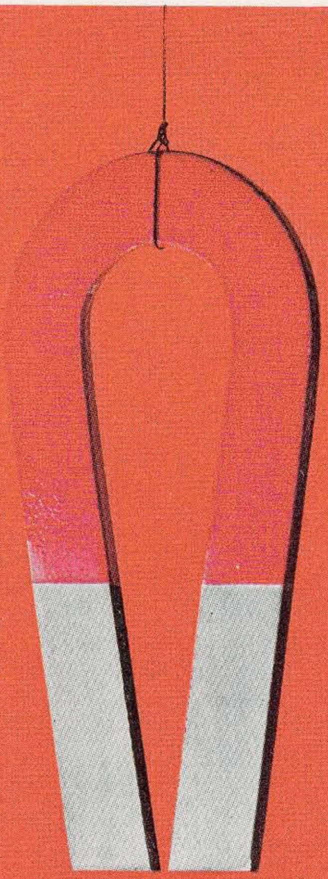
ENGINEERING | AND | SCIENCE

December 1962

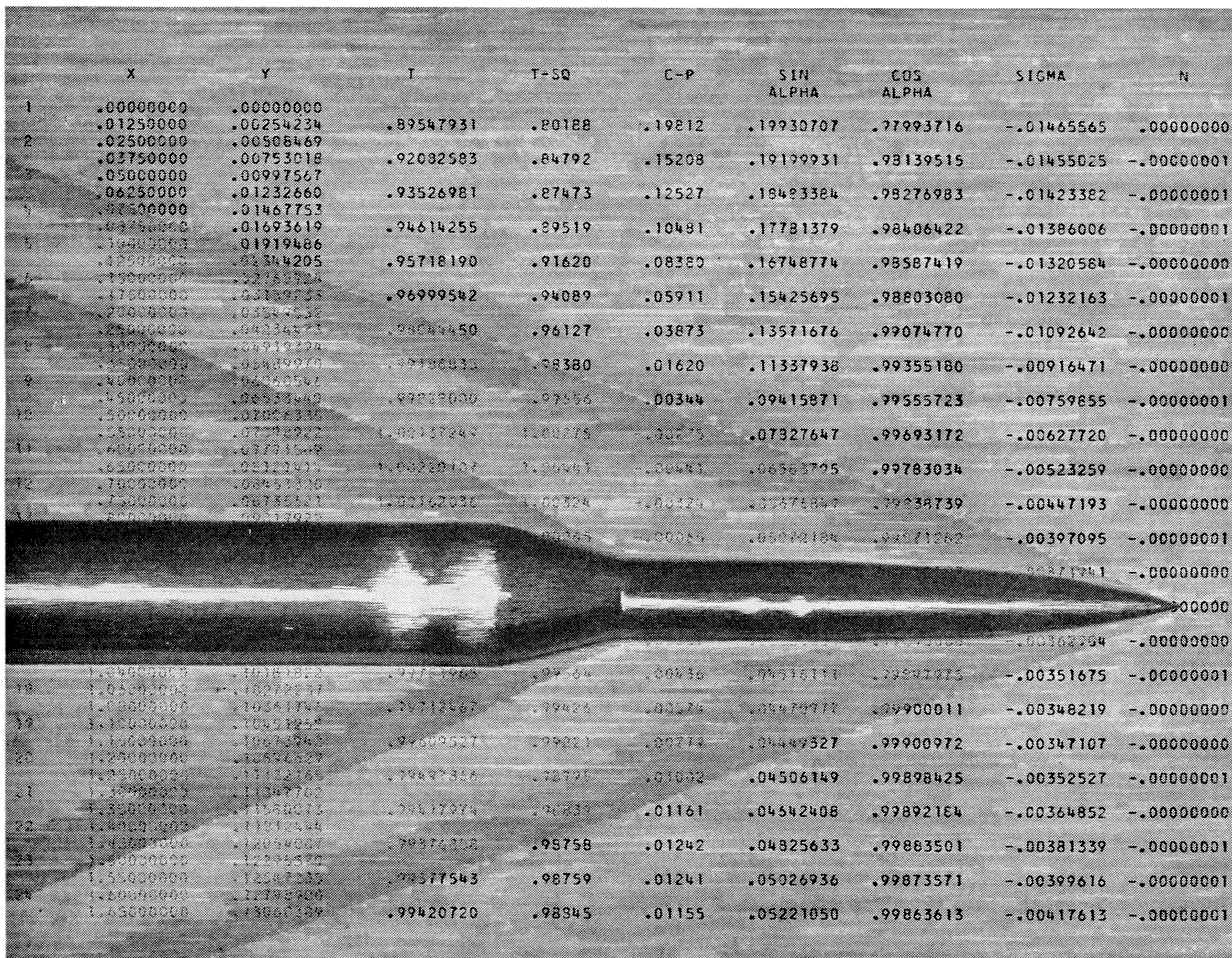
Plant flowering . . . page 3

Published at the California Institute of Technology



THE SHAPE OF SPEED
...A STIMULATING AREA FOR CREATIVE ENGINEERS

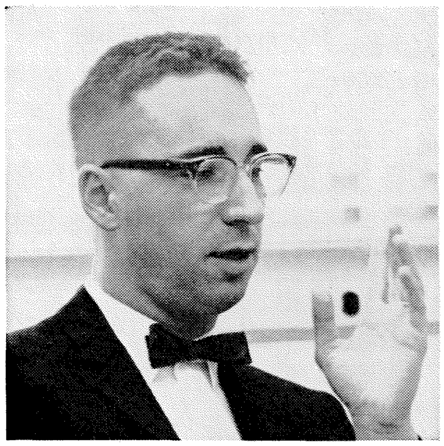
A basic problem facing the designers of submersible, sea-going, air-cushion, flying or space-seeking vehicles is the resistance of the liquid or gaseous fluids through which these craft must pass. The shape of the vehicle becomes critical in determining its speed and efficiency. Research on fluid dynamic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



The above is only one of hundreds of interesting assignment areas at Douglas. If you are seeking a stimulating career with an organization in the thick of the most vital programs of today and tomorrow, we invite you to contact us. Write to Mr. S. A. Amestoy, Douglas Aircraft Company, 3000 Ocean Park Boulevard, Santa Monica, California. Box 600-E. Douglas is an equal opportunity employer.

DOUGLAS

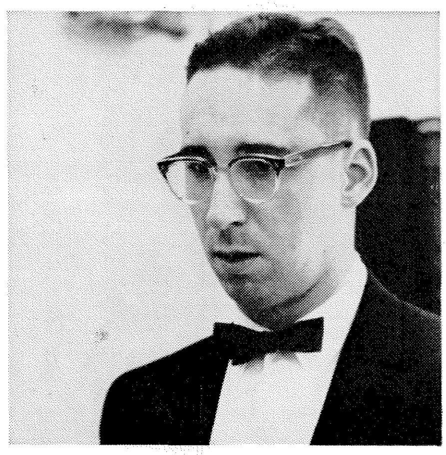
How long've you been out of school?



Since '52. Purdue. Then two years in the Navy and a year for my Masters at Caltech.

I came to Jet Propulsion Laboratory right after that. '55. I like it very much. It's a nice atmosphere for engineers to work in. There's a lot of work, a lot of hard work. But interesting.

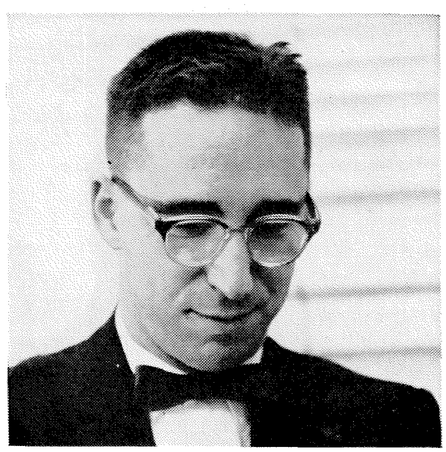
And because we're operated by Caltech, we can work closely with some of the top scientific minds in the country. I think that makes a difference. We have a lot of freedom within our individual disciplines, too.



I'm an Engineering Group Supervisor. Our group is among those responsible for communications with spacecraft designed by JPL to go to the moon and planets.

Among other things, we want to find out what the moon is made of, and if there's life on other planets. Contributing to space exploration is a challenging vocation.

We've excellent facilities here. One of the largest technical libraries, for example. There are at least two support people for every scientist and engineer at JPL. And they're all great to work with.



I bought a home close by. Only 20 minutes from coffee cup to coffee cup. My wife likes that. The kids like where we are, too. We like hiking and there are excellent trails minutes from our house.

You've just been chatting with Dick Mathison, JPL engineer. He likes his work. He likes where he works. Would you like to share in the challenging and important work he does? Maybe you can...why not write to JPL and see.

"Research and development for America's lunar, planetary and interplanetary exploration programs."

JET PROPULSION LABORATORY

Operated by California Institute of Technology for the National Aeronautics & Space Administration
4800 Oak Grove Drive, Pasadena, California
Attention: Personnel Department 103
"An equal opportunity employer"

ENGINEERING | AND | SCIENCE

On Our Cover

James Bonner, professor of biology, looks for laboratory-induced flowering in a cocklebur plant, used for studies on the hormone which causes plants to flower and bear fruit. Biologists have been trying to isolate this vital hormone for half a century. Now, Caltech biologists report an important advance in this research, in "Plant Flowering," page 28.

Richard P. Schuster, Jr.

author of "Some Misconceptions about Disarmament," on page 8, is a member of the Arms Control Studies Group at Caltech's Jet Propulsion Laboratory. Mr. Schuster received his BS in electrical engineering from Caltech in 1946 and another BS in applied chemistry in 1949.

He was plant manager for the Bray Chemical Company in Los Angeles for ten years before he came to JPL earlier this year when the Arms Control Studies Group was formed.

The Milky Way Galaxy

pictured on page 21 is not a photograph, but a painting, from the Lund Observatory in Sweden. Astronomers have photographed over a thousand million galaxies, but the Milky Way cannot be seen or photographed in its entirety because so much of it is hidden from us by gases, dust, and stars.

Picture Credits:

Cover, 14, 16, 26, 28—James McClanahan
14, 15 (top)—Robert M. Jeffrey
15 (bottom)—J. Douglas Stewart

DECEMBER 1962 VOLUME XXVI NUMBER 3

Some Misconceptions About Disarmament 9

1. Limited nuclear war is feasible. 2. The United States desires and is prepared to implement disarmament. 3. A United States shelter program is desirable. 4. The United States must not recognize Red China.

by Richard P. Schuster, Jr.

The Month at Caltech 14

The Values of Science 20

Science not only has great practical value, but it is interesting, exciting, and valuable for its own sake. For example—

by L. A. DuBridge

Student Life 26

Interhouse Dance

by Richard Karp '64

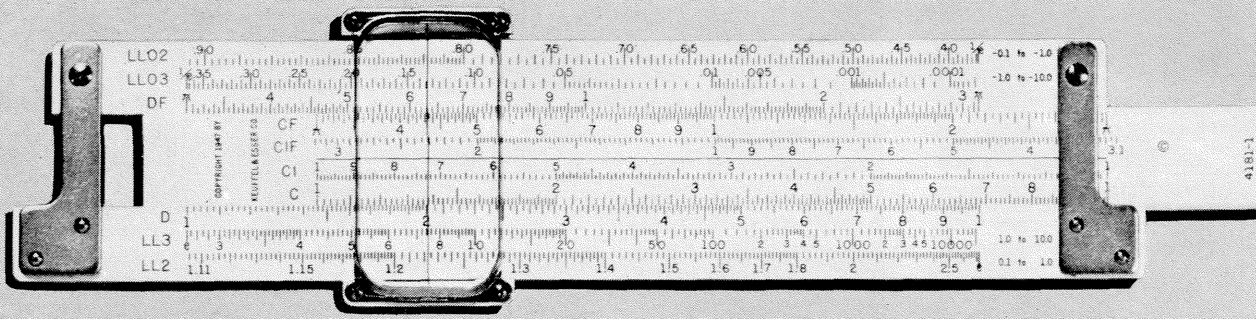
Personals 32

Alumni News 34

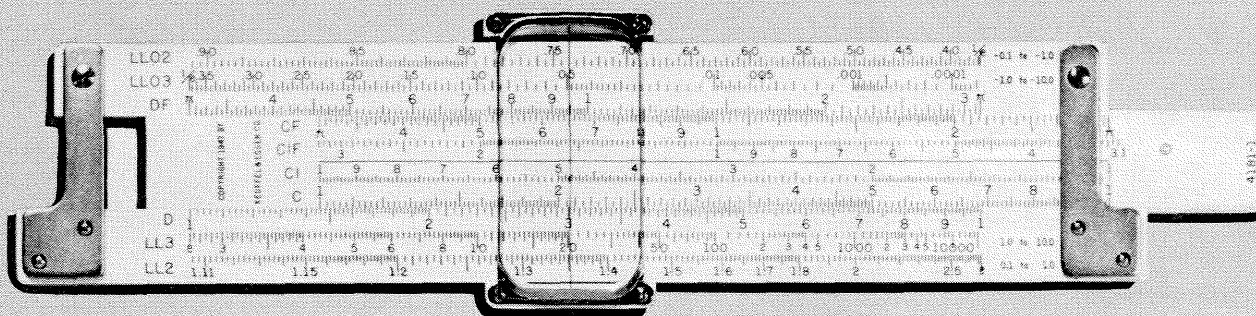
STAFF

Publisher.....Richard C. Armstrong '28
Editor and Business Manager.....Edward Hutchings, Jr.
Assistant to the Editor.....Gerda Chambers
Student News.....Richard Karp '64
J. C. Simpson '65
Photographer.....James McClanahan

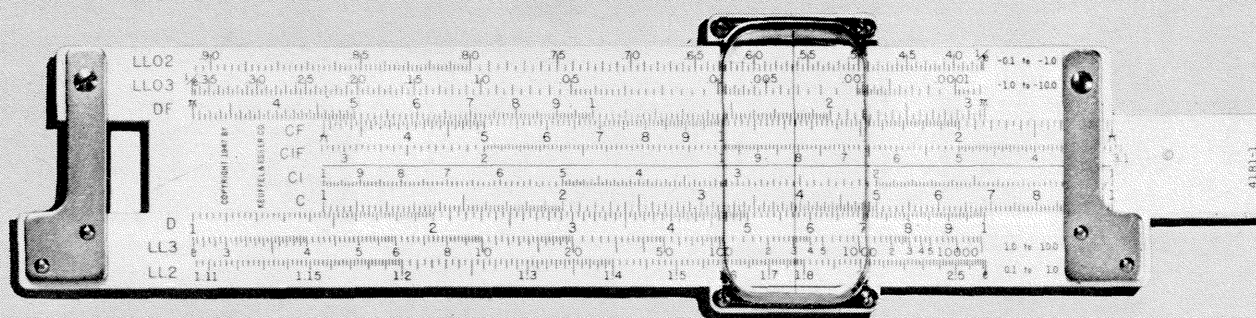
Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena, Calif. Annual subscription $4.50 domestic, $5.50 foreign, single copies 50 cents. Second class postage paid at Pasadena, California, under the Act of August 24, 1912. Manuscripts and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



MULTIPLY . . . your opportunities for advancement



DIVIDE . . . your time between classroom and job



ANSWER: AC's Career Acceleration Program

It takes only eight months in AC-Milwaukee's "Career Acceleration Program" to become an important member of one of the nation's top inertial guidance development and manufacturing operations. You will add to your technical background eight months of formalized classroom instruction in: **Ballistic and Cruise Missile Instruction and Laboratory, Engineering Analysis (Servo Mechanisms), Principles of Airborne Digital Computers, Basic Principles of Inertial Guidance, Probability and Statistics, and the Philosophy of Reliability**—plus rotating job assignments in Engineering, Manufacturing and Reliability Departments.

