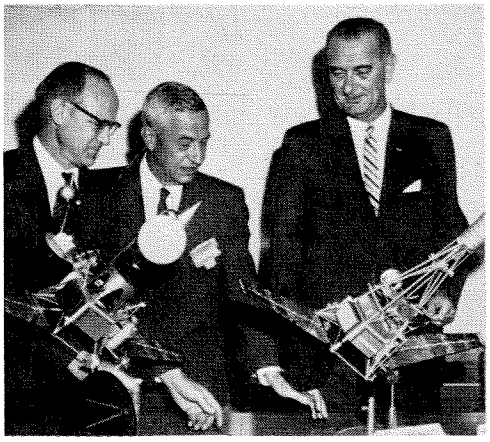
"Are more practical matters of interest to you? I hope so, for I trust that half of you may end up being engineers and putting scientific knowledge to use for the benefit of people. Airplanes? Ask Ernest Sechler, Hans Liepmann, Lester Lees. Lasers? Transistors? Plasma? Ask Robert Langmuir, Roy Gould, and Charles Wilts. Earthquake-resistant structures? Ask George Housner and Donald Hudson. Metals and alloys? Ask Don Clark, Pol Duwez. Computers? Ask Gilbert McCann. Smog? Ask Arie Haagen-Smit and Jack McKee. Sewage disposal? Ask Norman Brooks. I could go on and on."

DuBridge spoke with the same fervor on December 10 in Beckman Auditorium, when he said farewell to the Caltech community.

"I thought in 1946 and I still think that Caltech is the most wonderful place in the world to be."

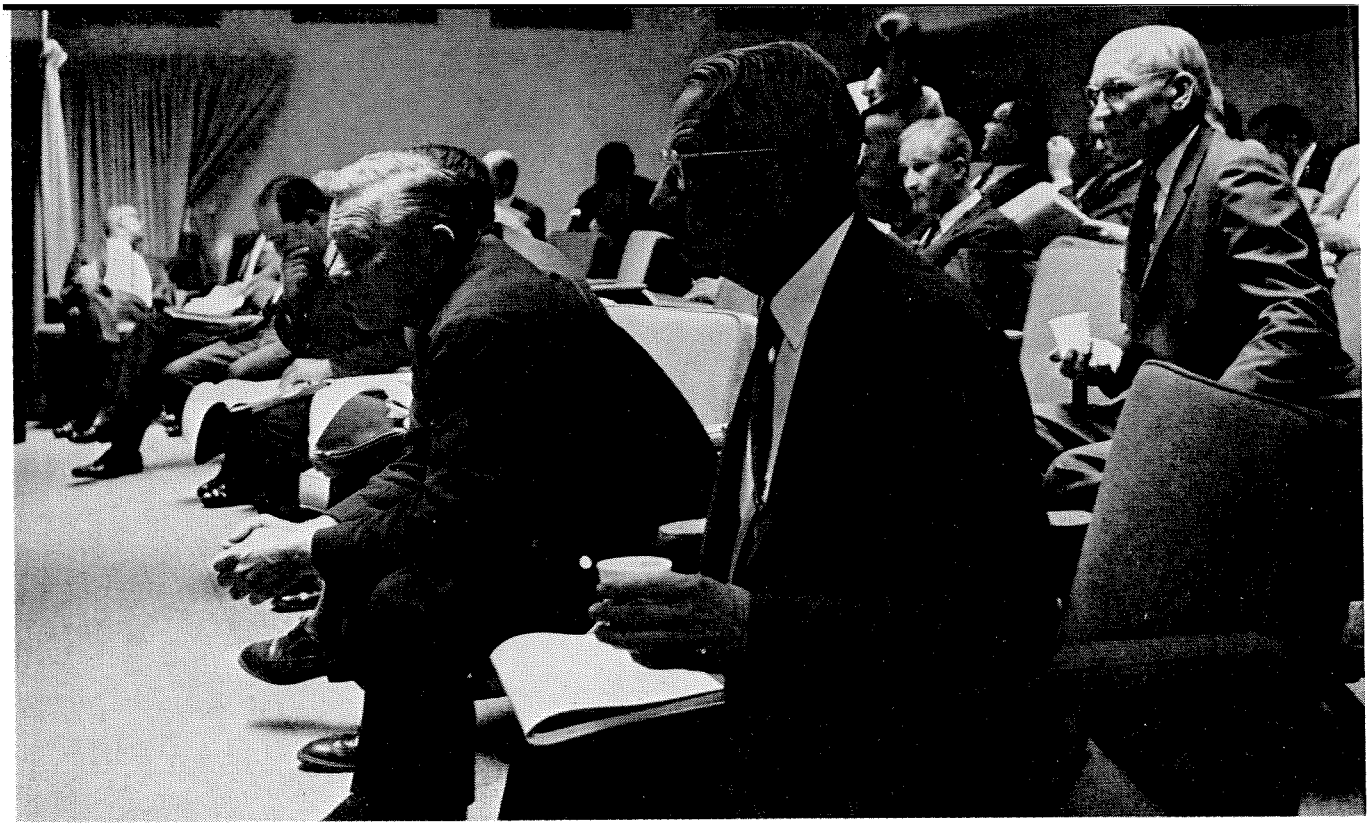
This tribute to Caltech is, perhaps, a fitting tribute to himself, for Lee DuBridge has written some of the most important chapters in the history of this "most wonderful place."

