In choosing your career...consider United States Steel
...the leader in the one industry that's truly basic!

IT has been said: “United States Steel is the industrial family that serves the nation and the world.” For in our homes and factories—in communications—in transportation—steel is basic.

This means that in the complex and ramified organization which constitutes United States Steel, unlimited opportunities are presented to the college graduate—whether his preference is engineering, administrative work, or any of a score or more of other activities in this highly diversified industry.

In the final analysis, United States Steel is men...men of high caliber, exceptional ability, broad vision and complete dedication. Traditionally, United States Steel looks to its young men of today to become its leaders of tomorrow.

For complete information on the opportunities available at United States Steel for young men of ambition and foresight, send for a copy of our free book—Paths of Opportunity. Doing so may very well be the beginning of a successful and rewarding career for you at United States Steel.

United States Steel Corporation, Personnel Division
525 William Penn Place, Pittsburgh 30, Pa.

Please send me a free copy of your book, “Paths of Opportunity.”

Name

(College) (Course) (Date of graduation)

Address

City.................................................. State....
How to engineer a career

Best career advice we know is to "make no little plans". If you're the kind who measures the outer dimensions of the future with the divider's legs standing in a giant stride, we think you'll be interested in the 3M Company.

This unusually fast-growing company encompasses a wide world of products and fields of interest that leave plenty of room for growth—yours and ours.

Take our measure... in terms that are vital to your career. 3M sales have more than doubled in the last five years. Fact is, more than 22% of the products now being sold by 3M were developed in the last five years... exciting products like "scotch" Brand Magnetic Tapes to guide rockets and "thermo-fax" Brand Heat-activated Copying Machines.

Of course, 3M people are responsible for this growth... through new ideas and creative engineering. And it means that they are growing, too... in responsibilities, earnings, opportunities.

If we sound like your kind of company, write us now for full information. Minnesota Mining and Manufacturing Company, St. Paul 6, Minnesota.
Lee Baker tells what it’s like to be ... and why he likes being ... a Manufacturing Engineer with IBM.

Despite his impending Service hitch, Lee was hired by IBM in 1953. As a Technical Engineer, he entered the General Manufacturing Education Program, a 10-month course with rotating assignments in all phases of the work: manufacturing, purchasing, production. Then came two years in Korea. Now back at IBM, Lee has been promoted to Production Control Engineer, responsible for designing systems to insure a smooth flow of work through the IBM electronic computer plant. “It takes creative engineering ability to design these systems,” says Lee, “and administrative ability to ‘sell’ a system to higher management.”

There are many excellent opportunities for well-qualified engineers, physicists and mathematicians in IBM Research, Development and Manufacturing Engineering. Why not ask your College Placement Director when IBM will next interview on your campus? Or, for information about how your degree will fit you for an IBM career,

*Solution at bottom of page*
IN THIS ISSUE

On our cover this month is Edward B. Lewis, professor of biology, and author of the article on page 19, "Two Wings or Four," describing genetic experiment at Caltech which has provided biologists with a working model for picturing the genetic control of development.

From this working model, Dr. Lewis, developed a four-winged fly—the fruit fly, Drosophila, which is such an ideal tool for genetic studies. Background of our cover picture. Drosophila, you will note, form the foreground; they take up the foreground, too, as a matter of fact; each of those bottles contains a family of them (two parents and—after just a few days—their hundreds of offspring).

Dr. Lewis was graduated from the University of Minnesota in 1939, came to Caltech as a teaching fellow and received his PhD here in 1942. After wartime service as a meteorologist with the Air Force in the Pacific he joined the Caltech faculty in 1946.

PICTURE CREDITS

Cover Nolan Patterson
pp. 22, 23, 24
p. 32 Thomas W. Harvey
p. 44 William Kaup
Edward Hutchings, Jr.

CONTENTS

In This Issue 3
Books 6
Letters 14
Two Wings or Four? 19
By turning a two-winged fly into a four-winged one, Caltech geneticists produce a working model for picturing the genetic control of development. by Edward B. Lewis.

The Campus 22
Some samples of a new collection of photographs by Thomas W. Harvey.

The Best Is None Too Good 25
By 1972 the American people may be sending about 50 percent of their children to college. How will we make room for them? How will we pay the bill? And what quality shall the education be? by L. A. Duhbridge

The Month at Caltech 32

Student Life 40
Here we go again.
by Brad Efron '60

Alumni Scholar 44

Personal 48

STAFF

Publisher........................................ Richard C. Armstrong '28
Editor and Business Manager........................... Edward Hutchings, Jr.
Editorial Assistant....................................... Gerda Chambers
Student News........................................ Brad Efron '60
Student Photographers................................. Dennis L. Paul '59
William R. Schmus '60

Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena, Calif., for the undergraduates, graduate students and alumni of the Institute. Annual subscription $3.50 domestic, $4.50 foreign, single copies 50 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under act of March 3, 1879. All Publisher's Rights Reserved. Reproduction of material contained herein forbidden without written authorization. Manuscripts and all other editorial correspondence should be addressed to: The Editor, Engineering and Science, California Institute of Technology. © 1957 Alumni Association, California Institute of Technology.

Printed in Pasadena PP 3
Left to right: Lou Bernardi, Notre Dame, '54; Norman Lorenson, Mich. St., '55; Ernest Schurmann, M.I.T., '53; Dick Swenson, Purdue, '50.

Go with us... and you'll Grow with us!

CONVAIR
FORT WORTH

CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION
Dr. M. A. Biondi (Massachusetts Institute of Technology, B.S., '44, Ph. D., '49) measuring ultra-microwave transmission through superconductors. This experiment is a joint effort of a group of Westinghouse scientists aimed at obtaining a better understanding of the nature of superconductivity.

Westinghouse Scientists Probe Secrets of Superconductivity, using...

The Coldest Cold

Temperatures within a fraction of a degree of absolute zero are produced routinely by Westinghouse scientists in their search for more knowledge of the important phenomena of superconductivity. These phenomena rank with the nature of nuclear forces as one of the most fundamental problems facing the theoretical physicist. When superconductivity is completely understood, its principles could well revolutionize the electrical and electronic industries.