In 32 weeks you're working on guidance systems for Thor, Titan II and Apollo and a modified Bombing Navigational System for the B-52C&D.

You've multiplied your opportunities for advancement with up-to-date knowledge in this rapidly changing area.

MILWAUKEE—In addition to the "Career Acceleration Program" there is a Field Service Program: Two- to four-month classroom and laboratory On-the-Job Training Program which involves training on inertial guidance systems or bombing navigational systems. Domestic assignments follow completion of program.

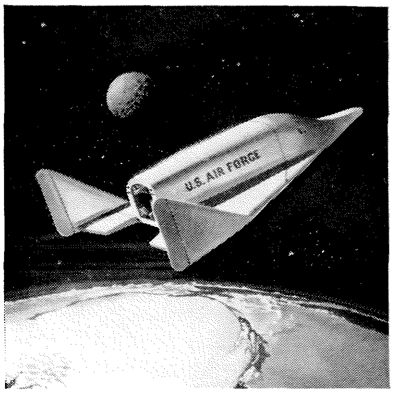
BOSTON—Advanced Concepts Research and Development On-the-Job Training Program—AC's Boston Laboratory is engaged in development of navigational systems for manned aircraft, ballistic missiles and space vehicles.

LOS ANGELES—Advanced Concepts Research and Development On-the-Job Training Program—AC's Los Angeles Laboratory is occupied with advanced guidance research for space vehicles and ballistic missiles, plus research in special purpose digital computers.

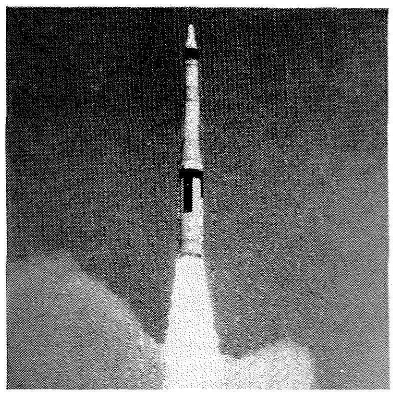
If you will soon have a BS, MS, or PhD in EE, ME, or Physics, contact your placement office or write Mr. G. F. Raasch, Director of Scientific & Professional Employment, Dept. 5753, AC Spark Plug Division, South Howell, Milwaukee 1, Wisconsin.

AC SPARK PLUG THE ELECTRONICS DIVISION OF GENERAL MOTORS

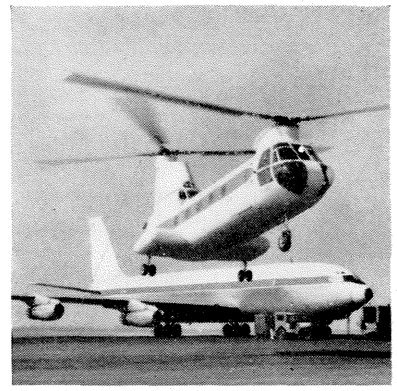
MILWAUKEE • LOS ANGELES • BOSTON • FLINT *An Equal Opportunity Employer*



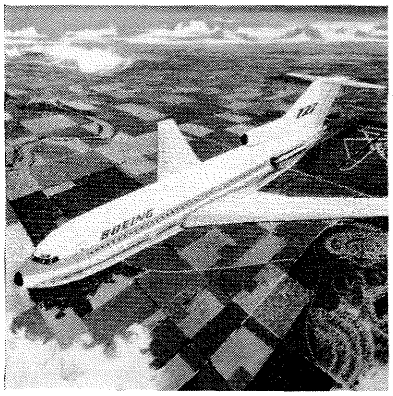
System contractor: DYNA-SOAR



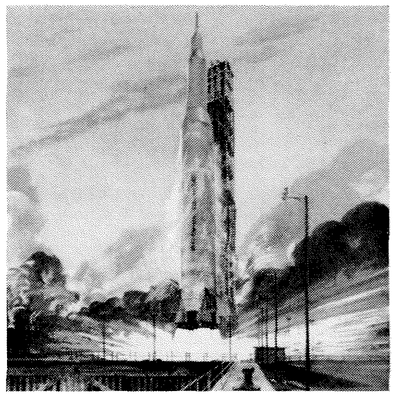
System integration: MINUTEMAN



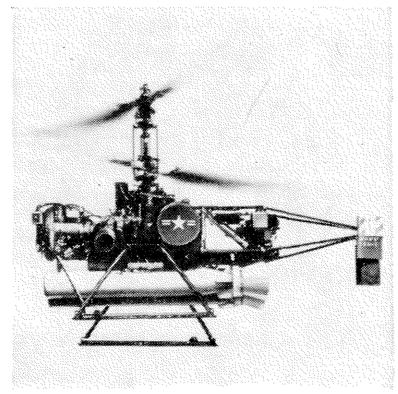
Boeing 707 with Boeing-Vertol 107



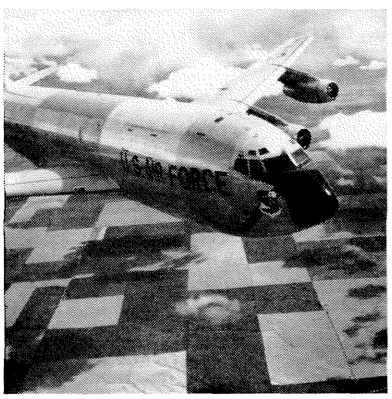
New Boeing 727 short-range jetliner



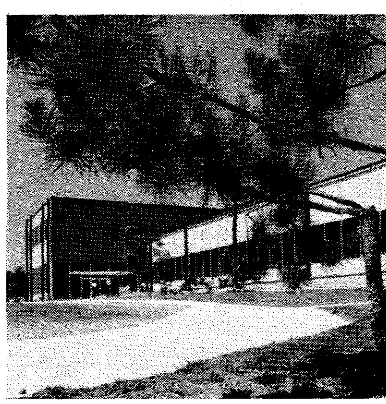
Space booster development: SATURN S-1C



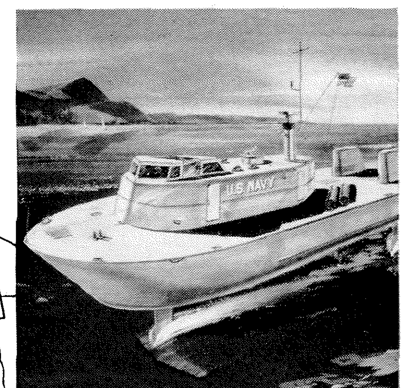
Boeing turbines power helicopters



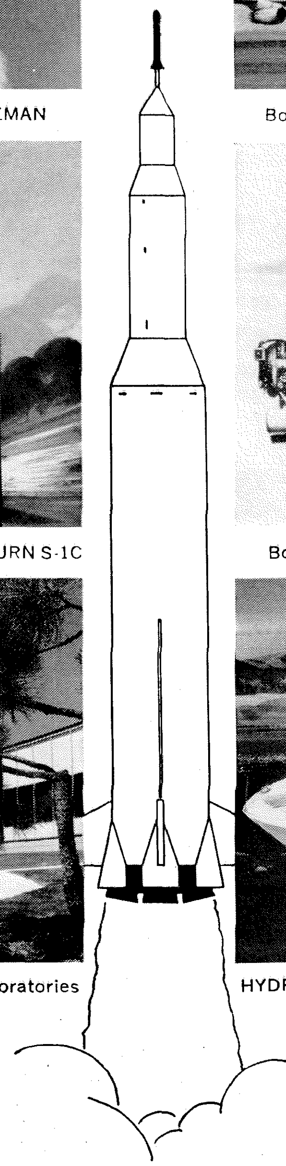
Boeing KC-135 jet tanker-transport



Boeing Scientific Research Laboratories



HYDROFOIL development, construction



CAREER BULLETIN FROM BOEING

The continuing expansion of advanced programs at Boeing offers outstanding career openings to graduates in engineering, scientific and management disciplines. At Boeing you'll find a professional climate conducive to deeply rewarding achievement and rapid advancement. You'll enjoy many advantages, including up-to-the-minute facilities, dynamic industry environment, and company-paid graduate study programs (Masters and Ph.D.).

For further information, write today to Mr. Conrad E. Brodie, The Boeing Company, P. O. Box 3822 - UCI, Seattle 24, Washington. Boeing is an equal opportunity employer.

BOEING

ENGINEERING AND SCIENCE
December 1962, Volume XXVI, No. 3

SOME MISCONCEPTIONS ABOUT DISARMAMENT

1. Limited nuclear war is feasible.

2. The United States desires and is prepared to implement disarmament.

3. A United States shelter program is desirable.

4. The United States must not recognize Red China.

by Richard P. Schuster, Jr.
Arms Control Studies Group, JPL

The most fundamental misconception about disarmament is the sweeping, all-inclusive action suggested by the concept "disarmament." Perhaps we wouldn't care so much about nuclear weapons if some sort of absolute guarantee were provided that they would never be used. So nowadays we tag our approach "arms *control*," with disarmament as a special, limiting, and perhaps ideal, case. The primary goal of arms control is a sufficiently stable balance of forces wherein an agreement violation or a threatening action would start, at worst, an arms race, not a war.

The government's appreciation of this was evidenced by a reorganization that took place in September 1961. The old United States Disarmament Administration, an ineffectual, understaffed office in the State Department that had existed for only one year, was superseded, by Congressional act, by a new agency jointly responsible to the President and the Secretary of State.

The responsibilities of the new Arms Control and Disarmament Agency, or ACDA, include research for policy formulation, preparation for and management of United States participation in international negotiations, public information, and preparation for and direction of United States participation in any international control systems that may be included in treaty arrangements. These responsibilities are primarily discharged through four bureaus – International Relations, Weapons Evaluation and Control, Science and Technology, and Economics.

Our study group at JPL was established earlier this year under the primary direction of the Science and Technology Bureau. Its particular goal is to contribute to those elements of arms control that pertain to outer space; however, studies by our group and by the Agency *may* deal with substantive provisions, political aspects, verification measures and procedures, international organizational patterns, and economic impacts of arms control agreements.

The literature of disarmament is certainly replete with contradictions, even among the experts, and what I see as misconceptions may be another person's dogma. In presenting the following misconceptions, I should also explain that one misconception doesn't necessarily follow from another, no priorities are suggested, and the thoughts are selective, not comprehensive.

Limited Nuclear War is Feasible

In case war breaks out somewhere, can its dimensions be restricted? Yes! There have been numerous examples since the second World War, including Korea, the Congo, Hungary, Suez, and Cuba.

The Korean War can help identify several concepts. The first is deterrence, which can be defined as the prevention of a hostile action by the threat of forcible retaliation. At the time of Korea the Strategic Air Command represented our deterrent. It failed; that is, war started. An outbreak of hostilities signifies the failure of deterrence. A second concept is that of limited war. Korea started as a less than total war and remained limited, even though the United States and Russia were intimately involved. A third concept is that non-nuclear war is feasible. Nuclear weapons were available at the time of Korea and were not used.

A hopeful sign is that, beginning with Korea, both the U. S. and Russia have continued to use limited, unilateral arms control concepts. One must be careful when using the word "unilateral," for to many persons "unilateral action" has negative connotations of surrender or a lack of resolution, instead of, simply, action taken in the absence of formal agreement. We must also remember that limited conflict requires two sides to keep it limited, two sides that strike some sort of tacit bargain not to exceed certain restraints.

A main point here is the practical nature of these concepts. As opposed to many of the postulations of the game theorists – people who suggest courses of action based on completely theoretical considerations – we are attempting here to emphasize what really has happened and still is happening, what restraints have been and still are recognized. We can already refer to a tradition for the non-use of nuclear weapons.

Why have these restraints been exercised? What does actually limit a war? Why, for instance, do conflicts so often stop at national boundaries? One can think of examples: Indo-China, Berlin, Korea. What makes a border a compelling place to draw a line in the event of war in that area is principally that there is usually no other *plausible* line to draw.

The distinction between nuclear and non-nuclear (or conventional) weapons is, or should be, crystal clear. A plausible line may be drawn. But within the family of nuclear weapons, there are no distinctions – no sharp discontinuities in the magnitude of weapons effects, the form in which weapons may be employed, the means of their conveyance or delivery, or the nature of their targets. One can talk of a 40-megaton weapon delivered with an ICBM or a one-ton weapon delivered from a six-shooter. There is a continuous spectrum, and any boundary – any intermediate limit – is entirely arbitrary.

Now, if it takes two to keep a war limited, and if the two parties, as they have in the past, strike some kind of bargain without explicit communication, the particular limit has to have some quality that distinguishes it from the continuum of possible alternatives; otherwise there is little basis for confidence on each side that the other acknowledges the same limit. The boundary between nuclear and non-nuclear weapons is the *only* one that I can imagine.

It is and will be sufficiently difficult to limit a conventional war, much less a nuclear one. It is extremely hard to imagine how the escalation of a limited war could be avoided. ("Escalation" here has its usual meaning: I drop one bomb, my opponent two; I drop three bombs, my opponent four.) Aside from the strange concept of limited war which usually implies a war fought "elsewhere," we might question how a major power will react today if its *own* borders are threatened. Can we imagine how the notion of "gentlemenly" (that is, conventional) war could survive the hatreds of a population facing defeat? Is it clear that a nation would more readily accept a conventional than a nuclear defeat? Which factor will prevail, the value of the objective or the nature of the weapons used to attain it?