1963—As the space age gains momentum, JPL becomes the place to see. Pickering and DuBridge show Vice President Johnson models of the moon-photographing Ranger spacecraft.



1965—A jubilant DuBridge points out the impact area of Ranger IX on a lunar map after the spacecraft's successful moon flight.

1963—At a meeting of the Distinguished Civilian Service Awards Board, DuBridge is flanked by Attorney General Robert Kennedy; Deputy Secretary of Defense Roswell Gilpatric; Secretary of Labor Willard Wirtz; Secretary of Health, Education and Welfare Anthony Celebrezze; Under Secretary of State George Ball; President John Kennedy; publisher Samuel Newhouse; Civil Service Commissioner John Macy; and UN Ambassador Henry Cabot Lodge.

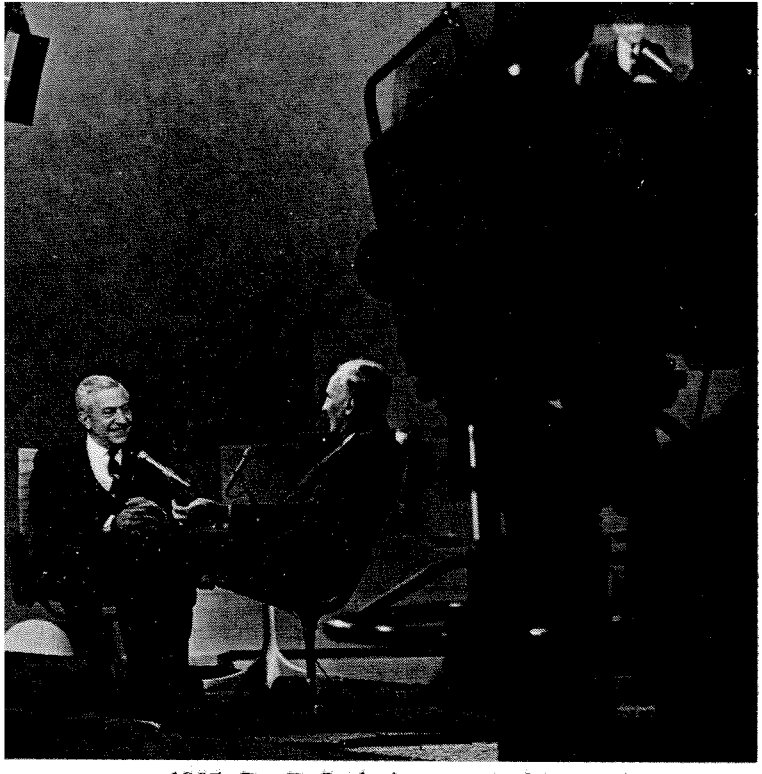


1966—DuBridge and Chairman of the Board Arnold Beckman (in the row behind him) watch tensely as JPL's Surveyor I makes its perfect descent to the moon's surface.

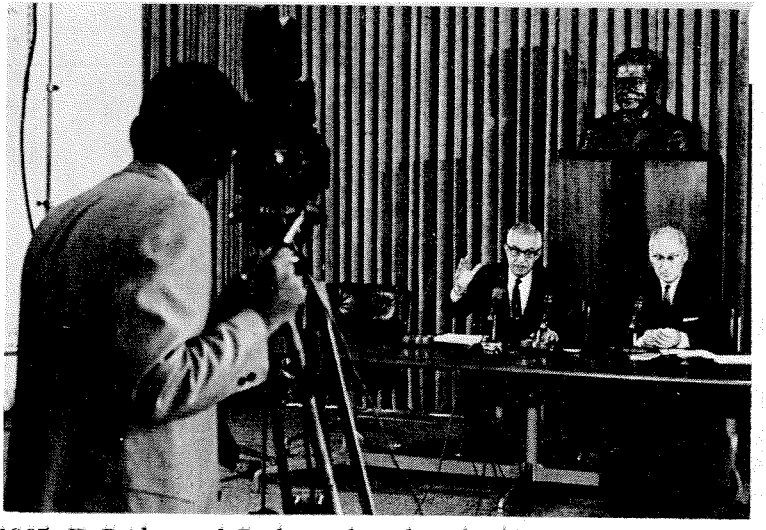
1965—DuBridge escorts a royal visitor, Princess Margaret, down the Olive Walk.