The basic principles of superconductivity have eluded an explanation since 1911 when the first example of the complete disappearance of electrical resistance in metal was discovered. Today scientists at the Westinghouse Research Laboratories in Pittsburgh, are making significant contributions to the field by their low-temperature research.

Superconductivity occurs in certain metals, alloys and compounds which, below characteristic transition temperatures, completely lose their electrical resistance. While in this superconducting state, they are perfectly diamagnetic, i.e. will completely exclude magnetic flux when placed in a magnetic field.

While this fundamental research is being conducted by theoretical physicists in search of knowledge and understanding of first principles, from even the terse description above of superconductivity, the imagination begins to run wild with engineering applications. An electronic computer using superconductivity memory elements will switch 10,000 times faster than conventional computer elements, will store 10 times as much information per unit space as ordinary computers. If the conditions can be fulfilled to make a substance superconductive in temperature regions other than that around absolute zero, design of every electrical or electronic product will be radically changed. Imagine considering the commonest electrical design problem without having to take into account electrical resistance!

While these exciting considerations whet the imagination, they are not the primary object of the low-temperature research going on at Westinghouse. This and many other research projects are being conducted to discover new phenomena and new knowledge of the universe. It is done on the belief that all research is an investment in tomorrow.

To the young, creative engineer this means exciting opportunities for graduate engineers in these exciting fields:

- ATOMIC POWER
- RADAR
- AUTOMATION
- SEMICONDUCTORS
- JET-AGE METALS
- ELECTRONICS
- LARGE POWER EQUIPMENT
  - and dozens of others

For more information on Westinghouse research in the field of superconductors and low-temperature studies, or information on job opportunities, write Mr. J. H. Savage, Westinghouse Electric Corp., P.O. Box 2278, Pittsburgh 30, Pa.
MERCHANT SAIL
by William Armstrong Fairburn and Ethel M. Ritchie

Reviewed by Paul C. Eaton
Dean of Students

The Humanities Library of the California Institute has recently come into possession of a six-volume work entitled Merchant Sail. This is the most nearly complete collection of information on the design, building, and operation of American sailing vessels, and of the relation of maritime commerce to the history of the colonies and of the Republic, that has ever been compiled—or perhaps that ever can be compiled.

Merchant Sail is the result of a lifetime of research, carried on as the recreation of a busy man, of the late William Armstrong Fairburn (1876-1947), naval architect, marine engineer, and industrial executive.

The set has not been offered for public sale but was published and distributed gratis to certain institutions as a public service by the Fairburn Marine Education Foundation, Inc., of Center Lovell, Maine. Its scope, depth, and thoroughness should make it very helpful to students of American history and economics, and invaluable to the maritime historian, amateur or professional.

The chronicle starts with the Virginia of Sagadahock, the launching of which into the Kennebec in 1607 was celebrated in Bath this year as the beginning of 350 years of shipbuilding in America. As befits a native of the state of Maine, Mr. Fairburn pays no attention to the claims of Haiti (1495), North Carolina (1526), Florida (1528), South Carolina (1562), Virginia (1585) or any other local "firsts" in shipbuilding, and proceeds from that point to record in Volumes I—III the ups-and-downs of American seaborne commerce from wood to steel, from sail to steam, pretty well down to World War II. Naval construction and operations, as well as the competition of steamships, are also discussed where they have significant relation to wind-driven merchant shipping.

Grand Turk, Great Republic, Shenandoah, Wyoming—all the great names are here. So, too, are Polly, Gold Hunter, Jere G. Shaw, and Transfer No. 6: pinnaces, brigs, snows, privateers, clippers and their predecessors and successors, barks and barkentines, the coasting schooners from the early pinks to the great six-masters, even the rigged wooden barges which formed the ocean-going

CONTINUED ON PAGE 10
Because *engineering* is a *profession* at GM
-we offer you a career—*not* a job

One reason engineering standards at General Motors are so high is that General Motors recognizes engineering as a profession. And the men who engineer the many different products made by GM are respected for the profession they practice.

That is why, when you are invited to join GM as an engineer, you don’t simply take a job—you start a career.

It is a career that is rewarding both professionally and financially—starting on your first day of association with GM at any one of its 35 divisions and 126 plants in 70 cities and 19 states.

During your early days at GM, for example, you work with a senior engineer who guides your career along professional lines.

You are also actively encouraged to pursue your education towards an advanced degree. For we at General Motors recognize that, in doing so, you will become more valuable to us and the engineering profession.

You are given the opportunity to obtain professional recognition through participation in engineering society forums, presentation of technical papers, winning of patents and other recognition of your accomplishments.

And you are also encouraged to take an active role in your community’s affairs—because a truly professional man is a good citizen as well as a good engineer.

All this is for a reason—and a good one.

Many of the men who will fill the key positions at GM in the future are the young engineers joining GM today. This is not theory, it is fact. For 14 of our 33 Vice-Presidents are engineers, 23 of our 42 Division General Managers are engineers, too.

Today we are looking for young engineers—such as you—who may fill these positions tomorrow. The rewards—both professional and financial—are substantial. If you feel you have the ability, write us. It could be the most important letter of your life.

GM positions now available in these fields:

- Mechanical Engineering
- Electrical Engineering
- Industrial Engineering
- Metallurgical Engineering
- Aeronautical Engineering
- Chemical Engineering
- Ceramic Engineering
- Mathematics
- Industrial Design
- Physics
- Chemistry

*General Motors Corporation*

Personnel Staff, Detroit 2, Michigan
Hughes fellowship programs
Howard Hughes Fellowships

Ten awards are open to candidates interested in studies leading to a Doctor of Philosophy or Doctor of Engineering degree or in conducting post-doctoral research. Each Fellowship provides a cash award.