Our inability to approach satisfactory answers to difficult questions such as these shouldn't deter us from adopting those positions that *are* tenable. While many influential persons demand a full spectrum of tactical nuclear weapons, I am unaware of a coherent, plausible strategy for using these weapons in limited nuclear war. There is continuing disagreement among these persons, within our government and within the Western alliance, as to just what such a strategy should consist of.

In attempting to counter what I consider to be this misconception, I would stress four points:

1. There is, relevant to the process of limiting war, a clear distinction between nuclear and non-nuclear weapons.
2. The principal inhibitions of the use of nuclear weapons may well disappear the first time they are used.
3. On the occasion of *our* first use of nuclear weapons, we should be at least as concerned with the precedents we establish as with our original tactical or strategic objectives.
4. We should recognize that the enemy will be making similar decisions in determining the nature and extent of *his* response.

The United States Desires and is Prepared to Implement Disarmament

One certainly might reach this conclusion if one were familiar with the United States proposals for a nuclear test ban and for general and complete disarmament. Our April 1962 treaty proposal would establish an International Disarmament Organization within the framework of the United Nations, and, as the treaty progressed from Stage I to Stage III, the United Nations would become increasingly involved in various U. S. affairs. (Of course, the affairs of other countries would be similarly "interfered with.") One of the basic provisions of our treaty proposal calls for an international police force that would evolve from Stage I through Stage III into a force that ultimately would be so strong that no state could challenge it. This means that U. S. security would ultimately depend upon this international police force.

Public opinion in the United States frequently suggests a considerable eagerness to reach deep into Soviet life and activities and, at the same time, a deep reluctance to accept intrusion here, particularly by a body which may include Soviet or satellite inspectors. International realities, on the other hand, would seem to require reciprocity.

In addition to the detailed description of just which armed forces, armaments, nuclear delivery vehicles, and weapons would be reduced in each stage of disarmament, considerable space in our Geneva proposal is devoted to the inspection system that must necessarily accompany these disarmament activities. Some of the principal features that could be anticipated in such an inspection system are as follows:

1. A corps of international personnel will be admitted to the United States to carry out inspection to assure compliance.
2. These inspectors may freely enter government installations, perhaps including offices engaged in military and foreign affairs, and account for equipment and materiel.
3. They may subpoena and interrogate persons engaged in activities related to armaments, or persons suspected of unlawful activity, and require them to answer appropriate questions or produce relevant documents and records.
4. They may require reports and returns from private citizens and corporations engaged in activities related to the manufacture of armaments.
5. They may come at any time to factories or industrial or commercial establishments dealing in equipment or materials relevant to the control agreement and inspect in any detail necessary the processes and fruits of production. Inspectors may also be permanently stationed in some establishments.
6. They may interrogate scientists and inspect laboratories.

You can see that what is subject to inspection in our disarmament proposal will be rendered open and unclassified, and the present practice of classification of defense materiel might be virtually superseded. Laws which forbid the disclosure of defense information could be replaced by laws which require officials and citizens of the United States *to* disclose such information and, indeed, perhaps by laws which make it criminal *not* to disclose such information.

One can speculate on the reception that provisions such as these will receive when their full import must be debated by the members of Congress. One writer on arms control has suggested, with some wisdom, I think, that it is not at all wise to try to transfer to the disarmament arena political arrangements which would otherwise be unattainable *because* they are politically unacceptable.

Consider the reception of this kind of planning in the U. S. not only in Congress and elsewhere in the government, but also in the population at large. Is it true that Americans are ready to accept the political and social effects of disarmament and that the Russians are the villains who are obstructing progress in these areas?

It may be pertinent here to refer to the characteristic American view that peace is the "natural" state of man. It follows that, since Americans are, by definition, peaceful, then negotiations are futile unless the *Soviet* system changes. There is even the opinion that we should be extremely suspicious if the Russians *do* under present circumstances accept a U. S. proposal, for we can then presume that we have made an error.

One more point: Unfortunately, to the layman, to those not in the secret councils, accepting the merits of our policies must generally be a matter of faith. The details of the efforts of the United States Government and of other governments in regard to disarmament are frequently shrouded in high classifications.

Aside from Congress, who, of course, must pass enabling legislation, who *are* the people in our government who actually work out the details on arms control and will implement disarmament if and when it occurs? Many of these people are civilians attached to the executive branch, to the Departments of State and Defense. Here is an anomaly, for not infrequently a considerable gap exists between the private and public aspects of our national life, as illustrated by the fact that all too often eminent men address themselves to matters of national policy only when they reach high office. Each administration appoints new people to jobs in agencies like the ACDA, people who previously were attorneys, businessmen, educators, or scientists. They may be able and intelligent and still have zero experience in any aspect of national or international affairs.

If this is a valid thought, and if foreign affairs and arms control are as intimately involved as I think they are, then is it surprising that some observers sometimes wonder if we have any coherent policy or strategy? With new, uninitiated people continually introduced into decision-making situations of almost unimaginable gravity, we should probably expect what, in fact, we find: group studies and committee decisions, or, rather, compromises reflecting at best the highest common denominator. There is more concern with how things are than with what things matter. Momentum is confused with purpose.

A United States Shelter Program is Desirable

Is it advisable to discuss bomb shelters? Here is one area where, relative to life in the atomic age, many Americans feel they have some positive, personal control over their future. Besides, the obvious features of bomb shelters are *really* obvious; for example, if a large national shelter program is undertaken, in the event of a nuclear attack some people's lives *will* be saved.

You can even draw curves, after stating your particular assumptions. With any given number of shelters, the heavier the attack, the greater the casualties. With any given attack level, the greater the number of shelters, the fewer the casualties.

Let's consider the not-so-obvious. How can private citizens, not to mention government experts, estimate the effects of a thermonuclear attack? How can they scale upwards from familiar tragedy (familiar meaning the newspapers or *Life* magazine, not personal experience)? How can they take the giant step from a serious fire, earthquake, or flood, or even a Hiroshima bomb, to a thermonuclear war in which each bomb may be equivalent to all of the explosives detonated in World War II? How can we assess panic or shock; or, in the event of an extraordinarily heavy attack, how can we assess anarchy?

This may sound pretty emotional, and perhaps it is, but some observers see in the "emotional" the not-so-obvious side of a shelter program that *must* be considered.

A civilian defense program seems to represent to many a highly authoritative threat of personal death and social destruction of even greater magnitude than the threat of nuclear weapons per se, since the program directly warns that war is highly possible and even imminent. Civil defense fits into a view of the world in which negotiation has failed and war is looming, whereas disarmament fits into a view of the world in which negotiation seems possible and war avoidable. The shelters themselves might be symbolically even more threatening to hopes of disarmament than the call for civil defense. The combined promise of life and warning of death could involve such strains in individual hopes and fears as to make possible much serious and damaging emotional interplay among most Americans: among individuals, who must make decisions about their families; among governmental officials, who must set policy; among political leaders, who must authorize the necessary appropriations; among businessmen, who must provide protection in factories; among merchants, who must be responsible for the construction of shelters; and among scientists, who must assume technical responsibility. And what if a mistake is made? What kinds of new tensions would arise?

Civil defense, rather than a passive military measure, is seen by some as a blatantly offensive move. Then the question is whether or not a commitment to the proposed program will tend to restrict the government's freedom to negotiate matters of arms control and disarmament.

The United States is the only Western power capable in the near future of developing any given deterrent strategy. Theoretically, we have all of the options; we can strike first, second, hard, not so hard, or not at all. England's Alastair Buchan has considered the effect on our allies of a U. S. shelter program. He finds, as the United States and Russia develop increasingly invulnerable deterrents, increasingly heavier blows must be struck if they are to be effective. And, the heavier the attack that is necessary, the less credible will be the American resort to it, the American reputation being what it is. Buchan finds that this would be true even if the U. S. were to undertake a massive civil defense program.

But the option of a civil defense program is not open to our European allies, who don't have the warning time, the wealth or resources, or the raison d'être — the invulnerable deterrent. A sheltered America and an unsheltered Europe would be an extreme, to say the least, source of tension within the Western alliance.

Time is what really defeats the shelter program. Back in 1 or 2 B.C. (before continental missiles) Civil Defense officials spoke of three-hour warning times — "plenty of time" for a population to go underground. More recently, these officials have spoken, hopefully, of thirty minutes' warning. Tomorrow, or perhaps the day after, Russia will have an effective nuclear submarine fleet, similar to our own, and I'll let *you* imagine what warning time will be available to most Americans and what use shelters will be under those circumstances.

The United States Must Not Recognize Red China

It is difficult at any time to attempt to discuss arms control or disarmament and not become embroiled in politics, and it is particularly difficult when Communist China is the country being discussed.

Communist China is an especially serious facet of what is generally referred to as "the Nth country" problem. Those concerned with this problem, and most arms control commentators seem to be, find increasing instability with the acquisition of nuclear weapons by each additional country. The United States was secure in a "stable" arms situation while she maintained her nuclear monopoly. Later, we learned to fear Russia as a second-power problem. There is irony in the fact that the United States and the Soviet Union then thought in terms of a third-power problem, Great Britain in terms of a fourth-power problem, France in terms of a fifth-power problem, and so on.

The problem, the instability, consists of the increased probability that something will go wrong, or, according to Murphy's law, the more that *can* go wrong, the more *will* go wrong. The greater the number of countries that possess nuclear weapons — countries with diverse and often opposing ideologies, territorial claims, and defense strategies — the greater the opportunity for lack of understanding or lack of communication or for an accident that could escalate into a major disaster.

While many countries have the potential of developing nuclear weapons, which country is *more* likely to do so in the near future than Red China? And would any other country, when its first atomic device was exploded, have a more threatening effect on U. S. security and morale? If the principal threat of Communist China is her acquisition of nuclear weapons, and if we see in nuclear weapons a peril to mankind, how is the present impasse to be resolved?

The suggested misconception was that the U. S. must not recognize Red China; we must not carry on any negotiations that would imply recognition. How can we even think of arms control or disarmament negotiations with the knowledge that Communist China, or *any* country capable of a major threat, will be excluded from the conference table? While the danger certainly exists that any potential Nth country might simply *refuse* to accede to a treaty, we can never know if an attempt is not made.

Lester Pearson said that we prepare for war like precocious giants and for peace like retarded pigmies. The 1962 Arms Control and Disarmament Agency's budget is approximately six million dollars. (Last year it was only one million dollars.) The military budget is about fifty billion dollars. I don't know if matters like arms control, disarmament, and peace can be expressed satisfactorily in terms of dollars, but these figures *must* give some idea of how and where national efforts are being exerted.

Our foreign policy difficulties may be less due to the choice of *wrong* alternatives than to the lack of *any* choice of alternatives. Inadequate arms control proposals, reflecting compromises among competing groups rather than logically consistent policies, have perhaps been inevitable. In any choice between rigidity and flexibility, Henry Kissinger sees that only in the purposeful is flexibility a virtue. U. S. bargaining techniques have stressed "reasonable" proposals rather than sought to explore *whatever* we wished, regardless of what the given Russian attitude may have been. We must have more positive goals than divining Soviet intent.

It is sometimes argued that to perpetuate military deterrence is to settle for a so-called peace based on fear. The extent of the "fear" involved in any arrangement — total disarmament, negotiated mutual deterrence, or anything else — is a function of confidence. If the consequences of transgression are plainly bad — bad for all parties, and little dependent on who transgresses first — we can take the consequences for granted and call it a "balance of prudence." What keeps us from stepping off a train before it stops is not "fear"; we just know better.

Senator Barry M. Goldwater of Arizona takes part in a panel discussion with students

The Mont

Leaders of America

Senator Barry M. Goldwater was on campus November 27 and 28 as the first visitor in the 1962-63 Leaders of America program, sponsored by the Caltech YMCA. As usually happens with guests on this program, the Senator had no trouble filling out his time at the Institute. He managed to have meals in as many of the Student Houses as possible, engaged in informal discussions in the Houses and in the Winnett Lounge, held office hours, engaged in a panel discussion at a student assembly, spoke at an Athenaeum Luncheon Forum on the 1962 and 1964 elections, and gave a public address in Culbertson Hall on "Goals of a Free Society."

The Leaders of America program was established in 1954 with a portion of the funds left to the Caltech YMCA as an endowment bequest by the late Dr. Robert A. Millikan. Since then this fund has been used to bring leaders of national repute to the campus for lectures, informal discussions, and personal contact with students. In the past the program has brought such outstanding people as Ralph Bunche, James B. Conant, Norman Cousins, Justice William O. Douglas, Sidney Hook, Martin Luther King, Archibald MacLeish, Abraham Maslow, Margaret Mead, Bishop James A. Pike, S. Radhakrishnan, Clarence Randall, and Victor Reuther.

Vice President for Business Affairs

Robert B. Gilmore was appointed Vice President for Business Affairs of the Institute this month. He has been Comptroller of the Institute since 1958. In his new appointment he succeeds the late George Green, who held the position from 1956 until his death last July.

Mr. Gilmore came to Caltech in 1948 as manager of the accounting offices. He had previously worked for 11 years in the Los Angeles and San Francisco offices of Haskins & Sells, accountants. A native of Mason City, Iowa, he was graduated from UCLA in 1937 with a BS in Business Administration. During World War II he served as a Major in the Army Finance Department.

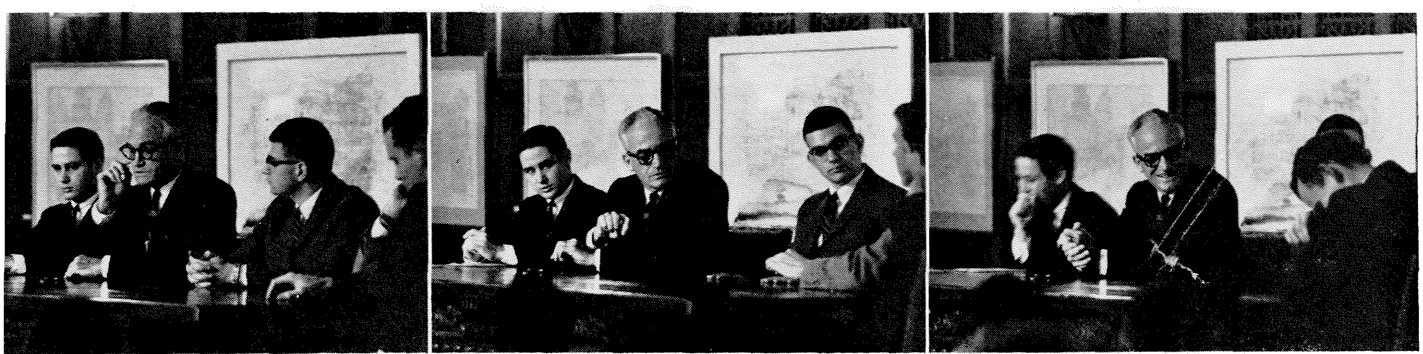
Mr. Gilmore is currently president of the Pasadena-Altadena Community Chest. He is a member and past-president of the Western Association of College and University Business Officers, and is active in the National Association of College and University Business Officers.