Some Milestones

1959	Two 90-foot radio antennae begin operating at Owens Valley Radio Observatory
	Goldstone tracking station established by JPL
	Tuition raised from $900 to $1,275
1960	Donald A. Glaser, PhD '50, receives the Nobel Prize in Physics
	Alfred P. Sloan Laboratory of Mathematics and Physics opens
	W. M. Keck Engineering Laboratories completed
	Page, Lloyd, and Ruddock student houses occupied
	Alles Laboratory for Molecular Biology completed
	Harry Chandler Dining Hall opens
	Cooperative Wind Tunnel closes
1961	Rudolf Mössbauer receives the Nobel Prize in Physics
	Karman Laboratory completed
1962	Four new graduate student houses open
	Winnett Student Center dedicated
	Firestone Flight Sciences Laboratory completed
	Mariner II launched
1963	Willis H. Booth Computing Center dedicated
	PhD program in applied mathematics initiated
	Option in planetary science introduced
	Tuition raised from $1,275 to $1,575
1964	Charles H. Townes, PhD '39, receives the Nobel Prize in Physics
	Ranger VII launched
	Beckman Auditorium dedicated
1965	Pass-fail system for grading freshmen adopted
	Richard Feynman receives the Nobel Prize in Physics
	Options in the humanities offered
	Steele Laboratory of Electrical Sciences completed
	Tuition raised from $1,575 to $1,800

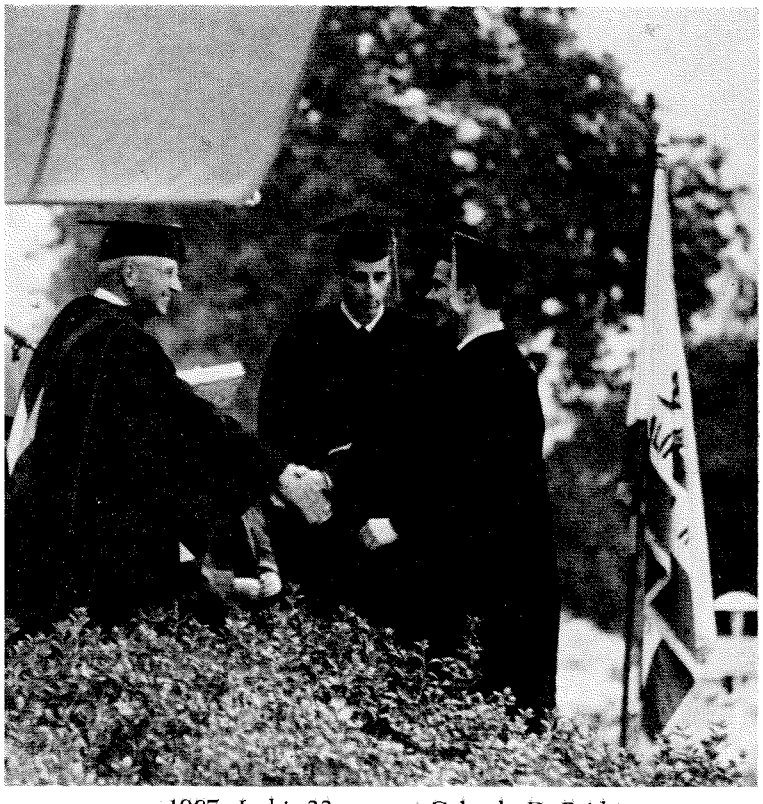


1967—Dr. DuBridge's support of innovation in education resulted in his involvement with National Educational Television and his appointment as chairman of the board of KCET in Los Angeles. Here he and Caltech trustee Simon Ramo discuss "Science and Society—A Race Against Time" on a program for the Los Angeles station.