Applications are invited from the United States and abroad for research and development work in the aeronautics field. Such work may be related to development and production of guided missiles at the California Institute of Technology, University of Southern California, Stanford University, Application closing date: January 15, 1953

Master of Science Fellowships

One hundred awards are open to participants in the Hughes guided missile program leading to the Master of Science degree within academic years. Tuition, admission fee, and books will be provided. During the summer and part-time during the academic year they will have the opportunity to work with experienced Hughes scientists and engineers, while receiving salaries based upon their ability and technical experience.

Applicants must receive his B.S. degree during the coming year in Aeronautical Engineering, Electrical Engineering, Mechanical Engineering, or Physics. Participants may request his graduate school from the following six institutions: University of Southern California, UCLA, Stanford University, University of Arizona, Purdue University, or West Virginia University.

Write, specifying appropriate fellowship to:
Office of Advanced Studies

Hughes

Research and Development Laboratories

Hughes Aircraft Co., Culver City, Calif.
tows of the early part of this century. And for each type and trade there are accounts of the supporting skills and activities of designer, master and mate, sailor and supercargo, rigger and adzeeman, longshoreman and wharfinger, clerk, banker, lawyer, managing owner, underwriter, crimp, cabin boy, and cook.

Soil under foreign flags

Mr. Fairburn lists the four-masted schooner *Laura Annie Barnes*, launched in 1921, also near the mouth of the Kennebec, as the last commercial sailing vessel built in America, but carries the story of sail under foreign flags down to the Finnish fleet of Capt. Gustaf Erikson, which once included the *Pamir*, lost in the hurricane of September 1957.

Volumes IV-VI are edited by Ethel M. Ritchie of Ojai, California, and deal specifically with the China, Australia, Manila, and India trades (IV), American shipbuilding (V), and an appendix of owners of clipper ships and the records of ships they owned, together with an index by vessels’ names of all ships mentioned in the preceding volumes (VI). The final volume also carries an admirable biographical account of Mr. Fairburn, itself a contribution to the record.

Some earlier books, like Capt. Arthur H. Clark’s *Clipper Ship Era*, Samuel Eliot Morison’s *Maritime History of Massachusetts*, Basil Lubbock’s *The Down Easters*, Clifford Ashley’s *The Yankee Whaler*, McNairn and MacMullen’s *Ships of the Redwood Coast*, dealing with limited areas in the general field, have achieved perhaps a better synthesis of the material and have made more apparent the interrelation of shipping and economic, political, diplomatic, even social developments. Mr. Fairburn’s 4,179 pages of fact, dimensions, times, tonnages, narrative and exposition contain the raw material of future studies. Lacking such a collection as this, log books, ledgers, customs house records, and the whole mass of supporting material of this great era in our commercial history could have become even more inaccessible because of dispersion than it already is.

Presumably, those with special knowledge will find errors or omissions in a work as comprehensive as *Merchant Sail*. Great Lakes navigation and the coastwise trade of California and the Northwest, for instance, get little space; while almost every gunk-hole in Maine is heavily, yet not always completely, documented. By and large, however, the work is a major contribution and, fortunately for the non-specialists who make up most of the library’s clientele, and who may want to skip the tabulated data, a very readable account of an important phase of the national heritage.

**ELASTIC WAVES IN LAYERED MEDIA**

by W. M. Ewing, W. S. Jardetzky and Frank Press

McGraw-Hill, N. Y. $10

Although the title suggests that this is a highly specialized book, it should appeal to a wide audience. Engineers working on delay lines or wave guides, geophysicists searching for oil, acousticians studying transmission in the ocean or atmosphere, physicists involved with electromagnetic wave propagation or solid friction—all make use of the techniques and results discussed by the authors.

Both experimental and theoretical aspects of the subject are covered on the elementary and advanced level. Perhaps the greatest contribution lies in the bibliography, which lists over 600 entries. The authors have scanned the world literature, including Russian and Japanese work in the field. Even when everything else is outmoded, this summary of the status of the field through 1955 will still be of value.

Frank Press, one of the three authors of this book, is professor of geology, and director of the Seismological Laboratory at Caltech.

**Why Vought Projects Bring Out The Best In An Engineer**

At Vought, the engineer doesn’t often forget past assignments. Like all big events, they leave vivid memories. And it’s no wonder.

For here the engineer contributes to history-making projects — among them the record-breaking Crusader fighter; the Regulus II missile, chosen to arm our newest nuclear subs; and the new fast-developing 1,500-plus-mph fighter, details of which are still classified.

The Vought engineer watches such weapons take shape. He supervises critical tests, and he introduces the weapons to the men with whom they will serve.

Engineers with many specialties share these experiences. Today, for example, Vought is at work on important projects involving:

- electronics design and manufacture
- inertial navigation
- investigation of advanced propulsion methods
- Mach 5 configurations

Vought’s excellent R&D facilities help the engineer through unexplored areas. And by teaming up with other specialists against mutual challenges, the Vought engineer learns new fields while advancing in his own.

Would you like to know what men with your training are doing at Vought... what you can expect of a Vought career?

For full information, see our representative during his next campus visit.

Or write directly to:

C. A. Besio
Supervisor, Engineering Personnel Dept. CM-2
Vought's Regulus II missile took shape just a short walk from the desks of its developers. Engineers handled the new hardware and monitored tests in person — literally flying the big missile on the ground at Dallas. It was a convenient arrangement while it lasted.

Then a big USAF Globemaster landed and taxied to Vought's Experimental Hangar. The missile was winched aboard and airlifted to a desert site for flight tests. By nightfall there was a 1,000-mile rift between Regulus II and home base.

Joe Boston was ready to step into this gap. As Project Assistant for Field Liaison, he'd already equipped Vought's desert crew for extensive flight tests. Now he'd make sure that test data and hardware flowed uninterrupted from the desert to Vought. High-speed feedback of facts on one flight could influence the success of the next.

Mail from the desert poured in to Joe at Vought. From project men at the flight test site came parts for immediate rework and return. From the flight test crew's mobile ground station came rolls of telemetered brush records. From the recoverable Regulus itself, came packets of oscillograph data. And from Field Service — for repair or replacement — an occasional wrench or relay.