Single-Minded Service

The Caltech Board of Trustees expressed "deep appreciation" this month to Herbert H. G. Nash for 40 years of "devoted and single-minded service" to the Institute.

Bert Nash, 67, has served Caltech longer than any administrative, non-academic employee. One of the busiest men on campus, he is Secretary of the Board of Trustees, Assistant Secretary and Assistant Treasurer of the California Institute Associates, and a member of several of the Institute's key administrative committees.

The varied duties of his office include administering the insurance programs for the Institute and the Jet Propulsion Laboratory, purchasing insurance, handling claims, making up the agenda for meetings of the Board of Trustees as well as



ty members during his visit to the campus on the YMCA Leaders of America program.

t Caltech

meetings of the Board's executive and finance committees, and keeping books for the Institute Associates. He personally takes the minutes of meetings of the Board of Trustees and its top committees.

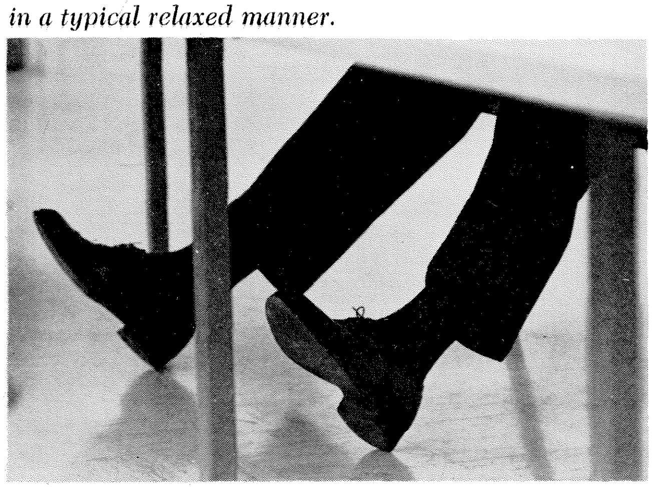
At this month's meeting of the Board of Trustees, President DuBridge proposed the following resolution, which was unanimously adopted:

"That the deep appreciation of the Trustees, Officers, and Faculty be extended to Mr. Nash and his very capable staff on this occasion, with the sincere hope that he may continue in this important post as long as time permits."

Since Bert Nash first came to Caltech as head accountant on Dec. 4, 1922, the Institute has grown from a small school with 467 undergraduates and 29 graduate students and a little more than $2,000,000 in assets into an internationally known teaching and research institution with more than 1,300 students (678 undergraduates and 661 graduate students) and more than $100,000,000 in assets.

Leader of America answers undergraduates' questions

in a typical relaxed manner.



New Trustees

J. G. Boswell II and John S. Griffith were elected to the Board of Trustees of the Institute this month.

Mr. Boswell is president of the J. G. Boswell Company of Los Angeles, producers and processers of agricultural products. He is also director of the Safeway Stores, Inc., and the Security First National Bank. A graduate of Stanford University (1947), he lives in Pasadena.

Mr. Griffith is president of the Far West Financial Corporation of Los Angeles. He has been engaged in real estate projects in southern California for 44 years. Mr. Griffith has been a mem-

STUDENTS' DAY

A Caltech undergraduate acts as a guide for visiting students at the 13th annual Students' Day on December 1. More than 1100 students and teachers from southern California high schools and junior colleges were on hand for the day of lectures and exhibits.

ber of the California Institute Associates since 1955 and was a director of the organization from 1957 to 1962. He is a director of the American Pipe and Construction Co., The Norris-Thermador Corp., and the Music Center Lease Co. His home is in Pasadena.

Anniversary

Robert F. Christy, professor of theoretical physics, attended a banquet in Washington, D.C., on November 27 in honor of the surviving members of the original 39 men, and one woman, who witnessed the first controlled self-sustaining chain reaction in the world's first nuclear reactor.

The banquet was sponsored by the American Nuclear Society and Atomic Industrial Forum.

Dr. Christy, a graduate of the University of British Columbia in 1935, received his PhD in 1941 at the University of California and joined the team of Dr. Enrico Fermi at Stagg Stadium of the University of Chicago in February 1942.

He worked on the calculation of the lattice, or geometrical arrangement of uranium and graphite, in the atomic pile erected in the old squash courts under the west stands of the stadium.

He was present the afternoon of Dec. 2, 1942, when the control rod was drawn and the first self-sustaining reaction experiment was a success. From that experiment he went to Los Alamos, where he worked on the development and building of the atomic bombs.

He came to Caltech as an associate professor in 1946 and has been a professor since 1950.

Honors and Awards

Alan J. Acosta, associate professor of mechanical engineering, is co-winner of the Lewis F. Moody Award, given annually by the American Society of Mechanical Engineers for the outstanding paper in the Society's Hydraulic Division. The paper dealt with cavitation problems in the high-speed turbo pumps used in rocket engines.

Frederick C. Lindvall, chairman of the division of engineering and applied science, has been made a member of the board of directors of the Huntington Memorial Hospital in Pasadena.

Simon Ramo, vice chairman of the board of directors of Thompson Ramo Wooldridge, and research associate in electrical engineering at Caltech, was chosen as "Man of Hope" by the Professions and Finance Group of the City of Hope. Granting of this fifth annual award establishes a Dr. Simon Ramo Medical Research Fellowship at the Institute for Advanced Learning in the Medical Sciences at the City of Hope.

THE VALUES OF SCIENCE

Science not only has great practical value, but it is interesting, exciting, and valuable for its own sake. For example—

by L. A. DuBridge

The modern technological society in which we live obviously owes most of its existence to the discoveries in science which have been made in the past 300 years, and to the imagination which has been used in putting those discoveries to practical use. If one pauses for a moment to reflect on the difference between the Western world of 1962 and the world of the time of Galileo and Newton, it is easy to see the enormous debt we owe to science. And when one realizes that changes in this world due to new scientific discoveries and their applications are taking place at a faster pace today than ever before in history, we have all the reasons we need for underlining the importance of public education in pure and applied science. A citizen who is illiterate in these matters can hardly be an intelligent citizen of modern America.

Yet there is another reason why it is important to give our people an opportunity to learn about science. That is because science not only has great practical value, but because it is interesting, exciting, and valuable for its own sake. Let me give you some examples of this belief which I have.

I can't at the moment foresee any practical inventions which will follow from the discovery made by the astronomers in recent years that the universe is probably more than 10 billion years old, and that the most distant galaxies that the Palomar telescope can see are so remote that the light which reaches us from them has been traveling on its way for over 6 billion years.

It may not improve your automobile or television set to have geologists discover that the most ancient rocks of the earth's surface are 4.5 billion years old, and that this is presumably the age of our earth and of the solar system. (Our solar system is thus a fairly recent arrival in a universe which is very much more ancient.)

Yet I think these are exciting things in themselves. The excitement began way back when Galileo turned his first telescope on the heavens, and observed that the planet Jupiter was possessed of moons which rotated about it – the first decisive evidence that not everything in the universe rotated about the earth . Then came Kepler, showing how the planets revolved about the sun; and Newton, with his brilliant and daring postulates of the universal laws of motion and of gravitation which brought, at last, law and order, precision, beauty, and predictability into the world.

It is precisely this feeling, this conviction, that there is law and order and beauty and predictability in the universe, which has been the guiding spirit of science ever since.

The modern concept of the universe is a majestic thing indeed. We do not yet fully understand it, of course; in fact, we become more aware of our ignorance every day. But we know now that ignorance is conquerable and that knowledge surely grows—slowly and painfully at times, often with many false leads, and often with the most obvious leads for a time unaccountably overlooked. But the picture gradually fills out. Today we see a universe stretching out billions of light years in all directions. It is composed of 100 billion or more galaxies, like our own Milky Way. Each galaxy is composed of 100 billion stars, more or less like our

Today we see a universe stretching out billions of light years in all directions. It is composed of over 100 billion galaxies like our own Milky Way, which is shown in the famous painting above. Our whole solar system is a tiny dot located somewhere about two-thirds of the way from the center of the Milky Way galaxy.

sun . And all of these galaxies are rushing madly away from each other with speeds up to half the velocity of light, as though they were the fragments of a colossal explosion which took place 10 or 15 or 20 or more billion years ago.

Yes, astronomy is an exciting subject – for its own sake.

And now, of course, the science of astronomy is about to take a new leap forward. Telescopes will someday be sent into space, free at last from the disturbing effects of the earth's atmosphere, which has impeded good observation throughout history. And what new things will be learned, how much farther we shall be able to see into space, what mysteries may be cleared up and what new puzzles discovered, we cannot begin to guess.

But now, lest you think astronomy is the only exciting field of science, let us look at the other end of the scale of size. Let us turn from the biggest thing man has looked at, the universe itself, to the smallest, the nucleus of the atom.

The discovery that nuclear energy could be converted to usable form created enormous popular interest in this subject, beginning in 1945. But physicists were excited about nuclei long before that. After Rutherford and Bohr did their great work before World War I, proving that the atom did indeed have a tiny but heavy nucleus at its center, surrounded by a cloud of electrons, a massive attack (massive at least by the standards of 1915) began on the atomic nucleus – to find out how big it was, what it was composed of, whether it could be broken up into yet smaller constituents, and what held such pieces together.

Year by year the picture evolved. All nuclei, it turned out, were composed of protons and neutrons. The forces between these particles, the energies involved in packing them together or tearing them apart, were slowly unraveled. New nuclei could be created almost at will by shooting high-speed protons or neutrons into an existing nucleus. These might stick, or they might knock out other protons or neutrons, or whole groups of them. The stage was then set for the surprising discovery in 1939 that a nucleus of uranium could be completely torn apart on collision with a rather slow neutron, the phenomenon of fission.

One of the greatest of all scientific mysteries, of course, is the mystery of life itself. Living things are so complicated! There are as many atoms in a tiny living cell as there are stars in a galaxy. They are grouped into large molecules which are also bewildering in their complexity. And this tiny cell grows, multiplies itself, can cause other types of cells to form – and a human being may be the ultimate result.

The molecular basis of life

Only in the last few years has it become possible to learn something of the molecular basis of life. We know that the original egg cell from which a complex creature will eventually grow contains all the information required to produce that creature. This information is enclosed within a group of structures in the nucleus of each cell, called the chromosomes. These chromosomes are, in turn, made up of chains of tinier particles called genes. Each individual gene, it turns out, governs the building of a particular type of molecule which performs an essential role in the cell's function. These genes are themselves giant molecules built of submolecular groups, each of which has been analyzed and identified. Their essential feature is a molecule of a chemical substance known as DNA, which is a particular nucleic acid. The DNA molecule, it turns out, is the ultimate coding element which contains the information necessary to build new molecules. The DNA molecule also has the property of reproducing itself, and thus the whole basis for the hereditary process is contained in this molecule.

Does this discovery have any practical results? As yet it would be hard to answer yes to this question. But, surely, the fact that human beings can understand and interpret some of these basic mysteries of life is one of the great achievements of science.

Let me touch on just one more field of science in which there have been important advances in our understanding in recent years – the field of geology, the study of the earth. A geologist was once visualized as a husky, outdoors-type man, clad in high boots and equipped with a hand pick, who trudged out through the wild country examining chunks of rock and noting the structure of the landscape. The groundwork for knowledge of the earth's surface was indeed laid in this way, Today, however, a typical geologist remains in his laboratory, surrounded by a bewildering array of elaborate scientific instruments. The tools for studying the nature of the earth's surface and the structure of the earth's interior have multiplied with astonishing rapidity in recent years, and our knowledge of the earth has grown accordingly.

The measurements of radioactivity and of isotopic constitution of the heavy elements gives us our best information about the age of the earth. It is from such measurements that it has been determined that the earth must be around 4.5 billion years old. Here the geologists join hands with the astronomers in tying the history of the earth and the solar system to the history of the rest of the universe.

But the geologists are interested also in probing into the earth's interior. They discovered many years ago that the tiny little tremors registered by a sensitive seismograph are caused by elastic waves which are generated by earthquakes in the earth's crust, or by storms at sea, or by other disturbances. These elastic waves travel not only in the crust of the earth, but through the crust into the next layer, known as the mantle, and even through the mantle into the hot dense core of the earth. As these waves travel, they are reflected from various layers or discontinuities in the earth's structure, and they are refracted, or bent, as they pass from one kind of material into another and the velocity of the waves is changed. Thus, by analyzing these records one can tell the depth of the various major discontinuities; one can deduce the elastic properties of the materials in the crust, the mantle, and the core.