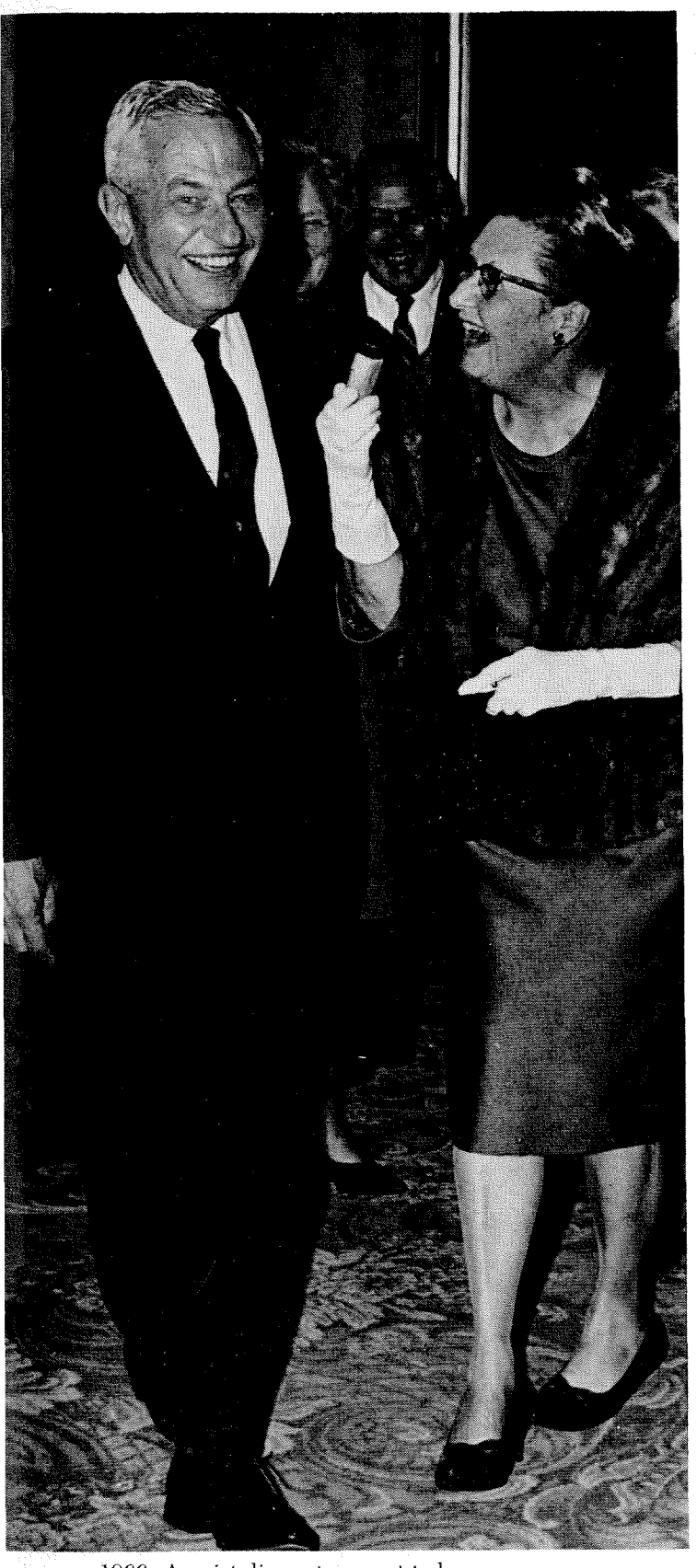
1967—DuBridge and Beckman launch Caltech's $85 million "Science for Mankind" development campaign. DuBridge delayed his retirement to get the fund drive started.

1967—One president shakes hands with another—student body president Joe Rhodes, the first sophomore elected to that office.



1967—In his 22 years at Caltech, DuBridge has congratulated more than 8,000 graduates and sent them off into the world.

1967—DuBridge, grandfather of five, makes an experienced Santa at the annual Athenaeum Christmas party.



1966—A quiet dinner turns out to be—
to his surprise—a party at which 500 faculty
and friends fete his 20 years as Caltech president.
Mrs. DuBridge is ready with smelling salts.

SPECIAL ASSISTANT TO THE PRESIDENT

"Science and technology are now essential elements of national concern and national policy . . . . It is imperative that ways be found to continue to bring scientists and engineers into policy-making and policy-advising positions in even more intimate and extensive ways . . . ."

These convictions have led Lee DuBridge from Caltech to his appointment as Special Assistant to the President for Science and Technology.