Joe served as clearing house and consultant. Flight data was reduced and released to design and support groups. It revealed not only missile performance, but the temperatures and pressures of a strange new environment. When data pointed toward design changes, Joe's time and cost estimates helped specialists reach decisions.

Thanks to Vought's fast overland relay of hardware and data, the records of one flight were decoded and digested in time to improve the next hop. Dividends in performance and reliability were obvious after six flights had been logged by Regulus II.

All six had been flown by one vehicle.

Chance Vought uses comprehensive testing and data analysis to assist the engineer through unexplored problem areas. Test facilities strengthen every phase of the development cycle, and procedures are aimed at feeding data quickly into the engineering process.
If you are interested in hydraulics...

Here's what Pump Engineering at Ingersoll-Rand can mean to you...

No business or industry could long survive without pumps. Their vital liquid-moving function is a fundamental part of our modern civilization. That's why pump engineering offers such a varied and fascinating career — cutting across virtually every branch of every industry.

Ingersoll-Rand's Cameron Pump Division in Phillipsburg, N.J., is one of the oldest, largest and most progressive pump manufacturing plants in the world. As an engineer engaged in research, design, manufacture or sales of I-R pumps, you can be sure of three things — prestige, permanence and progress. The Company is a leader in its field, and so are the men you will work with. Here, long-range security and opportunities for advancement are second to none. For further information on leadership careers at Ingersoll-Rand, contact your Placement Office, or write to Ingersoll-Rand, 11 Broadway, New York 4, New York.

EXCELLENT OPPORTUNITIES NOW AVAILABLE:

- Sales Engineering — ME, IE, EM, EE, CE — Bachelor
- Design Engineering — ME — Bachelor & Master
- Production Engineering — ME, IE — Bachelor
- Business Engineering — Engineering & Business Degrees — Bachelor & Master

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y.
Avco Manufacturing Corporation is a builder of quality products for the commercial economy and high-performance military systems for national defense. Aircraft engines, electronics systems, farm implements, kitchen components and the nose cone for the Air Force Titan intercontinental ballistic missile are being produced by Avco today.

The foundation for Avco tomorrow is being laid at our Research and Advanced Development Division. We know that the technology of the future will be built on scientific research being done now. Amazing new materials and new means for creating useful power hold out the promise of great advances in transportation, in agriculture, in consumer products, in nearly every aspect of our future economy. New scientific knowledge and its imaginative application can turn these promises into reality. Work at the Research and Advanced Development Division has already shown what rapid strides can be taken in a short time.

The division is composed of outstanding scientists and engineers who work in an environment that fosters creative investigation. It is the "breakthrough" division of a progressive manufacturing organization. Avco management recognizes the role of the scientist in modern technology. Avco's determination to make things better for America places the resources of a large, diversified, aggressive company firmly behind the Research and Advanced Development Division.

Avco's new research division now offers unusual and exciting career opportunities for exceptionally qualified and forward-looking scientists and engineers in such fields as:

Science:
- Aerodynamics
- Electronics
- Mathematics
- Metallurgy
- Physical Chemistry
- Physics
- Thermodynamics

Engineering:
- Aeronautical
- Applied Mechanics
- Chemical
- Electrical
- Heat Transfer
- Mechanical
- Reliability
- Flight Test

Write to Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Division, 20 South Union Street, Lawrence, Massachusetts.
Beverly Hills, California

Sir:

I was fascinated by the letter in your October issue which gave the statistics on the reunion of the Class of '32. I was particularly interested in Questions 18 and 19 in the questionnaire sent to all class members, which dealt with past and present political convictions of the class.

Question 19, about the present opinions of the class (90.7% Republican) is easy to understand, but the results of Question 18 are rather unusual. In fact, 64% Republican in 1932, at the depth of the depression (or fairly close to it) when graduating scientists and engineers had very poor employment prospects, indicates at best a lack of political awareness in the Class of '32 in '32. As I recall, Mr. Hoover didn't do too well in the election that year.

John Wise '57

Pasadena, California

Sir:

The introduction to your October article, “A New Technique of Education,” describes the author, Dr. Simon Ramo, as “a noted scientist.”

After recovering from the shock of seeing the editorial kidnapping of a noted engineer, I read the article with great appreciation. It was true to form, Caltech engineering style. Ramo, like all Caltech doctorates in engineering, is not at a disadvantage among scientists but he is first, last and all the time an engineer of whom that profession is proud.

He was granted a B.S. in E.E. degree with Phi Kappa Phi high honors by the University of Utah in 1933 for the completion of a course in Electrical Engineering. At Caltech, he made an outstanding record as graduate student and teaching fellow in Electrical Engineering and in 1936 obtained the distinguished degree Ph.D Magna Cum Laude in Electrical Engineering. His major research program from which we learned much was carried on in the 1,000,000 volt laboratory and his doctorate thesis title was “A Proposed New Standard for High Voltage Measurement.”

He is a registered professional engineer, winner in 1941 of an Eta Kappa Nu award for engineering achievement, a Fellow of the American Institute of Electrical Engineers and of the Institute of Radio Engineers, all of which, as well as his writings and inventions, testify to the fact that though he can be properly called a scientist and also a musician of ability, he is by profession an engineer. His onetime professors claim the right to have him known as such.

Royal W. Sorensen
Professor of Electrical Engineering Emeritus

EDISON NEEDS ENGINEERS

CIVIL
ELECTRICAL
MECHANICAL

Southern California Edison Company, the fastest-growing electric utility company in the United States, serves one of the fastest-growing areas of the nation.

In anticipation of future power requirements, Southern California Edison is pioneering in an experimental atomic electric generating plant which will be the first in the West to produce electricity on a commercial basis.

Because of Edison's growth and its policies of leadership in technological fields and promoting from within, the opportunities for advancement with the company are at an unprecedented high.

Edison's employee benefits include a medical and sick leave plan plus outstanding retirement, vacation and insurance plans. For all the details please write or call:

Mr. C. T. Malloy, Southern California Edison Company.
P.O. Box 351 - Michigan 7111, Los Angeles 53, California.