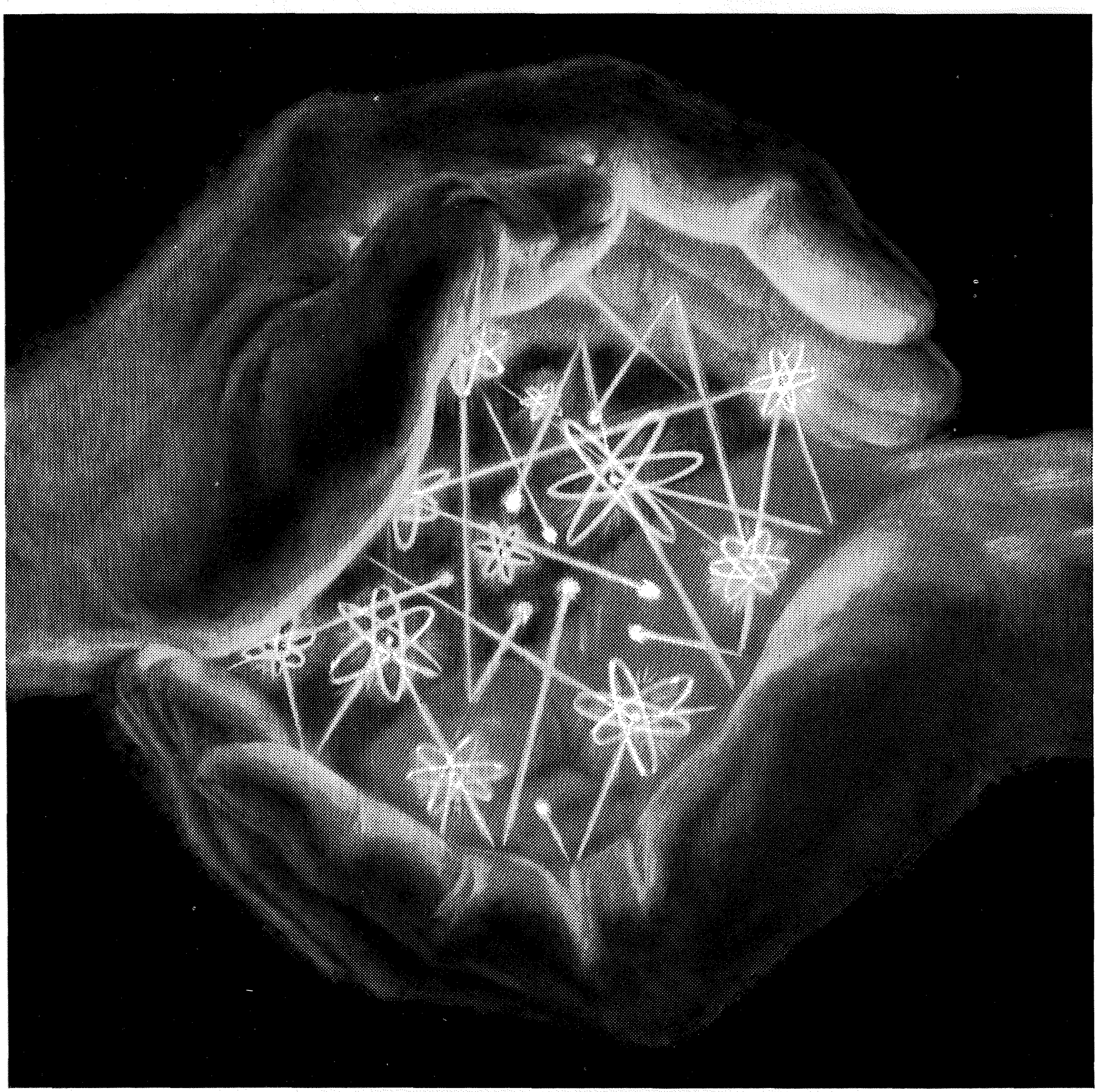
The geologists, however, are not wholly satisfied with what they can learn from seismographs, and they are now embarked, with the help of the National Science Foundation, on one of the daring scientific projects of modern times; namely, to drill a hole clear through the earth's crust, penetrating into the mantle which lies beneath. Spectacular new knowledge about the nature of the earth's crust and the underlying mantle is sure to result from this project.

The interests of scientists

Thus, we see that the interests of scientists range from the interior of the earth to the most distant galaxies, from the structure of the atomic nucleus to the structure of living cells, through the nature of all the chemical materials of which the universe is composed.

A few years ago, all of these different branches of science – geology, physics, biology, chemistry, astronomy – were somewhat compartmentalized, and each subject built up its own techniques and its own knowledge somewhat independently of all the others.

Today this is no longer true. Chemists, physicists, and biologists join in studying the molecular basis of life. They are joined by the astronomers



in studying the structure and history of the earth and the solar system. The electrical engineers developed elaborate computers which contribute to the more rapid interpretation of knowledge in all fields.

Possibly the most spectacular enterprise in which all the sciences come together is that of space exploration.

To the American public it may appear that the primary purpose of the U. S. space ventures is simply to get a man on the moon and bring him back. But it goes far deeper than that; our space program is a vast program of scientific research. Every space capsule which has been launched is actually a miniature scientific laboratory. It is equipped with instruments to measure magnetic fields, cosmic rays, radiation from the sun or from other parts of the universe, instruments to get a better look at the moon or the planets, and, eventually, instruments to determine whether any forms of life are to be found on the moon, or Mars, or Venus.

Mariner II

Right now (December 7) a space capsule known as Mariner II is on its long journey toward the planet Venus. Ever since the launching on August 27, all of the scientific equipment on the Mariner has been in operation, and the measurements have been relayed back to receiving stations on the earth by radio. Only three watts of radio power are actually being transmitted from the Mariner radio antenna, yet, with the huge receiving antennas here on earth, this will be sufficient to allow transmissions until the capsule has receded more than 35 million miles from the earth and has passed well beyond the planet Venus into a permanent orbit around the sun.

A magnetometer is measuring the magnetic fields in space – principally, now, the magnetic field of the sun, which has never before been accurately and directly measured. And it has also been learned that there are fluctuations in the field caused by clouds of charged particles which the sun frequently ejects into space, and which travel out for a billion miles or so, carrying their own magnetic disturbances with them. Magnetic storms which disrupt radio communication here on the earth may be caused by similar clouds–the results of giant, and so far mysterious, eruptions on the surface of the sun.

As Mariner II nears Venus on December 14, four radiation-measuring devices will be turned on to scan the surface of the planet. Two of these will operate in the infrared, giving some idea of the temperature within the Venus atmosphere. Two will operate at short radio wave-lengths, which hopefully will see through the atmosphere to the surface and report temperature conditions there.

Any practical value to this? I don't know. Is it nevertheless exciting? You must agree that it is. And now the Russians have launched a similar, and larger, capsule to perform a similar mission on a journey to Mars.

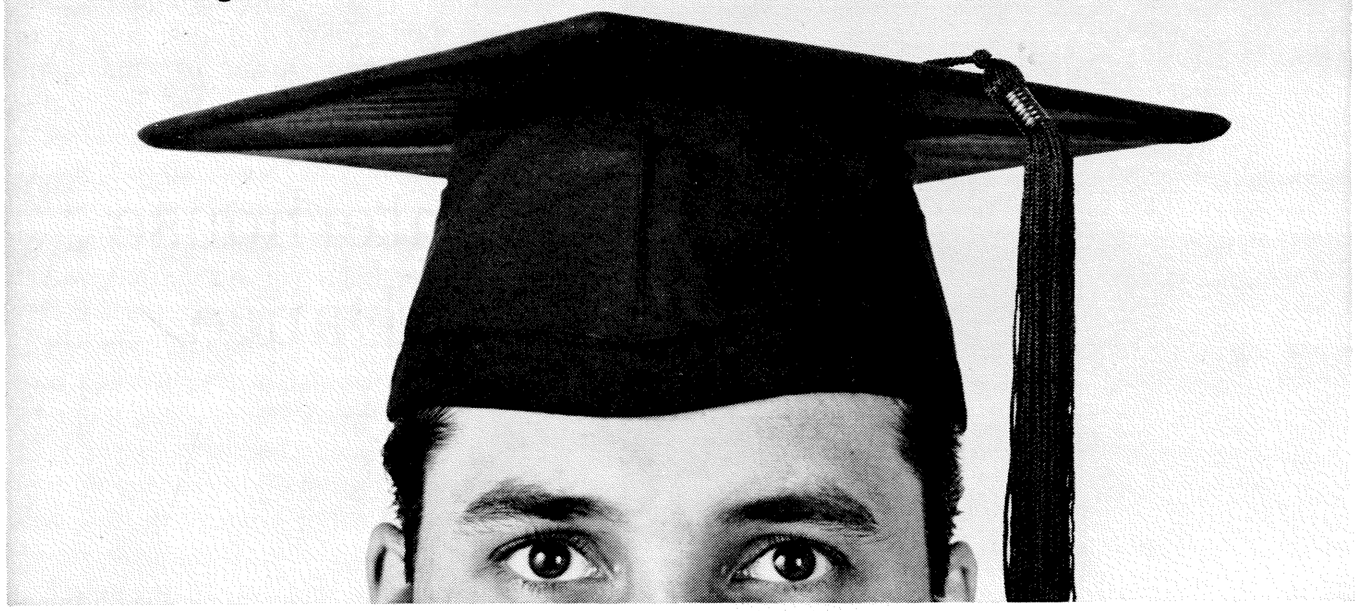
Even more exciting space ventures lie ahead. There will be more capsules to encircle the earth and measure the ion clouds trapped there. Capsules will land on the moon, and measure moonquakes and how seismic waves travel through the moon's interior. Devices will sample the stuff on the moon's surface and analyze it chemically, and probe beneath the surface to find out how hard or how soft it is – whether it is mostly made up of dust, or whether it is dirt, or solid rock. Television cameras will take close-in pictures of the moon's surface, and show the small features forever hidden from earth-bound telescopes. And then men will go, too, acting as still more versatile scientific instruments to look and see and test and photograph and measure many things.

Apollo project

A joy ride to the moon would interest me very little – spectacular though it might be, as a stunt. A scientific expedition to the moon, however, is one of the greatest enterprises in human history. That is what the Apollo project should mean to the American people. It is a project where all the sciences and all the techniques join together to extend man's knowledge just a little further into the unknown.

You will see, then, why I say that science is exciting and worth while in itself. The study of science enlarges a student's horizon, gives him a finer and more adequate concept of the nature of the world and of the universe in which he lives, and brings him in touch with some of the greatest achievements of the minds of men. In these respects the study of science has much in common with the study of literature, of history, of philosophy, and even of art and music.

Looking towards a Ch.E., E.E., M.E. or Chemistry degree?

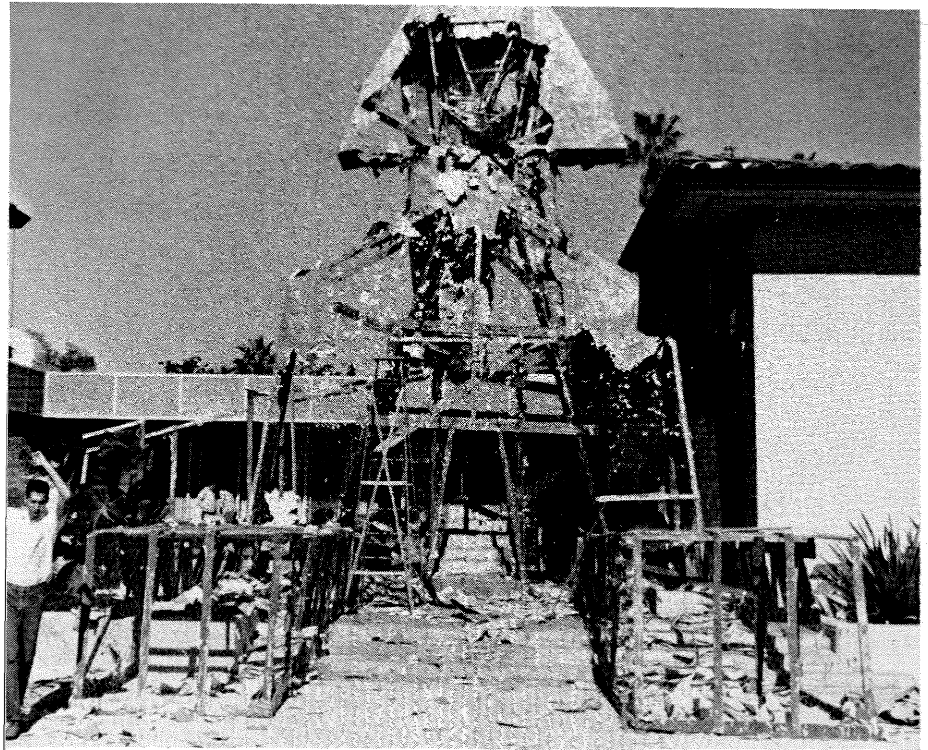


Look ahead to the advantages of a career in Monsanto production

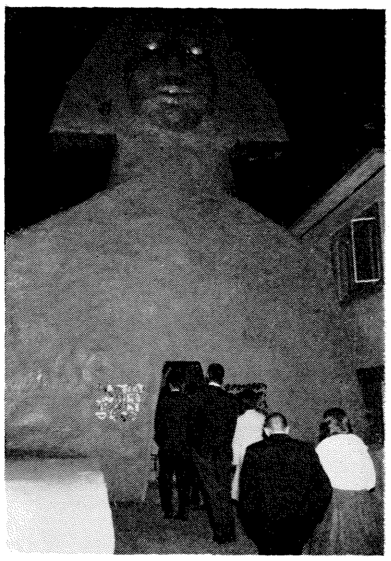
Let's face it. Production is the very heart of a billion-dollar *producer* like Monsanto. Here's where the young engineer meets technical challenges second to none. Here's where he can display his talents daily . . . helping increase yields, improve processes, raise efficiency, lower costs, boost profits. Here's where Monsanto's on-the-job training can help him move ahead faster . . . personally and professionally.

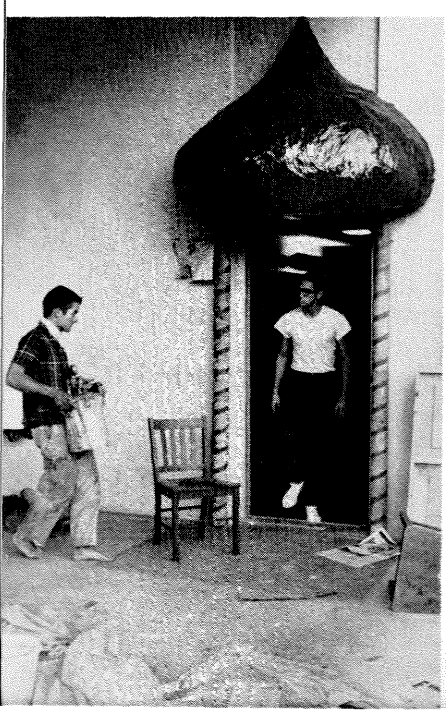
Monsanto production men are known by many titles—Maintenance Staff Engineer, Plant Technical Services Engineer, Production Supervisor . . . to name a few. Try one on for size *now* . . . then see your Placement Director to arrange an interview when we visit your campus soon. Or write for our new brochure, "You, Your Career and Monsanto," to Professional Employment Manager, Department EM-6, Monsanto Chemical Company, St. Louis 66, Missouri.

All qualified applicants will receive consideration without regard to race, creed, color or national origin.



Interhouse Dance





Each year about this time, the Student Houses turn into jungles, rivers, overseas countries, and comic strips. Preparations for the Interhouse Dance begin anywhere from four weeks to six days before the big night. By four weeks before the dance, most of the Houses have already decided on a "theme." (This year's themes ranged from "Aztec Exotica" to "Arabian Nights" and "Ruin.")

About this time, too, there is some concern about how much all this is going to cost. Estimates have varied from a low of $250 to a high of over $750 for each House, and the total spent by the seven Houses usually amounts to about $3500.