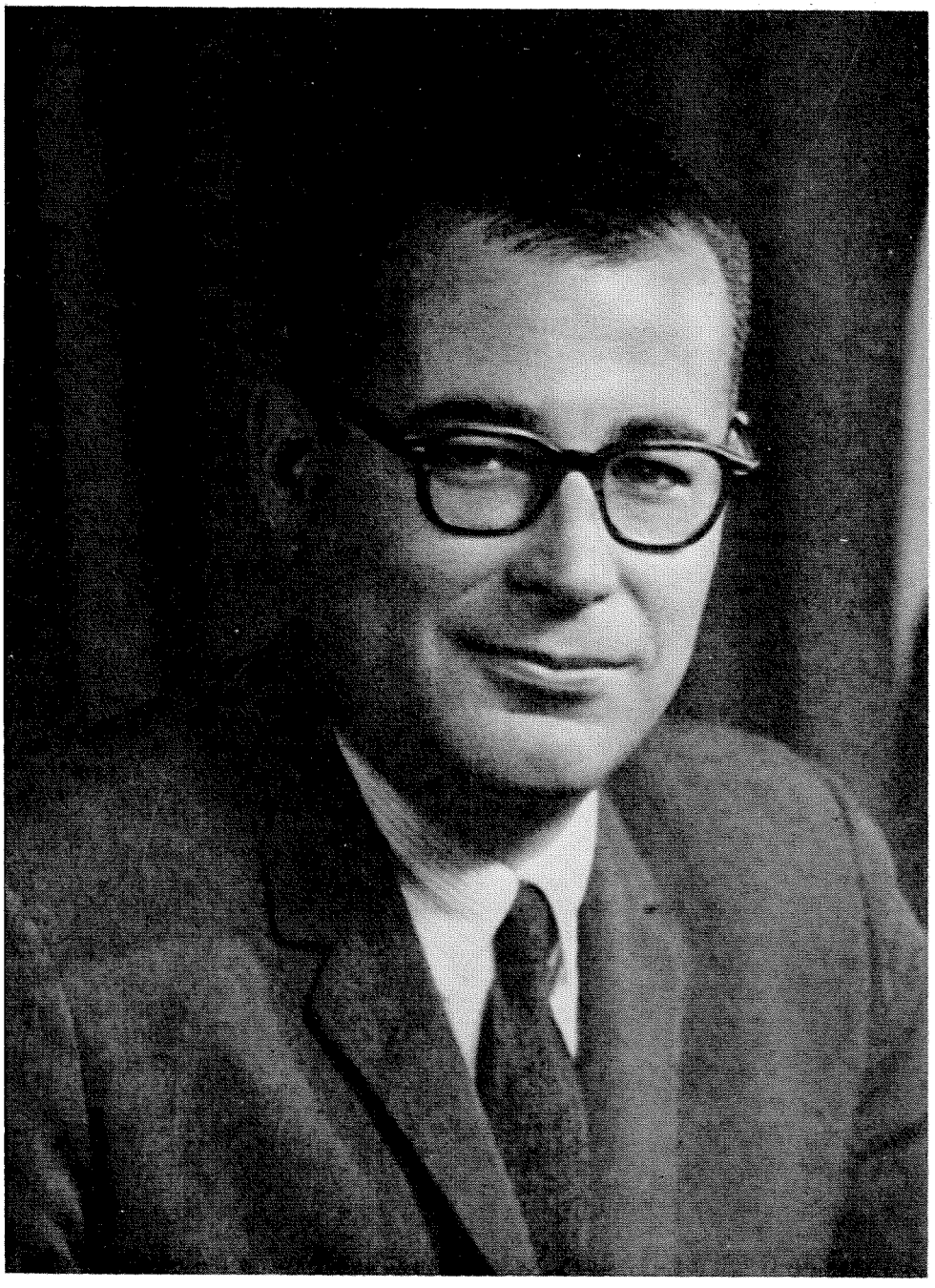
It is a job for which he has had extensive preparation. In 1951 President Truman appointed him to the government's new Science Advisory Committee, established to maintain contact between the federal government and the scientific community. The next year President Eisenhower asked DuBridge to become chairman of that committee, a job he held until 1958 when the responsibilities were expanded into a full-time position.

Now, two administrations later, in that full-time role, DuBridge will have three major responsibilities. As adviser to the President he will consult with the chief executive on the coordination and adoption of policy necessary to a healthy growth of science and technology and to the welfare of the country. As chairman of the Federal Council on Science and Technology he will coordinate the array of scientific activities of the government. And as chairman of the Science Advisory Committee he will call on the best scientific minds in the country to help solve the national problems involving scientific matters, from nuclear energy to education and research in the universities.

In addition to his experience as a physicist, research director, educator, and administrator, Lee DuBridge takes to Washington a nationwide reputation as "Senior Spokesman for Science." He will bring all these to bear on the problems of strengthening science and education in this country. □

Some Milestones

1966	75th anniversary of Caltech
	Surveyor I makes a soft landing on the moon
	Division of the Humanities becomes The Division of the Humanities and Social Sciences
1967	Robert A. Millikan Memorial Library dedicated
	$85 million development campaign launched
	Surveyor III makes elaborate soil tests on the moon
1968	Noyes Laboratory of Chemical Physics opens
	Proposal to admit women undergraduates passed
	Tuition raised from $1,800 to $2,100



Harold Brown

Caltech's New President

Harold Brown, Secretary of the Air Force, will be the new president of the California Institute of Technology. He will come to Caltech shortly after he leaves office on January 20, at the end of the Johnson Administration.

Robert F. Bacher, who has been Caltech's provost since 1962, will serve as acting president during the period between Lee DuBridge's departure for Washington and Harold Brown's arrival in Pasadena.

Dr. Brown, 41, is a physicist who has won worldwide respect for his outstanding scientific and administrative abilities. Always quick to understand and solve problems, he was graduated from the Bronx High School of Science at 15, with a 99.5 average. He went through Columbia University in two years. ("Everything was accelerated during the war," he says modestly.) He was elected to Phi Beta Kappa at Columbia and also won the Green Memorial Prize for maintaining the highest undergraduate record.