Southern California Edison Company
LIVE BETTER—ELECTRICALLY
ENGINEERING AND SCIENCE
graduate study opportunity...

an important “plus” benefit at Los Alamos!

When a scientist or engineer comes to Los Alamos to work, it is important to him, and to us, that his fund of knowledge continues to grow. For that reason, the Graduate Center at Los Alamos is one of this interesting community’s most valuable assets.

The Center, operated by the University of New Mexico, offers graduate programs in the fields of nuclear, mechanical and electrical engineering, chemistry, physics and mathematics.

Additional facts of interest . . .

- Instruction is by recognized leaders in their scientific fields from the laboratory staff and from the University of New Mexico
- Classes are held in the evening, a few minutes from your Los Alamos residence
- One-half of your tuition is paid by the Laboratory
- Unique laboratory facilities and equipment are available
- Los Alamos technical library, among the nation’s most complete, is open 24 hours each day for study and research.

College graduates in the physical sciences and engineering who are interested in accepting important research assignments and at the same time continuing their advanced education are invited to write for more information. Details about the Laboratory, the Graduate Center and the delightful family living conditions in northern New Mexico will be sent by return mail.

Los Alamos Scientific Laboratory

of the University of California

Los Alamos, New Mexico
"Here are some of the facts about Honeywell that have most interested the young engineering graduates we talk to."

HONEYWELL IS A GROWTH COMPANY!
A growth company is one in which men move ahead because of opportunity and challenge...in which problems are turned into progress...and employment, sales and income increase steadily.

Honeywell, world leader in automatic controls, is such a company. For the past 30 years, sales have doubled or tripled every five years ($1.1 million in 1926; $287.9 million in 1956.) Employment has increased from 720 to over 30,000 in the same period and net earnings have climbed from $.4 million to $22.5 million.

The future is even more challenging. Planned diversification puts Honeywell in such new fields as office and factory automation, process control, plastics, atomic energy, electronics, missiles and satellites.

Honeywell has the proven skills to design, engineer and build the equipment required by an increasingly automatic world and to sell its products profitably.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sales ($000,000)</th>
<th>Net Earnings ($000,000)</th>
<th>Plant Space (Square Ft.) (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1926</td>
<td>1.1</td>
<td>.4</td>
<td>158</td>
</tr>
<tr>
<td>1931</td>
<td>5.4</td>
<td>.6</td>
<td>200</td>
</tr>
<tr>
<td>1936</td>
<td>13.5</td>
<td>3.0</td>
<td>432</td>
</tr>
<tr>
<td>1941</td>
<td>24.3</td>
<td>2.6</td>
<td>603</td>
</tr>
<tr>
<td>1946</td>
<td>45.9</td>
<td>5.7</td>
<td>1,284</td>
</tr>
<tr>
<td>1951</td>
<td>135.2</td>
<td>8.9</td>
<td>2,296</td>
</tr>
<tr>
<td>1955</td>
<td>244.5</td>
<td>19.3</td>
<td>3,460</td>
</tr>
<tr>
<td>1956</td>
<td>287.9</td>
<td>22.5</td>
<td>5,365</td>
</tr>
</tbody>
</table>

Honeywell's growth in sales!

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Hourly</th>
<th>%</th>
<th>Salaried</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1926</td>
<td>720*</td>
<td>540*</td>
<td>75*</td>
<td>180*</td>
<td>25*</td>
</tr>
<tr>
<td>1931</td>
<td>1,150</td>
<td>839*</td>
<td>73*</td>
<td>311*</td>
<td>27*</td>
</tr>
<tr>
<td>1936</td>
<td>3,139</td>
<td>2,200</td>
<td>70</td>
<td>933</td>
<td>30</td>
</tr>
<tr>
<td>1941</td>
<td>4,240</td>
<td>2,859</td>
<td>67</td>
<td>1,381</td>
<td>33</td>
</tr>
<tr>
<td>1946</td>
<td>9,474</td>
<td>6,490</td>
<td>68</td>
<td>2,984</td>
<td>32</td>
</tr>
<tr>
<td>1951</td>
<td>17,182</td>
<td>10,796</td>
<td>63</td>
<td>6,386</td>
<td>37</td>
</tr>
<tr>
<td>1955</td>
<td>25,608</td>
<td>14,853</td>
<td>58</td>
<td>10,755</td>
<td>42</td>
</tr>
<tr>
<td>1956</td>
<td>30,353</td>
<td>17,301</td>
<td>57</td>
<td>13,052</td>
<td>43</td>
</tr>
</tbody>
</table>

Honeywell's growth in people!
RESEARCH AND ENGINEERING ARE IMPORTANT AT HONEYWELL!

One indication of how important research, design-development and product engineering are to Honeywell's continued growth is the fact that over half of Honeywell's more than 12,000 products were not made by the company 5 years ago.

Some of the problems which Honeywell research and engineering have solved recently are: the development of variable inlet-air diffuser systems for jet engines, which adjust to the speed of the aircraft, allow such advanced planes as Convair's B-58 to reach design speed; the production of the space reference system for the Earth Satellite Rocket; and the production of the Supervisory DataCenter* central control panel which enables one man in one location to read and control temperatures for even the largest building.

Major research programs now underway at Honeywell include: the development of new techniques and the discovery of new materials to overcome the problems of extremely high temperatures created by high-speed aircraft and guided missiles; the development of automatic control systems for industrial automation; the development of even more accurate navigation systems for aircraft and rockets which may be called upon for intercontinental and interplanetary travel.

HONEYWELL MEN ADVANCE RAPIDLY!

Naturally, in a company committed to growth, opportunities are numerous for the engineers and scientists who can contribute to that growth. And at Honeywell, other factors accelerate advancement.

Engineers predominate among our vice presidents, divisional executives and department managers. Attitudes and opinions of our scientists and engineers are understood and supported by management.

Honeywell is composed of small units working as a team. These units multiply opportunities for early managerial experience and lay the foundation for more important managerial assignments in future years.