Then construction begins. Interhouse construction finds some of the most unlikely people out in their House courtyard, putting up untold amounts of papier-maché, lumber, chicken wire, and paint. Quiet members of the House become suddenly gung-ho and decide on all sorts of ambitious projects, like, "Hey, guys, how about putting up a mechanized whale? We can have him forty feet long and spouting water, while his tail moves in time to some nautical music!"

"But where will we put him? Between the 45-foot Alaskan seal and the triple-life-size statue of Walt Disney?"

"Well, look. If we move the seal to 35 feet above the roof, instead of 20 feet, and then we . . ."

Some of the grandiose schemes are quickly junked, but enough remain so that Interhouse is usually a contest to sée who can get the most the highest and paint it the fanciest.

As a result, there is a great need for assorted lumber and other interesting items. Typical items collected this year in just one House included a female mannikin head with long, black, Egyptian hair; a 1300 rpm ¾ horsepower motor geared down to 2 rpm; assorted pulleys and governors; and liquid latex to manufacture artificial skin for an automated but life-sized belly-dancer.

Although there is no formal judging of which House has the "best" display; as in the Olympic games, there is much discussion on which House *is* "best." Opinions vary, depending on which House the person voicing them is from. But different Houses are remembered for different things.

Fleming House, for example, traditionally begins construction as late as possible. As a result, Fleming tends to rely heavily upon painted wrapping paper stretched across the second floor and lounge entrances. Fleming broke all records this year with their early construction start (five days before the dance).

Dabney tries to have many small, ingenious items as part of their display, and this year experimented with a rock-and-roll band, whose volume was exceeded only by the colors of their coats.

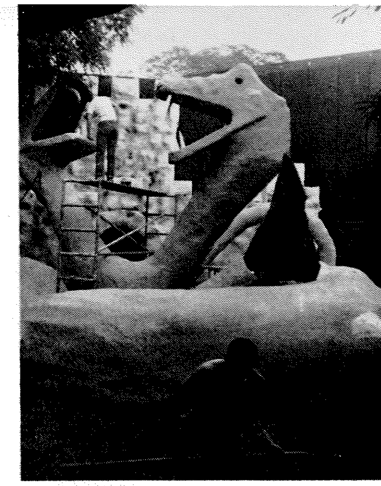
Blacker invariably floods their courtyard because a flooded courtyard requires less construction. This year was no exception as a smallish river wended its way through the courtyard and visitors entered into a lounge converted into a castle.

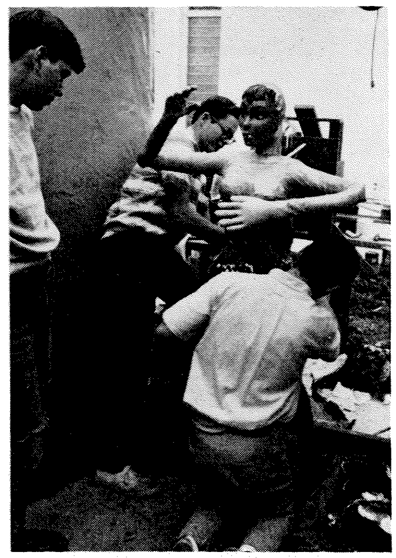
Lloyd features a general slowness of construction in the weeks prior to Interhouse, followed by a mass flurry in the last few days. This year, Lloyd didn't quite make it, and early visitors found a foundation of chicken wire and a broom supporting the entrance to the "Arabian Nights."

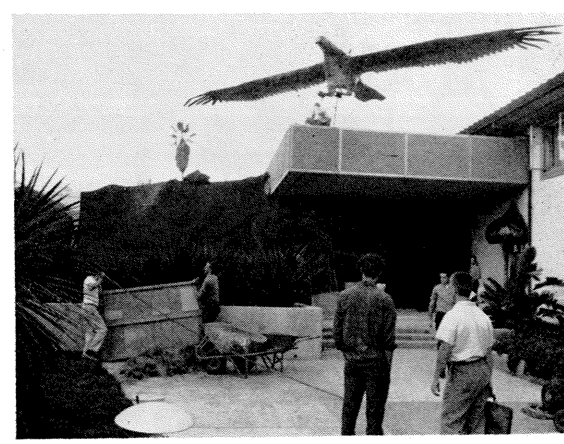
Page, Ricketts, and Ruddock are best remembered for the Trojan Horse fiasco of two years ago, when all three Houses joined together to build a gigantic city of Troy complete with a Trojan horse more than 40 feet high. A heavy rain the day before the dance caused the stomach of the horse to dissolve away, however, creating an impressively hollow display.

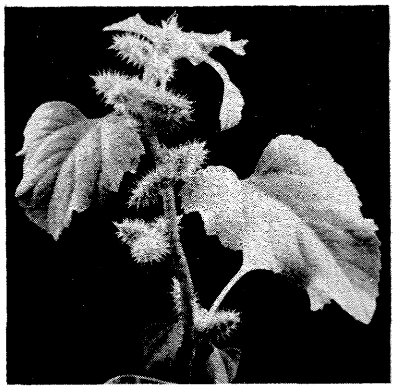
The day after the dance everything must be torn down and courtyards returned to normal. A week later, a Buildings and Grounds crew assesses the damage, determined to find at least $100 worth per House. Shortly thereafter, courtyards and lounges finally *are* cleaned up and nothing remains of the year's biggest dance – except the mountain of miscellaneous material that is stored away under the old Student Houses in preparation for next year.

– Richard Karp '64









Plant Flowering

Scientists have been trying for more than half a century to isolate the hormone that induces plants to flower and bear fruit. Now James Bonner, professor of biology at Caltech, and Jan Zeevaart, research fellow, have evidence that this hormone which transmits the stimulus to flower could be a steroid – a fatty substance like the sex hormones in animals. The hormone has been given the name "florigen."

Caltech scientists are now making an intensive effort to isolate and chemically identify florigen. One reason why there is great interest in determining the composition of the hormone is the possibility of using a synthetic version of it to control crop production. This could have far-reaching effects on the world's food supply.

The U.S. Public Health Service has assigned Dr. Erich Heftmann, noted steroid chemist, to Caltech to help in this work.

A hormone is a substance that is synthesized in one part of an organism and produces an effect in another part. Hormones are vital metabolic regulators in plants as well as in animals. Thiamine and niacin, which are vitamins, are examples of plant hormones. In plants they regulate root growth. (Both, incidentally, were recognized as plant hormones by Dr. Bonner.)

In their research on florigen, Drs. Bonner and Zeevaart have been using two plants which can be made to flower easily, the cocklebur (above) and the Japanese morning glory. As studies in the Caltech plant physiology laboratories have shown, it is the length of the dark period, rather than the amount of light, that is vital to flowering. The cocklebur, a short-day plant, flowers only when it is exposed to nights that are more than 8½ hours long. If the dark period is cut down even 15 minutes, the flower bud will not form. Nor will it form if the plant is exposed to a single flash of light during the 8½ hours of darkness. Yet florigen is so potent that if just one leaf of the cocklebur is protected, and gets the required amount of darkness, it will synthesize enough florigen to induce the whole plant to flower.

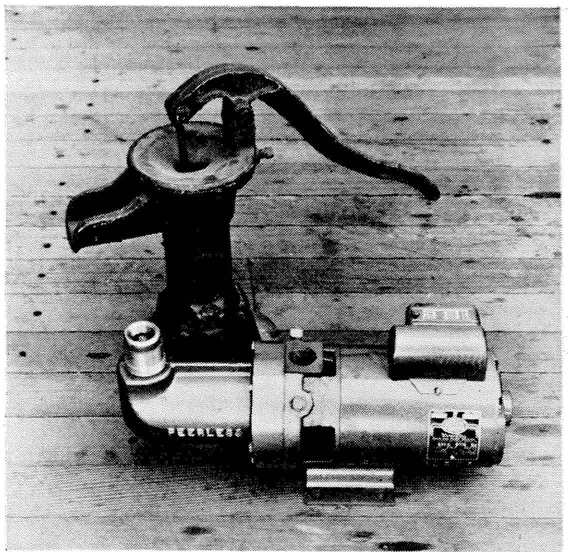
Since biologists have been unable to isolate florigen by direct means, Bonner and Zeevaart tried attacking the problem indirectly. They removed all but one leaf from each of several cocklebur plants. Each single-leafed plant was then dipped into an anti-metabolite solution before it was given the proper dark period. Each of these solutions was designed to prevent the synthesis of a particular biological substance, such as protein or nucleic acid.

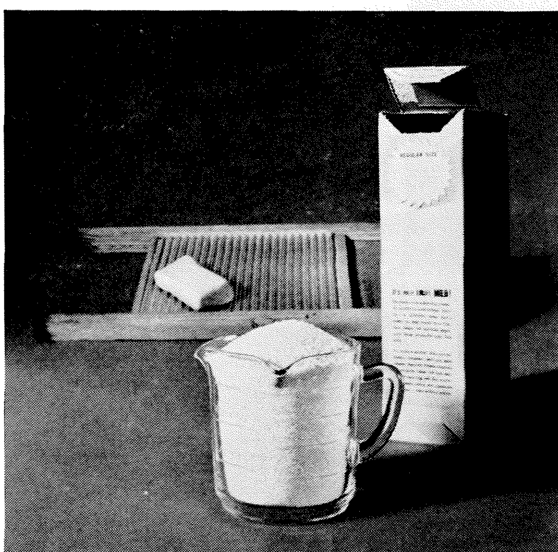
If a leaf were to be dunked in a protein anti-metabolite, for example, this solution would be absorbed into the leaf and would prevent the synthesis of florigen, provided florigen were a protein. If florigen were not a protein, this particular anti-metabolite would not affect its synthesis and the plant would flower.

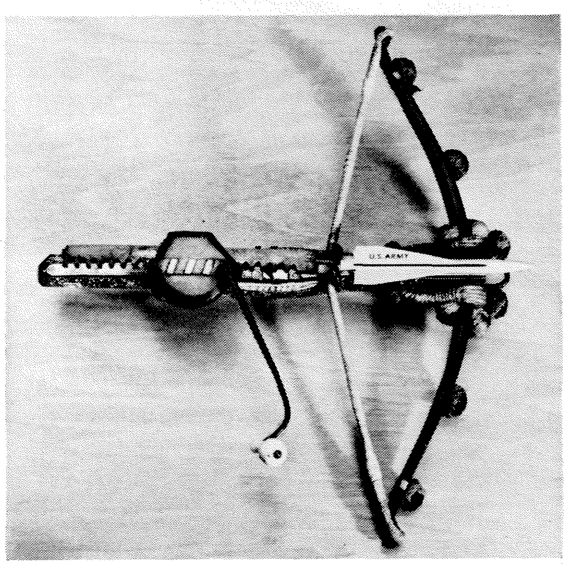
The only solution that completely prevented flowering in the cocklebur was a steroid anti-metabolite compound, indicating that florigen may be a steroid. Biochemists know a lot about steroids and are able to synthesize many. Once isolated, florigen should be easy to synthesize.

Using synthetic anti-steroids and steroid sprays, growers could spread crops over longer seasons, producing them when needed. Anti-steroids, by preventing flowering, could accelerate growth of the edible parts of plants. Sugar cane plants, for instance, use ten percent of their energy in producing flowers. Suppressing the flowers might mean as much as a ten percent increase in the yield of sugar.

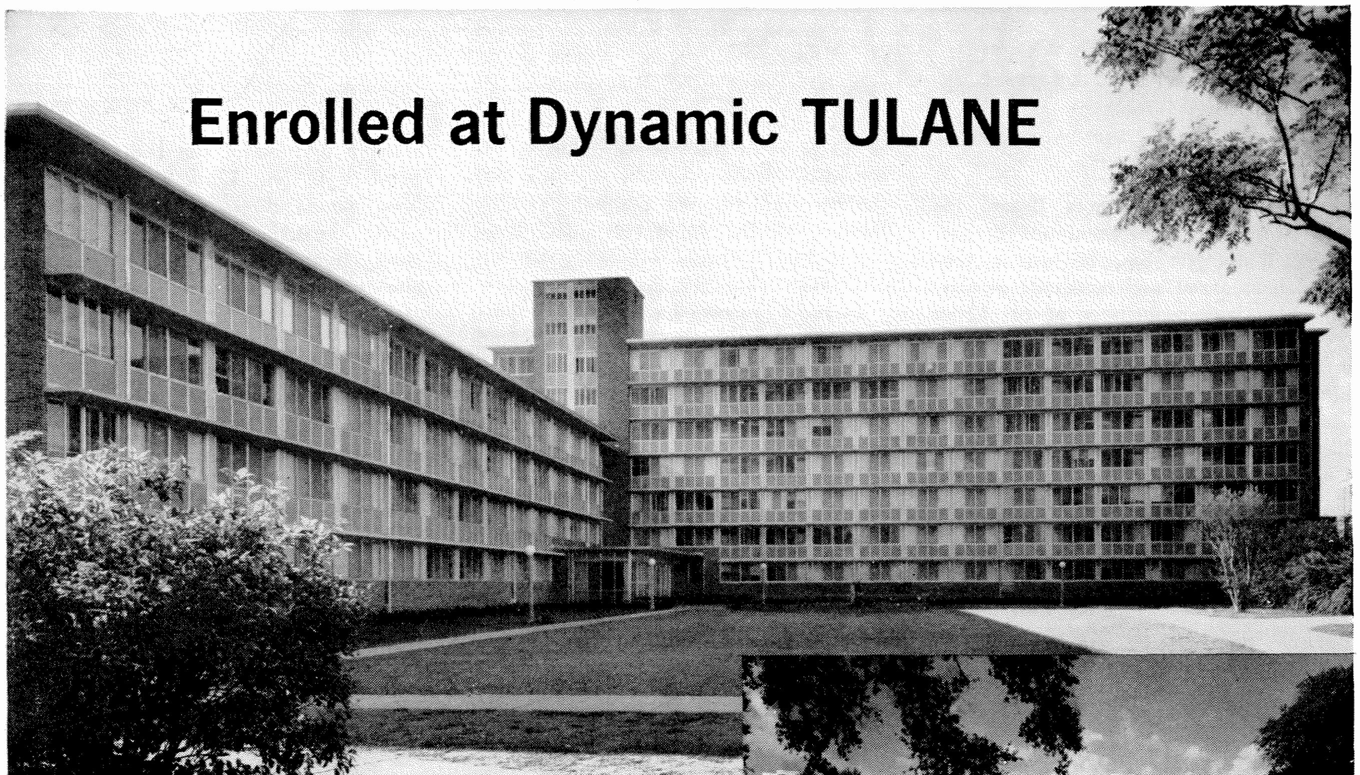
The work on florigen in Caltech's plant physiology laboratories is supported by the National Science Foundation and the Herman Frasch Foundation.