At 22 Brown received his PhD in physics from Columbia and while working on his doctorate was appointed Lydig Fellow and physics lecturer. After receiving his doctorate in 1949, he became a lecturer in physics at the Stevens Institute of Technology in Hoboken, New Jersey.

In 1950 he put aside teaching for a career in research and development as a staff member of the University of California's Lawrence Radiation Laboratory at Berkeley. He joined the staff of the Laboratory's Livermore branch when it opened in 1952 and in 1960 succeeded Dr. Edward Teller as its director.

At Livermore he was closely associated with Project Plowshare, a program seeking to apply nuclear power to peaceful uses such as recovering oil deposits, creating heat reservoirs, excavating harbors, and utilizing low-grade ores. He also studied the feasibility of creating water reservoirs in arid regions through the use of nuclear explosives.

He served as scientific adviser to the United States delegation at the 1958 nuclear weapons tests detection conference in Geneva and as senior science aide to the American delegation at the nuclear test ban conferences in Geneva in 1958 and 1959.

In 1961 he was named one of America's ten outstanding young men by the U.S. Junior Chamber of Commerce. He also received the Navy's Distinguished Public Service Award that year.

Brown became Director of Research and Engineering for the Defense Department in May 1961. This was the third-ranking civilian job in the Defense Department. Before coming to the Pentagon post he had been a scientific adviser to the Air Force, and he was a member of the Navy's special steering committee to guide the development of the Polaris missile.

President Johnson named Brown Secretary of the Air Force in 1965. In that position he has had a three-sided job—Air Force technical adviser, general supervisor of all research and development in the Department of the Air Force, and operational chief of the Advance Research Projects Agency and the Weapons Systems Evaluation Group. It was recognized that he would bring to that office a deep perceptiveness about people, a remarkable ability as a listener, and great competence in recognizing and solving scientific problems. These attributes helped him to deal with what could have been an extremely difficult situation, and over the three years the military leaders, who had looked on him as an esoteric scientist, grew to trust and admire him as a person and to respect his decisions.

His colleagues describe him as "dynamic, vigorous, straightforward," and as a man who exhibits "high integrity as well as a great intellectual capacity." He is an inveterate reader and averages four or five books a week. His wife, Colene, is a Purdue University graduate and a former department store buyer. They have two daughters—Deborah, 13, and Ellen, 11.

When President DuBridge originally announced his intention to retire in the summer of 1969, a faculty committee was appointed to recommend candidates for a new Caltech president to the board of trustees. This committee had been hard at work for 18 months when DuBridge requested that his retirement date be moved up to this January in order to accept his new appointment. In those 18 months the committee had assembled a list of 150 names, and 40 of these were investigated in detail. This faculty committee and a trustee committee then thoroughly studied 15 of the 40 and narrowed the field to six, who were interviewed in off-campus visits. Finally, four men were invited to come to Caltech to meet with the trustees, faculty, and students. The result was the selection of Harold Brown, and the comment from the committee chairman: "Our committee was determined to find not just a good president, but a great one. We feel confident that we have done just that." □

FINAL EXAM

What company was responsible for the following engineering innovations?

The transistor_____
Radio astronomy_____
Negative feedback_____
High Fi and Stereo_____
Synthetic crystals_____
TV transmission_____
Magnetic tape_____
Sound motion pictures_____
Microwave relay_____
Electronic switching_____
The solar battery_____
Telstar_____

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We hope the above final can be the start of something great.

ALBERT TYLER

1906-1968

Albert Tyler, Caltech professor of biology and a member of the faculty since 1929, died on November 9 of a heart attack. He was 62.

Dr. Tyler was born in Brooklyn, New York. He attended Columbia University and received his BA there in 1927. Although he had been a chemistry student, he became interested in the work of Columbia's great geneticist, Thomas Hunt Morgan, and he asked Morgan to take him as a graduate student. When Morgan came to Caltech in 1928 to start the biology division, Albert Tyler transferred with him and became the first student to earn a PhD in biology at Caltech (in 1929) and the last graduate student of Dr. Morgan.

In his years at the Institute, Dr. Tyler helped bring about a basic change in his field—the expansion of classical experimental embryology into modern developmental science, with its emphasis on genetics and molecular biology. He was well grounded in classical embryology, especially of marine invertebrates. He was one of the first scientists to apply modern physiological and biochemical methods to the study of development.

Tyler made some of his greatest contributions through his research on fertilization. He was especially known for his work on the chemistry and physiology of the fertilization process and for his contributions to the fertilizin-antifertilizin theory.