HONEYWELL OFFERS MANY EXTRA BENEFITS!

Honeywell's extra benefit program is one of the most liberal in industry. There's free group life insurance... free accident and sickness insurance... free hospital insurance. You'll find a generous policy on paid vacations and holidays and a modern retirement program paying lifetime benefits.

Whichever Honeywell division or location you choose, you'll be assured of special training to help you advance in your career. This training includes regular on-the-job instruction, formal classes at the company and tuition-aid courses at nearby institutions.

HONEYWELL'S MAIN FIELDS AND LOCATIONS ARE:

- Minneapolis—Aeronautical, Ordnance and Heating and Air Conditioning Controls.
- Philadelphia—Industrial Instruments, Computers, Controls and Valves.
- Wabash, Indiana—Heating and Air Conditioning Control Dampers and Electronic Air Cleaners.
- Denver—Oscillographic and Photographic Equipment and Research.
- St. Petersburg, Florida—Inertial Guidance Systems.
- Seattle, Washington—Ordnance Controls, Missiles and marine research laboratory.
- Monrovia, California—Ordnance Controls and Missiles.
- Los Angeles—Aeronautical and Heating and Air Conditioning Controls.
- Boston—Industrial Instruments, Servo Components and Controls; Data Processing Systems.
- Freeport, Illinois—Precision Switches.
- Chicago—Heating and Air Conditioning Controls.
- Hopkins, Minnesota—Corporate Research Center.
- Beltsville, Maryland—Data Recording Systems.
- Toronto, Canada—Manufacture of complete line of company products.
- International—Manufacturing Plants in Newhouse, Scotland; Amiens, France; Frankfurt, Germany; Amsterdam, The Netherlands; and Tokyo, Japan. Plus 166 Sales and Service offices throughout the world.

HOW TO LEARN MORE ABOUT HONEYWELL!

A Honeywell representative can answer your questions and give you additional information about opportunities at Honeywell. Please consult your college placement office for the date of his next visit to your campus.

Meanwhile, you will want to read "Your Curve of Opportunity in Automatic Controls." Write R. L. Michelson, Personnel Administrator, Dept. TC29D, Minneapolis-Honeywell Regulator Company, 2753 Fourth Avenue, South, Minneapolis 8, Minnesota.

* Engineering and Research Facilities
  • Sales and Service Offices

Honeywell

First in Controls

NOVEMBER, 1957
...on science and research

"In every field of science, advances in knowledge are forcing more and more specialization. As disciplines become narrower and their interactions harder to discern, communication among specialists becomes more difficult. At the same time, the relevance of political, economic, and social factors in the broad application of physics, chemistry, and mechanics to major practical problems is increasingly evident. Many such problems, unlike research at the frontiers of the specialties, are too broad in their implications and too complex in detail to be solved by any expert working alone. The research team, uniting the diverse skills of many specialists, and using the best mathematical tools — theoretical and computational — is probably the most successful means of discovering realistic, timely, and original solutions to important problems of public welfare and security."

—F. R. Collbohm, President
By turning a two-winged fly into a four-winged one, Caltech geneticists produce a working model for picturing the genetic control of development

By TAMPERING WITH the genes of the tiny Drosophila fly we have constructed a four-winged fly at Caltech. Such a fly is really a contradiction in terms. As every school boy (who has had biology) knows, flies have only two wings. How then does a four-winged fly arise—and what is the significance of such a useless creature?

Be assured that the California Institute has not been under contract to develop and produce such monsters. Instead, the four-winged fly was a by-product of some basic studies of the nature of the hereditary material. Perhaps someday knowledge gained from such studies will help prevent the occurrence of similar kinds of monstrosities among human births.

Why do we use the fly in experiments on heredity? To perform such experiments we need to breed large numbers of individuals in a short time in a small space. The Drosophila fly admirably fulfills these conditions; a new generation appears every ten days, and a single pair can produce hundreds of offspring in a small culture bottle on an inexpensive food in a few days.

The genetics of this fly is a part of the broad program of genetics that T. H. Morgan and his colleagues initiated at the California Institute in 1928. In fact—in the period from 1910 to 1928—it was Morgan and his group at Columbia University who demonstrated that the genes are arranged in a linear order in the chromosome—much like beads strung on strings.

In 1942, it was discovered at Caltech that there are places in the chromosome where what at first had appeared as a single gene turned out, by finer methods of analysis, to be a cluster of functionally related genes. The genes responsible for the four-winged fly belong to such a cluster—called the “bithorax” cluster.

The normal fly (shown on page 20) has a pair of wings and, behind them, a pair of tiny club-shaped organs—the balancers or halteres. The balancers are thought to provide a gyroscopic action which is used to stabilize the flight of the insect. It is these balancers which are modified into wings in the case of the four-winged flies.

Such flies represent a combination of two extremely rare mutations belonging to the bithorax cluster. The first mutation, a “bithorax” type, was found in 1925 by Professor Curt Stern. It causes an overgrowth of the front half of the haltere so that it resembles the front half of the normal wing.

In 1948, some experiments with x-rays at Caltech produced another kind of mutation that resulted in a
The normal fly has a pair of wings and, behind them, a pair of small club-shaped organs called balancers or halters.

fly in which the back half of the haltere develops an overgrowth resembling the back half of the normal wing. This mutant is therefore given the name post-bithorax.

We felt that we could best test the validity of these interpretations of the mutant effects by combining the mutants in such a way that both are expressed in the same individual. Then, a fully formed wing should arise in place of the balancer.

To combine the two abnormal mutants required several steps. First, bithorax females were mated to postbithorax males. The offspring of this mating are perfectly normal two-winged flies. They are “carriers,” however, of the two mutant genes. These carriers were then allowed to produce offspring which numbered 18,711 flies. Among the 18,711, only three proved to have been cases in which the two mutants were combined together in one and the same chromosome. The final step was to breed together these rare individuals. From this mating, a pure-breeding strain of four-winged flies (shown on page 21) was developed.