Enrolled at Dynamic TULANE



MEN'S DORMITORY. MAIN ARCHITECTS: *Diboll-Kessels and Richard Koch; S. Wilson, Jr. & Associates.* GENERAL CONTRACTOR: *Farnsworth & Chambers.* MECHANICAL CONTRACTOR: *Cabirac Mechanical Contractors, Inc.* CONSULTING ENGINEERS: *Jos. E. Leininger & Associates.*

JENKINS VALVES

for long-range dependability, long-time maintenance economy

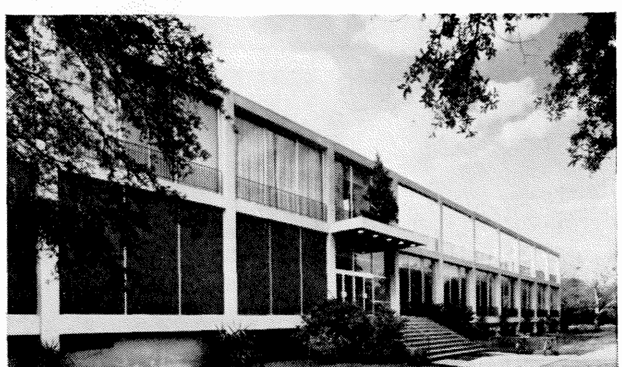
"Dynamic" is the word for tradition-laden, prestige-rich, 127-year-old Tulane University in New Orleans.

Nowhere is Tulane's dynamism more remarkable and articulate than in its current building program.* Examples: the three brand new, beautiful and beautifully functional structures pictured here.

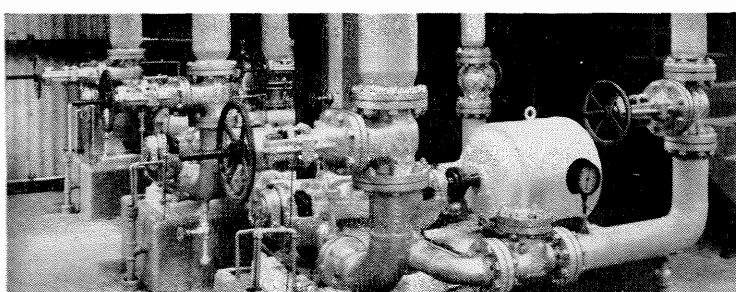
If you toured these buildings and the power plant which serves the campus complex, again and again and again you'd see the distinctive Diamond-mark that identifies Jenkins Valves. And small wonder: a university which had its beginnings more than a century ago just naturally thinks in terms of long-range dependability, long-time maintenance economy . . . precisely the qualities which make Jenkins Valves the "Standard of Quality" by which other valves are measured! Yet — and this fact still comes as a pleasant surprise to some specifiers — *they cost no more!* Jenkins Bros., 100 Park Ave., New York 17.

*Tulane's supervisory and liaison personnel for the building program: Harold E. Pique, Director of Planning; George F. Johnson, Director of Physical Plant; Charles E. Gilbert, Utilities Superintendent.

APARTMENT BUILDING *for married students.* MAIN ARCHITECTS: *Goldstein, Parham & Labouisse.* GENERAL CONTRACTOR: *J. A. Jones Construction Co.* MECHANICAL CONTRACTOR: *Sciambra & Masino.* PLUMBING CONTRACTOR: *Jas. F. O'Neil Co., Inc.* CONSULTING ENGINEERS: *Design Engineers & Associates.*



UNIVERSITY CENTER *features swimming pool, bowling lanes, radio station, cafeteria, ballroom.* MAIN ARCHITECTS: *Curtis & Davis and Associates; Edward Silverstein.* GENERAL CONTRACTOR: *Farnsworth & Chambers.* MECHANICAL CONTRACTOR: *Sciambra & Masino.* CONSULTING ENGINEERS: *Leo S. Weil; Walter B. Moses.*



POWER PLANT. *Boiler feed water pumps and Jenkins Valves shown.* MAIN ARCHITECTS: *Paul Charbonnet, Jr.* GENERAL CONTRACTOR: *Gervais Favrot Co.* MECHANICAL & PLUMBING CONTRACTOR: *Comfortaire Co., Inc.* CONSULTING ENGINEERS: *Leo S. Weil; Walter B. Moses.*

JENKINS
MOST TRUSTED TRADEMARK IN THE VALVE WORLD ®
VALVES
JENKINS
SINCE 1864
Jenkins Bros

Available From Leading Distributors Everywhere

Personals

1922

Edward G. Kemp died of cancer on September 20 in Hermosa Beach. He was a self-employed insurance broker. An avid athletic fan, he was a ten-letter man as an undergraduate at Caltech. He was a member of St. Cross Episcopal Church in Hermosa Beach, where he served on the Vestry. He was also a member of Masonic Lodge 557 and of Al Malaikah Shrine Temple, and had served as Hermosa Beach City Councilman. He is survived by his wife; two sons, Edward G. II and Parker Brooke; and six grandchildren.

1925

Hugh K. Dunn, PhD, is now senior research physicist in the Communication Sciences Laboratory at the University of Michigan.

1927

Howard Starke, executive vice president of the Hawaiian Cement Corporation since 1960, has been elected president of the firm. He has a background of 35 years in the cement industry, and served in various executive positions with the Riverside Cement Company in California prior to joining Hawaiian.

1928

L. Judd Eastman has been made head of the valuation division of the State Board of Equalization in Sacramento. His division has responsibility for setting assessed valuations on properties of the public utilities in the state. He has been a member of the division since 1935.

1931

Glenn M. Webb is now director of exploratory research in the research and development department of the American Oil Company in Whiting, Indiana. He has been with the company since 1948.

1932

Worrell F. Pruden, MS '33, and *Robert B. Freeman,* MS '33, PhD '36, have both received promotions in the engineering department of Columbia-Geneva Steel, a division of the U.S. Steel Corporation in San Francisco. Pruden has been named director of engineering, a newly created position. He has been chief engineer since 1951. Freeman is now chief engineer. He was formerly assistant to the general manager of operations.

1935

Richard H. Jahns, PhD '43, has been made dean of the College of Mineral Industries at the Pennsylvania State University. He joined the Penn State staff in 1960 after 14 years on the faculty at Caltech, where he was professor of geology.

Louis T. Rader, MS, PhD '38, is now president of the Univac Division of Sperry Rand, the computer division of Remington Rand in New York. He has also been named a director of St. John's University in Jamaica, N.Y. Louis was formerly vice president of the International Telephone and Telegraph Company.

1936

Stuart R. Ferguson is manager of

quality control for the Analytical and Control Division of the Consolidated Electrodynamics Corporation in Pasadena. He has been with the company since 1961.

1943

William Hovanitz, PhD, is now associate professor of zoology at Los Angeles State College. He has been on the faculty since 1959. The Hovanitzes and their three children live in Arcadia.

1944

Warren G. Schlinger, MS '46, PhD '49, is research supervisor of Texaco's Montebello Research Laboratory. He is a recent co-patentee of two U.S. patents, one which covers improvements in the treatment of hydrocarbons, and the other improvements in the separation of carbon dioxide from gaseous mixtures.

1945

Walter K. Deacon, MS, is now operations manager at the Torrance, California, plant of Vickers Inc., a division of the Sperry Rand Corporation. He has served as chief engineer there since 1958.

Hugh S. West has received a diploma in agency management from the American College of Life Underwriters – one of the top professional designations in the insurance field. Hugh is assistant secretary in the agency department of the Connecticut General Life Insurance Company in Hartford.

Ralph S. White, Jr., is now president and director of the Pacific Electro Magnetics Company, Inc., in Palo Alto, a California supplier of "high-performance miniature general purpose instrumentation magnetic tape recorders" and related equipment.

1948

Warren Harrison is now manager of engineering and industrial sales at The Trane Company's Los Angeles sales office. He has been with the company since 1948.

1950

Leo F. Frick, AE, is now on the staff of the mechanical engineering department of the University of California's Lawrence Radiation Laboratory in Livermore. The Fricks live in Orinda with their three children.

Fernando J. Corbato is now associate professor of electrical engineering at MIT. He has also served since 1960 as associate director of the MIT Computation Center, where he has been employed since 1956. He is co-author of *Spheroidal Wave Functions.*

1951

Robert F. Connelly is now manager of the Millipore Technical Service Office for the Los Angeles area. He was formerly research chemist and sales manager of the Bray Oil Company in Los Angeles.

1952

Ronald T. McLaughlin, MS, PhD '58, is now assistant professor of civil engineering at MIT. He was formerly a research fellow at Caltech. The McLaughlins have one child, Roné-Claire.

A. J. Dessler is now professor of atmospheric and space science at the Southwest Center for Advanced Studies in Dallas, Texas.

John A. Carlson, MS, PhD '55, writes that he has joined the staff of the mechanics research division of the American Machine and Foundry Company in Niles, Illinois. He had been working as a research project supervisor at the Teletype Corporation. The Carlsons' fourth son, Clifford, was born last April 1.

1959

Harvey Hansen, junior assistant sanitary engineer with the Public Health Service in Greeley, Colorado, was married December 17, 1961, to Miss Betty Hiatt of Shenandoah, Iowa.

ISN'T THAT GREAT?

"Yes, George . . . yes . . . sure, George . . . I know, but who reads that stuff? The minute our guys see that envelope with Caltech on it they prob'ly put it in the circular file. They know what's inside . . .

"Well, look — I mean, maybe I'm no expert, but watcha wanna do is stop this bulk mailing . . . send your letters first class . . . That'll cost two thousand bucks right off, huh? . . . Yeah, that *is* a lot of money, but . . . Well, now gimme a chance, George.

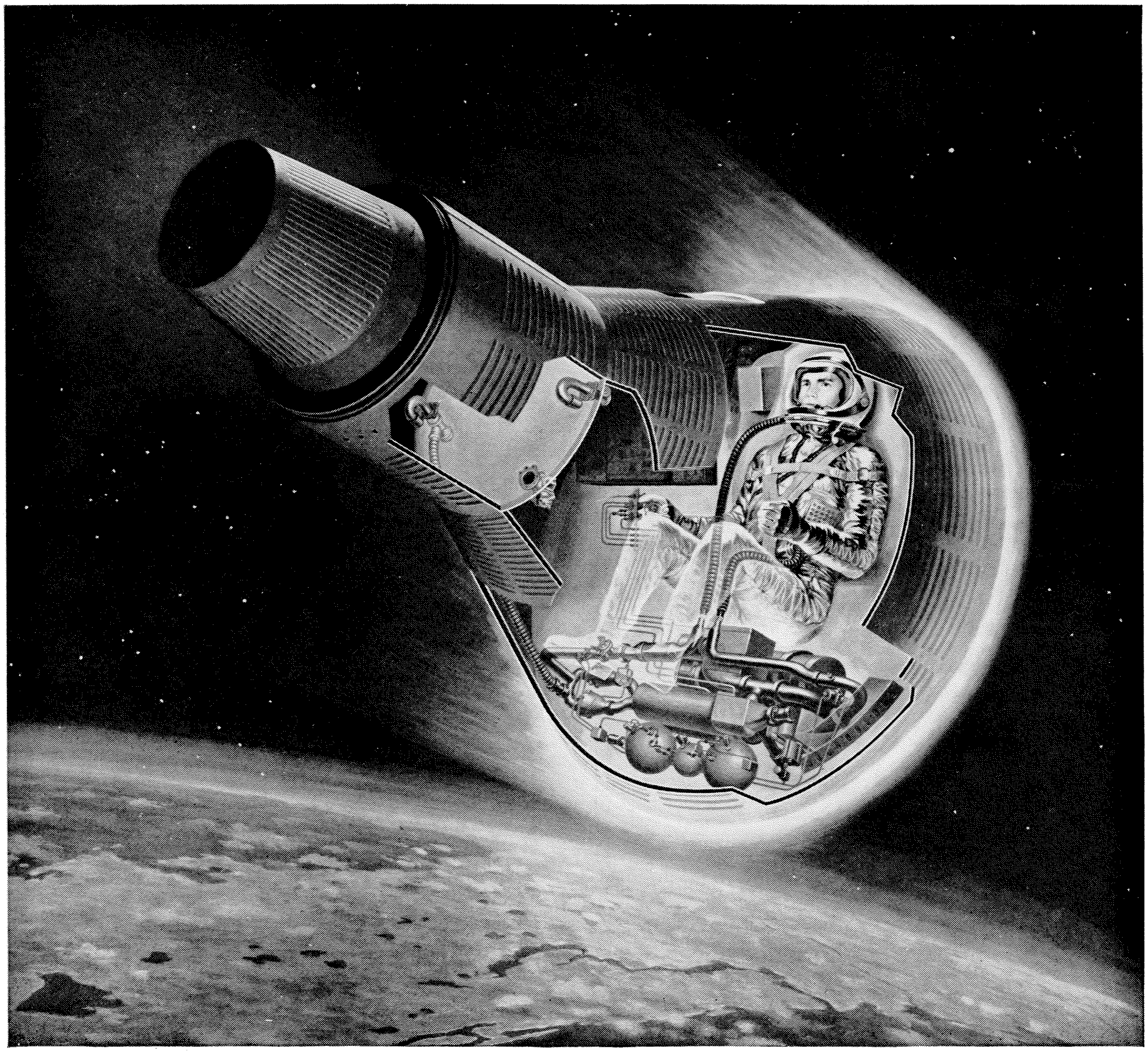
"First class, see? Then you get yerself some fancy letterhead and envelopes, maybe orange, engraved — with a real nifty monogram — like a slipstick or a gear or somethin' . . . not less than a thousand for that, huh?

"Yeah, but boy — what results! You'd make a million. Then — get this George — you *hand type all* the letters, see — maybe make a coupla mistakes, see — to make it look real. Then . . .

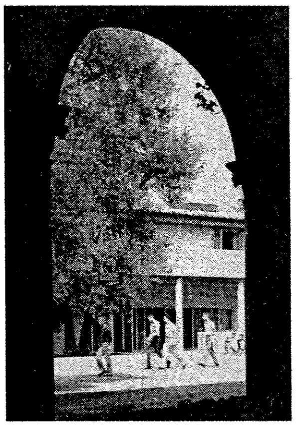
"Really? . . . Not enough time? . . . Even if you hired three, four extra typists? Huh . . . Sure you have to pay 'em but think of what a big impress—. Two or three thousand bucks more, huh? . . .