During the last ten years of his life, Albert Tyler turned his attention to studies of the macromolecular events during embryogenesis in the sea urchin, and especially to the role of "masked messenger" RNA and the properties and developmental role of cytoplasmic DNA.

Dr. Tyler was a trustee of the Marine Biological Laboratory at Woods Hole, Mass., for 14 years. He served on numerous committees and as a consultant to various organizations, among them the National Science Foundation and the World Health Organization. He had also been president of the Society of General Physiologists and of the American Society of Naturalists.

Colleagues and friends paid tribute to Dr. Tyler and to his work at the Institute at a memorial service held in Dabney Lounge on the Caltech campus on November 18.

"...I'm kind of a marriage counselor for the ocean..."

Vic Taylor is a corrosion specialist for International Nickel at its testing lab in North Carolina.

"...*That old ocean doesn't like us sometimes. She rusts boats, eats away metals, destroys coatings...what we're trying to do is come up with alloys she can live with.*"

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"...*Remember how car bumpers used to corrode? Now it's a different story. And boats last longer, too. Diving bells go deeper than anybody ever dreamed of...*"

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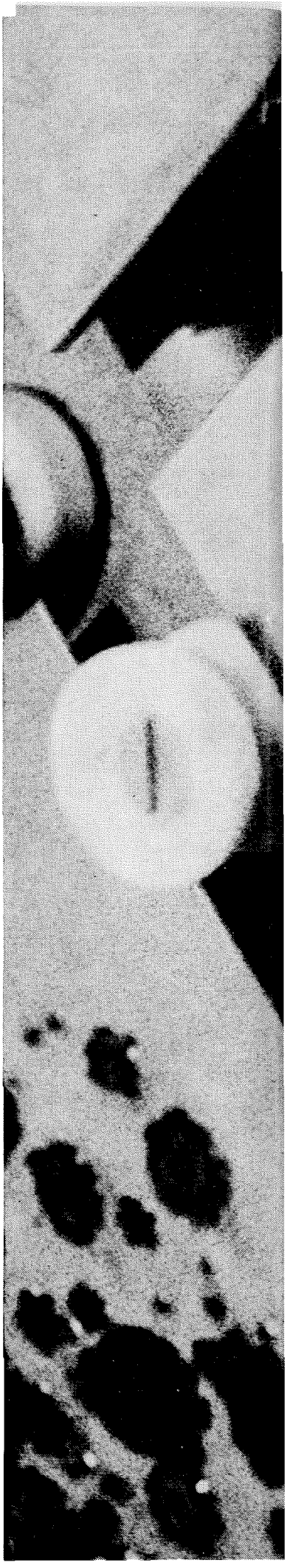
Vic holds a nickel-chrome plated automobile bumper which was tested in the corrosive seaside atmosphere.



Photography by W. Eugene Smith.

"It never crossed my mind that IBM wanted Mechanical Engineers."

"IBM is so involved in the electronics field, I'd always assumed they weren't particularly interested in M.E.'s," says Andy Simon.

Andy got his M.E. degree in 1967. He's now a packaging engineer in memory development at IBM.

Andy found out why IBM needs good mechanical engineers when he went to his campus interview. As electronic packaging gets smaller and packaging density increases, a lot of new problems arise. And the M.E. has to solve them.

As Andy says, "When I design the hardware package for a microelectronic memory unit, I deal with heat transfer and other thermal problems, vibration and shock analysis, and electromagnetic compatibility. The associated connector design work gets me into stress and creep analysis and Hertz contact stress and evaluation."

Then comes production

That's only part of Andy's job. After his team designs, develops, and produces a prototype memory unit, he has to work closely with manufacturing engineers, advising them on machines and processes to mass-produce the unit.

"It's tough but rewarding work," says Andy, "because the problems change with each new assignment. So an M.E. gains a lot of experience fast. The kind of experience that helps him move ahead fast."

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LETTERS

Pasadena

EDITOR:

I have compared the original and the published versions of L. E. Fraenkel's review of Saul Kaplun's and J. D. Cole's books (*E&S*—October 1968). The severe editing of the first half of the review has, in my opinion, not only led to omission of important material, but has in various ways distorted the meaning of Fraenkel's review. I hope it will be possible for you to print the original version of the first half of the review.