The extreme rarity with which the two mutants recombined was expected, since it was already known that these genes are in the same cluster—that is, they are exceedingly close together in the chromosome.

Position of genes

The rule about determining the position of genes can be expressed in another way. If a female inherits a certain genetic defect from her mother, and a quite different defect from her father, the chance that one of her eggs will receive both of these defects depends on how easy it is to get a recombination between the affected genes in the female’s maternal and paternal chromosomes. The affected gene in the maternal chromosome must actually be physically recombined with the affected gene in the paternal chromosome by an interchange or “crossover” between these two threadlike structures. The closer the affected genes are to each other, the less often such a crossover occurs. In fact, we use this principle to define the gene: a gene is a unit within which crossovers do not occur.

What good is a four-winged fly?

What, if anything, can we learn from a four-winged fly? One thing we hope to learn is how genes affect the development of an organism. We know that the genes are the core of living matter. They provide the information that enables the cells to grow and multiply and develop into the fully formed organism. In other words, they not only account for the transmission of characteristics from the parents to the offspring, but they are also thought to control the whole course of development of the organism from fertilized egg to adult.

In recent years much has been learned about what genes do besides simply making copies of themselves to be handed on from one generation to the next. Thus, each gene seems to control the production of a specific catalyst or enzyme which in turn controls a biochemical reaction. A whole group of investigators in the biology division at Caltech are probing this biochemical aspect of genetics.

Is such a gene-controlled chemistry sufficient to explain how, during its growth and development, an organism acquires its shape and form and elaborate differentiation of parts?

We are not sure of the answer. Instead, as a working hypothesis, we postulate that the development of a living organism is an orderly unfolding in time of many different sequences of biochemical reactions—each ultimately gene-controlled. Curiously, all of the cells of the developing organism seem to contain the same num-
The four-winged fly has fully formed wings in place of the balancers, and a greatly enlarged thorax.

ber and kind of genes. In other words, there appears to be no mechanical sorting out of the genes according to part and function.

If development is to be explained in terms of the action of genes, it becomes necessary to picture it as a gradual and orderly “turning on,” so to speak, of systems of genes. The bithorax and postbithorax mutants probably represent part of one such system. Thus, the bithorax cluster is concerned, among other things, with determining whether flies shall have two wings or four wings. We infer this from the fact that, in the presence of the abnormal or mutant genes, bithorax and postbithorax, the normal pathway of development is interfered with and a four-winged fly results.

Now we have good reason to believe that flies evolved from an ancestral type which had four wings. In the evolutionary process, the second pair of wings were reduced to the balancers. From this we speculate that the normal (as opposed to the mutatb) bithorax and postbithorax genes must somehow have originated as new genes whose function was to elaborate substances which suppress the potential development of the second pair of wings.

Origin of new genes

Geneticists picture the origin of new genes somewhat as follows: first the “old” gene duplicates; then one of the two identical genes thus formed is free to mutate to a “new” gene having a new function while the old gene is retained to carry out the old function. To be sure, a great many other changes—and perhaps many other new genes besides bithorax and postbithorax—had to arise before the modern fly evolved.

For example, as if to compensate for the reduction of the second pair of wings, the wing-bearing section of the fly underwent an enormous overdevelopment and produced an elaborate pattern of bristles and hairs. The fly shown in the picture above has both wing-bearing sections enormously overdeveloped. This is not surprising, of course, when it is realized that in such a fly there has been no alteration in the systems of genes which are responsible for overdeveloping the wing-bearing region.

What can we infer about the role of the bithorax cluster of genes in normal development? We postulate that, during the course of development of a normal fly, this system of genes is present but effectively inoperative in the wing-bearing section. In the haltere-bearing section, on the other hand, these genes elaborate a series of substances which direct the pathway of that section from wing formation toward haltere formation.

A working model

What determines the essential difference between the wing and haltere-bearing section? We postulate that there is a gradient in the concentration of some chemical substance during the development of the embryo, such that the concentration is relatively much greater in the haltere-forming region than it is in the wing-forming region. It would then be the function of the normal genes of the bithorax cluster to exploit this gradient—to amplify it into an “all-or-none” response. That is, the bithorax cluster would normally be inoperative in the section which ordinarily produces wings, but would be “turned on” (by the presence of greater amounts of the postulated substance) in the section which produces halteres. The normal genes of the bithorax cluster would then elaborate a set of substances which would direct the haltere-forming section to make halteres.

We have a working model for picturing the genetic control of development. Whether it is the correct model or not remains to be seen. In pursuing that model, however, we should make progress in our understanding of the living organism.
THE CAMPUS

Some samples from a new collection of photographs

by THOMAS W. HARVEY

Left: Throop Hall, oldest building on the campus.
Below: Kerckhoff biology laboratories.
Engineering building, completed in 1950.

Blacker, one of the four student houses.
Robinson Laboratory of Astrophysics.

Colonnade between Fleming and Ricketts Houses.

Church Laboratory of Chemical Biology, dedicated in 1956.
The Best Is None Too Good

By 1972 the American people may be sending about 50 percent of their children to college. How will we make room for them? How will we pay the bill? And what quality shall the education be?

by L. A. Dubridge

The American people now send 30 percent of their children to college, and the chances are better than even that in 10 years, more or less, the number will be approaching 50 percent. In some of the more prosperous states 50 percent of the high school graduates now enter college.

The number of children who reached age 17 and who thus could potentially be applicants for admission to our institutions of higher education was 2,300,000 in 1956; it will be 3,900,000 in 1972—an increase of 70 percent. If the fraction of these who enroll in college continues to increase as in the past, we will have more than doubled college enrollments by that year.

If our present great educational system of 1800 colleges, junior colleges and universities is just adequate for present enrollments (and I hear little complaint about space going to waste!) then we are going to have to build the equivalent of 1800 more colleges by 1972. Double in 15 or 20 years the plant that has taken 300 years to build! The task is staggering; until 1972 it will cost about a billion dollars a year for physical facilities alone.