"Well, now listen — 'cause here comes the clincher. In the letter you tell each 'lumnus to WIRE his gift — COLLECT!! How about that! . . . Isn't that great, George? . . . Hey, George . . . it's great . . . *isn't* it?

YOUR ALUMNI FUND COUNCIL SUGGESTS YOU USE THE DO-IT-YOURSELF-TYPE POSTAGE-FREE ENVELOPE. IT WILL REACH US FAST ENOUGH THANK YOU.



CALTECH CALENDAR



ALUMNI NEWS

January 10
Winter Dinner Meeting
Rodger Young Auditorium

ATHLETIC SCHEDULE

Basketball

December 15
Caltech at Cal Western

January 5
Caltech at UCR

January 8
Pomona at Caltech

January 11
Caltech at Cal Lutheran

January 12
Caltech at Biola

CALTECH YMCA ATHENAEUM LUNCHEON FORUM

Reservations by Tuesday noon

January 9
—Albert Ravenholt
AUFS Specialist on the Far East

FRIDAY EVENING DEMONSTRATION LECTURES

Lecture Hall, 201 Bridge, 7:30 p.m.

January 11
Mariner II
—Robert J. Parks

January 18
Nuclear Physics
—Ward Whaling

ALUMNI DIRECTORY

A new directory is now being prepared and current information is needed on all alumni. If you have not returned the Alumni Office card sent to you recently, please fill out the form below and mail to:

Alumni Office
California Institute of Technology
1201 East California Boulevard
Pasadena, California

Name ____________________

Address ____________________

City ____________ State ________

Title of present position ____________________

Name of organization ____________________

City of employment ____________________

Degrees from other institutions ____________________

ALUMNI ASSOCIATION OFFICERS

PRESIDENT
William L. Holladay, '24

SECRETARY
Donald S. Clark, '29

VICE-PRESIDENT
Peter V. H. Serrell, '36

TREASURER
John R. Fee, '51

BOARD OF DIRECTORS

Robert Boykin, '34
Patrick J. Fazio, '53
G. Russell Nance, '38
Richard W. Powell, '40
William H. Saylor, '32
William H. Simons, '49
Charles P. Strickland, '43

ALUMNI CHAPTER OFFICERS

NEW YORK CHAPTER

President — Victor Wouk, '40
Electronic Energy Conversion Corp.
342 Madison Ave., New York 17, N.Y.

Vice-President — Bruno H. Pilorz, '44
75 Echo Lane, Larchmont, N.Y.

Secretary-Treasurer — Harry J. Moore, '48
590 Madison Avenue, New York 22, N.Y.

WASHINGTON, D. C. CHAPTER

Chairman — Willard M. Hanger, '43
2727 29th St., N.W., Washington 8, D. C.

Secretary — Cmdr. Joseph B. Deodati, '46
7933 Deepwell Dr., Bethesda, Maryland

SAN FRANCISCO CHAPTER

President — Lee A. Henderson, '54
Spectromagnetic Industries
521 Lebanon St., Hayward, California

Vice-President — Edwin P. Schlinger, '52
Scott-Buttner Electric Co., Inc., Mountain View, Calif.

Secretary-Treasurer — Dallas L. Peck, '51
U. S. Geological Survey, Menlo Park, Calif.

Meetings: 13th Floor, Engineers Club, 206 Sansome St., San Francisco
Informal luncheons every Thursday at 11:45 A.M. Contact Mr. Farrar, EX 9-5277, on Thursday morning for reservations.

CHICAGO CHAPTER

President — Laurence H. Nobles, '49
Department of Geology, Northwestern University
Evanston, Illinois

Vice-President — Philip E. Smith, '39
Eastman Kodak Company
1712 Prairie Ave.
Chicago, Illinois

SACRAMENTO CHAPTER

President — G. Donald Meixner, Jr., '46
4416 Hazelwood Ave., Sacramento, Calif.

Vice-President — Robert K. Breece, '47
4812 "I" St., Sacramento 19, Calif.

Secretary-Treasurer — Dudley E. Bennett, '47
4535 Marble Way, Carmichael, Calif.

Meetings: University Club, 1319 "K" Street
Luncheon first Friday of each month
Visiting alumni cordially invited—no reservation

SAN DIEGO CHAPTER

Chairman — Maurice B. Ross, '24
3040 Udal Street

Secretary — Frank J. Dore, '45
Astronautics Div., Convair

Program Chairman — Herman S. Englander, '39
U. S. Navy Electronics Laboratory

Kodak beyond the snapshot...

(random notes)

Resist education

A certain engineering college recently asked us for a contribution not of money but of a small object suitably symbolic to deposit in the cornerstone of a new building. After thinking about it a bit, we sent three intricately shaped bits of metal so small that one of them got lost and never found its way into the box that will be opened some day to show our descendants the topics that engineers in 1962 regarded as fresh and promising. Is it not true that the engineering mind today is much occupied with working metals and semiconductors in ways to get as much performance as possible from as little bulk as possible?

Doggone right. In addition to making deposits in cornerstones, we have been busy expanding the line of photosensitive resists on which this hot new art so strongly depends. Everybody in it should be delighted to learn of KOR, a new one that's 10 to 15 times as sensitive to arc light and 30 to 100 times as sensitive to tungsten light as Kodak's well-known resist, KPR. This opens up the possibility of exposing KOR by a projected image instead of by contact printing, but the photographic speed is still a little low for an ordinary enlarger. A high-intensity projection printer will turn the trick.

If you don't even know what we are talking about, you have a dangerous blind spot in your education which you could repair quickly by sending a buck to Eastman Kodak Company, Rochester 4, N.Y. for a copy of "Photosensitive Resists."

Cheaper than rubies maybe

We have entered the laser rod business. This decision looks logical enough. Lasers are a) very, very, very promising and b) connected by a strong thread to a technology about which we feel cocky —namely, non-silicate rare-earth glass, which we broke open commercially 25 years ago for photo lenses.

It was a thrill to hear that a rod of ours commenced action at a threshold of only 4 joules at room temperature. It emitted at 1.06μ by transition of Nd^{+++} from $4F_{3/2}$ to $4I_{11/2}$ (not down to ground state, which is $4I_{9/2}$). Its time to technological obsolescence will be inevitably and indubitably short.

Meanwhile, for the people busy feeling out the ground rules of laser engineering for machine tools, weapons, etc., our neodymium-boron-barium-lanthanum-thorium-strontium glass is a good first choice because 1) neodymium needs no refrigerants (fluorescence doesn't return Nd^{+++} to ground state); 2) 1.06μ is convenient to phototubes, phosphors, and photography; 3) threshold for laser action comes at ⅓ the energy input that Nd^{+++} needs in silicate glass.

You have heard of ruby lasers? They depend on Cr^{+++}. Cr^{+++} depends on the crystal field to define its energy levels. Rare earths don't need a crystal field because their 4f levels are shielded by 5s electrons. Therefore they can work in glass, which can come big and homogeneous. Already a 2″ x ¼″ rod with ends tuned to reflect ~100% and 98% at 1.06μ costs less than a decent used motorcycle.

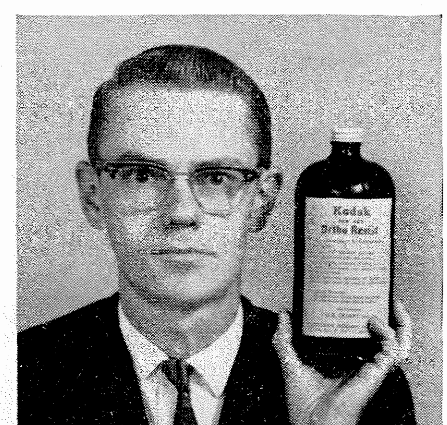
Adhesive findings

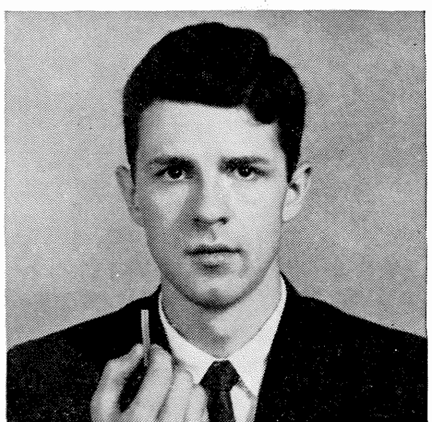
Mr. Guy V. Martin, 110 Yale Blvd., S.E., Albuquerque, N.M., has found EASTMAN 910 Adhesive vastly superior to soft solder for transmitting ultrasonic vibration. He has used up to 60 kc and electrical power inputs up to 200 watts at temperatures up to 200°F.

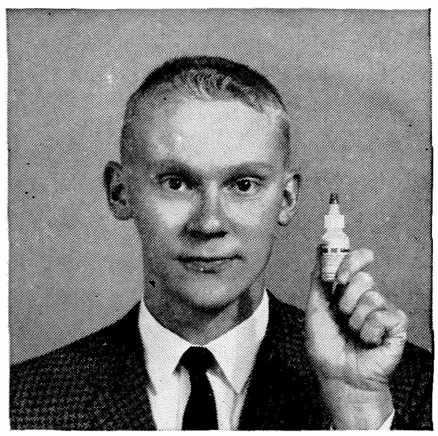
When he feeds energy like that through a solder bond from a transducer of laminated nickel sheets to an application tip, the solder deteriorates progressively and the transmission drops steadily. An EASTMAN 910 bond acts differently. Without apparent change, it transmits three to four times as long as solder takes to reach disintegration.

When the 910 bond finally snaps, it does so all at once with an audible snap. In the case of aluminum bonded to the nickel, rupture always takes place between the adhesive film and the aluminum. With other metals, plastics, ceramics, or glass bonded to the nickel, the rupture divides itself between one interface or the other and doesn't appear within the film.

Mr. Martin claims that for some 30 years Kodak has been very obliging in furnishing him helpful information from time to time. We claim that in volunteering his adhesive findings, he has now amply repaid us. We shall be very happy to furnish you, too, with helpful information for 30 years. EASTMAN 910 Adhesive is obtainable in a $5 sample kit from Eastman Chemical Products, Inc., Kingsport, Tenn. (Subsidiary of Eastman Kodak Co.). It develops great strength within seconds.



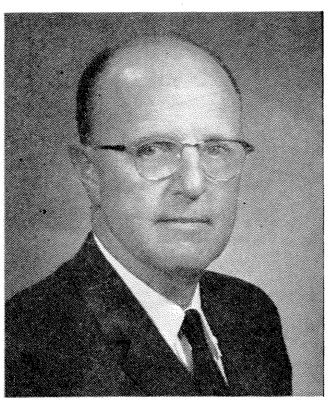




ALL SORTS OF PRODUCTS, ALL SORTS OF CAREER DEDICATION AT KODAK FOR THE SCIENTIFICALLY ORIENTED, B.S., M.S., OR PH.D.

EASTMAN KODAK COMPANY
Rochester 4, N.Y.

AN INTERVIEW WITH G.E.'s DR. GUY SUITS, VICE PRESIDENT AND DIRECTOR OF RESEARCH



Dr. Suits has managerial responsibility for the General Electric Research Laboratory and as a member of the Company's Executive Office he is directly concerned with G.E.'s over-all research programs and policies. He joined G.E. in 1930 as a physicist, and holds 76 patents, is Chairman of the Directors of Industrial Research, member of the National Academy of Science, Director of American Institute of Physics, previous Chairman of Naval Research Advisory Committee and Fellow of the AIEE, AAAS, and IRE, and has been Vice President and Director of Research since 1945.

For complete information about these General Electric training programs, and a copy of Dr. Suits paper "The New Engineer And His Scientific Resources," write to: Personalized Career Planning, General Electric Company, Section 699-05, Schenectady 5, New York.

How Scientists and Engineers Work Together in Industry

Q. Dr. Suits, I've heard a good deal about the scope of your programs. Is your research mostly in physics and electronics?

A. This is a common misconception. The work of the many laboratories of General Electric "covers the waterfront" in science and in advanced engineering technology. Some laboratories specialize in electronics research, others in atomic power, space technology, polymer chemistry, jet engine technology, and so forth. Actually, the largest single field represented by the more than 1000 Ph.D. researchers in General Electric is chemistry.

Q. Is this research performed principally by people with Ph.D. degrees in science?

A. General Electric research covers a broad spectrum of basic and applied work. At the Research Laboratory we focus largely on basic scientific investigations, much as in a university, and most of the researchers are Ph.D.'s. In other Company laboratories, where the focus is on applied science and advanced engineering, engineers and scientists with B.S. and M.S. degrees predominate. Formal college training is an important preparation for research, but research aptitudes, and especially creative abilities, are also very important qualities.

Q. What are the opportunities for engineers in industrial scientific research and how do scientists and engineers work together in General Electric?

A. Classically, engineers have been concerned with the problem "how," and scientists with the question "why." This is still true, in general, although in advanced development and in technological work scientists and engineers work hand-in-hand. Very close cooperation takes place, especially in the increasingly important fields of new materials, processes, and systems. Certainly in General Electric, a person's interest in particular kinds of problems and his ability to solve them are more important than the college degree that he holds.

Q. What does it mean to an engineer to have the support of a large scientific research effort?

A. It means that the engineer has ready access to the constant stream of new concepts, new materials, and new processes that originate in research, and which may aid his effort to solve practical problems. Contact with research thus provides a "window" on new scientific developments—world-wide.

Q. How does General Electric go about hiring engineers and scientists?

A. During each academic year, highly qualified technical people from General Electric make recruiting visits to most college campuses. These men represent more than 100 General Electric departments and can discuss the breadth of G.E.'s engineering and science opportunities with the students. They try to match the interests of students and the Company, and then arrange interview visits. The result of this system is a breadth of opportunity within one company which is remarkable.

Experienced technical people are always welcome, and they are usually put in contact with a specific Company group. Where no apparent match of interests exists, referrals are made throughout General Electric. In all cases, one finds technical men talking to technical men in a really professional atmosphere.

Q. Are there training programs in research for which engineering students might be qualified?

A. There certainly are. Our 2-year Research Training Program at the General Electric Research Laboratory gives young scientists a chance to work with experienced industrial research scientists before carrying out research and development on their own.

In addition, there are seven Company-wide training programs. Those that attract the largest number of technical graduates are the Engineering and Science, Technical Marketing, and Manufacturing Training Programs. Each includes on-the-job experience supplemented by a formal study curriculum.

Of course, not all graduates are hired for training programs. In many cases, individuals are placed directly into permanent positions for which they are suited by ability and interest.

GENERAL ELECTRIC