P. A. LAGERSTROM

For the record, Dr. Fraenkel's original review of Fluid Mechanics and Singular Perturbations *read:*

The theory describing the flow past bodies of a viscous fluid is a notoriously difficult one; the governing equations (Navier-Stokes) can be solved exactly and explicitly for only a few highly artificial cases, and approximation schemes invariably meet difficulties demanding and stimulating increasingly subtle mathematical techniques. In the years 1954-57 there appeared from Caltech four great papers: "The Role of Coordinate Systems in Boundary-layer Theory," S. Kaplun (1954); "Examples Illustrating Expansion Procedures for the Navier-Stokes Equations," P. A. Lagerstrom and J. D. Cole (1955); "Asymptotic Expansions of Navier-Stokes Solutions for Small Reynolds Numbers," S. Kaplun and P. A. Lagerstrom (1957); and "Low Reynolds Number Flow Past a Circular Cylinder," S. Kaplun (1957). These papers not only gave a fresh and clearer view of the various approximation schemes for very viscous and for nearly inviscid flow but also systematized and extended significantly the mathematical technique implicit in Prandtl's boundary-layer theory. Indeed, these papers did much to provide the applied mathematician with new tools that have since then been applied to an astonishing variety of problems. These tools now form part of the subject known as "singular perturbations," a phrase used to describe methods for solving boundary- or initial-value problems which involve a small parameter in such a way that the "obvious" expansion in terms of that parameter fails to approximate the desired solution throughout the physical domain. Saul Kaplun, to whom Lagerstrom and Cole attribute the principal ideas in this work, died in 1964 at the age of 39.

Fluid Mechanics and Singular Perturbations is in two parts. The first contains Kaplun's three published papers and preliminary drafts of intended papers on his approach to singular perturbations and on the lift at low Reynolds number of two-dimensional bodies. The second part contains similar drafts of some of his extensive work on the problem of flow separation. The editor's work consisted of selection, of minor changes with respect to notation and errors of transcription, and of the provision of a most helpful commentary.

The first paper—concerning "optimal co-ordinates," in terms of which the boundary-layer solution contains the entire outer flow not merely to first but to second order—makes an elegant and satisfying beginning. The remainder of Part I shows exceptional depth. The problem of very viscous flow—that is, flow at low Reynolds number—past a circular cylinder seemed anomalous from 1851, when Stokes found that his approximate equations had no appropriate solution, until 1910, when Oseen resolved the difficulty in a manner very satisfactory for fluid mechanics but of an essentially *ad hoc* character. (The application of Oseen's method to the circular cylinder is actually due to Lamb.) Kaplun's approach was systematic; put both the Stokes and the Oseen equations into their proper setting; led to a scheme which could, in principle, be continued to arbitrary order; and gave a new view of the relationship, in delicate problems of this kind, between various expansions of the desired solution. Previously, it had not been suspected that an extension of Prandtl's ideas for flow at large Reynolds number might remedy the difficulties at the other end of the range.

Part II of the book, on the behavior of solutions of the boundary-layer equations near a point of zero skin-friction, is strictly for specialists—and ardent specialists at that. This material is not in the final form that Kaplun hoped to produce, and a number of the results were also found by Stewartson in 1958. Nevertheless, there is no doubt that Kaplun's thorough analysis (first of the Von Mises form of the equations and then of the transformation to the physical plane), with its careful interpretation of the basic meaning of each step, adds substantially to what is known of this difficult aspect of boundary-layer theory.

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Caltech Lecture Series

JANUARY

20 David G. Elliott, supervisor, Propulsion Energy Group, JPL—"Beyond Mars With Nuclear-Electric Propulsion"

27 Ronald F. Scott, professor of civil engineering—"Soil Is Everywhere"

FEBRUARY

3 Albert Ravenholt, American Universities Field Staff—"Red China and the Proletarian Cultural Revolution"

10 Harrison Brown, professor of geochemistry and of science and government—"Science, Technology, and Economic Development"

17 Edward B. Lewis, Thomas Hunt Morgan Professor of Biology—"Genes, Sex, and Development"

24 Marshall Cohen, professor of radio astronomy—"New Approaches to Radio Astronomy"

MARCH

3 Eric F. Goldman, Rollins Professor of History, Princeton University—"The Metro-american: The New American of the 1960's"

Concert and Drama Series

JANUARY

18 Two one-act plays: Harold Pinter's "A Slight Ache" and N. F. Simpson's "A Resounding Tinkle."

21 "By George"—Max Adrian in the original London and Broadway hit.

25 The Roger Wagner Chorale.

FEBRUARY

1 Shirley Verrett, mezzo-soprano.

8 Repertory Dance Theatre of the University of Utah.

14 Kipnis Mime Theatre.

15 L.S.B. Leakey—lecture on the "Latest Evidence on Man's Evolution in Africa."

28 Isaac Stern, violinist.

MARCH

7 "Phaedre," by Racine, will be performed in French by Productions d'Aujourd'hui.

14 First Chamber Dance Quartet.

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Planning and coordinating come naturally to Bob. As a Production Control Specialist with General Electric's Medium AC Motor and Generator Department, he keeps production lines running smoothly. Coordinating machinery, raw materials and labor is crucial to any efficiently run business.

With a mechanical engineering degree from Cornell, in 1962, and an MBA in personnel administration from George Washington, in 1963, Bob sought to plunge directly into meaningful work. He'd had enough theory and simulations to last him for awhile.

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