We now spend 3 billion dollars a year in operating our universities and colleges—about $1,000 per student. It is unlikely that the cost will go down; in fact, to bring faculty salaries to where they should be it must go sharply up. Thus we should add a billion dollars a year immediately to the budget, and by 1972 we may need to be spending $1,400 per student, or 8 billion dollars a year for higher education—in addition to a billion a year needed for plant additions.

As President de Kiewiet of the University of Rochester recently remarked in a brilliant paper on the subject, “All this is absurdly too much.” “Or,” he adds, “is it?” He goes on to point out that American industry is spending at the rate of 25 billion dollars a year for new plant facilities. (Southern California alone is spending a billion dollars a year for new plant.) American Telephone and Telegraph spent a billion dollars last year on new telephone equipment. If we can spend that much on helping people talk to each other, might we not spend an equal amount in helping them have something to talk about? Furthermore, 3 billion dollars a year is only 75 cents out of each $100 of Gross National Product. In 1972, 8 billion dollars will be only $1.30 out of each $100 of the projected GNP for that year.

The bill has got to be met. The American people will not tolerate having half their qualified youngsters refused admission to college. The only question is: When shall we pay, and how? Shall we meet the bill soon enough—or too late? Shall we meet it by tuition fees or private gifts or taxes, or by how much of each?

But the quantitative problem is not the most serious one. Americans can scrape up an additional 3 or 4 billion dollars a year by 1972 if they have to. Much more difficult—and more important—than the question

"The Best Is None Too Good" has been adapted from a talk given at the Conference on Engineering and Scientific Education in Chicago on November 1, 1957.
of how many students are to be educated is the question of what quality shall the education be.

The conclusive test of what the quality of an educational institution has been is, of course, the quality of the alumni. If the alumni of 25 years ago appear to have reached, in relatively substantial numbers, positions of high achievement and if they occupy posts of responsibility in government, in industry and in universities, we can then surely conclude that 25 years ago that institution was doing a fine educational job—or, at least, was attracting exceptionally able students.

A long history of alumni success is the earmark of the great institution. And since greatness has tremendous inertia (it is difficult to achieve but, once established, has a tremendous tendency to persist) we are usually safe in taking past performance, if consistently maintained, as a good measure of present quality or the lack of it.

Now, if the measure of past achievement in a given field is the success of the alumni, then we must ask what are the sources of this success? What factors make for continuing high quality? There are, I think, at least four:

1. Quality of students
2. Quality of faculty
3. Quality of leadership
4. Quality of teaching and research facilities

Each of these factors is worth a brief discussion.

Students—The matter of student quality is not usually given adequate nor adequately candid attention. The blunt fact is that, by any sort of test of intellectual ability ever given, the average quality of students at some institutions is very substantially higher than that found at others. In fact, the upper quartile of students at some colleges may hardly come up to the lower quartile at others.

Now, this is not bad; in fact, it is good and should be encouraged. Top-grade students will get a better education if they are in a place where there is stiff competition; and less able students will also do better if they are not hopelessly outclassed by their colleagues.

Difference in performance

It needs to be realized that in technical subjects like mathematics and physics, which require a high degree of quantitative imagination, the difference in performance between a top student and a mediocre student is really very great. It is far greater than the difference suggested by giving the one a grade of 99 percent and the other 60 percent, for example. It is not a ratio of 5 to 3, but a ratio of 5 to 1, or 10 to 1—or, occasionally, 100 to 1—that we are dealing with.

Trying to accommodate in one class a spectrum of student achievement ranging over a ratio of 10 to 1 presents serious difficulties, to say the least. That means a problem assignment which takes 2 hours for the best student takes 20 hours for the least able student. If we compromise and let the slowest student off with 5 hours of work, the best student may not even bother to solve such easy problems at all. How we attack this difficult problem is one of the prime questions of technical education.

There are some people who will say we need not worry about the outstanding student; he will take care of himself. And they will point to the Thomas Edisons and Charles Ketterings who had very little formal education at all.

But I think this attitude is wrong—very wrong. The future creative leaders of our science and technology should have the most challenging opportunities to develop their capacities—intensively and early. You can point to certain great scientists and engineers who are self-taught—but I can point to many, many more who developed under the challenging and understanding encouragement of a great teacher—such as Ernest Rutherford, Niels Bohr, or Robert Millikan, to name but three in the field of physics.

There are so many examples of a great scientist building up a school from which other great scientists have come, that we are forced to the conclusion that—though a few may come through handsomely, even though neglected—we can substantially increase the yield of good technical people if we provide the stimulation, the encouragement and the practical help that a high quality educational center can give. Maybe the most important function of a great center or a great teacher is just to attract the best students and let them stimulate each other. If so, that is a most significant contribution.

Quality and quantity

What shall we do, then, about student quality as enrollments rise? Shall we tighten up the admissions policies of our colleges, cutting off, say, by 1972, the lower half or two-thirds of those who would now be admitted—educating only those of ever-higher intellectual capacity?

There are some who advocate this course—and advance in its favor perfectly sound arguments about the importance of quality versus quantity. Others advocate this course to save money.

Nevertheless, this extreme measure will not be accepted by the American people, who are determined to have greater, not less, educational opportunities. Nor is this solution, I believe, either practical or desirable—for four reasons:

1. Our selecting and predicting techniques are not nearly good enough to refuse a higher education to half of those who desire it. We would be cutting off many who, because of poor schooling, poor home environment, or other reasons, have made a slow start but may still do very well.

2. In the engineering fields we need men with a variety of skills. And not all the talents we need are necessarily reflected in high academic standing. The old
adage that "the A students make the professors and the C students make the money" is no longer good statistics, but it still is more than occasionally true.

3. The quantitative shortage of scientists and engineers is sufficiently severe and sufficiently long-term that we should seek to recruit a larger rather than a smaller percentage of students into our engineering schools.

4. Finally, there is no conclusive evidence that under proper conditions rising enrollments in a particular institution necessarily result in declining quality or in lesser opportunities for the gifted student.

What then do we do to keep broad educational opportunity and also to insure the quality of training we need? I would propose:

1. Expand facilities for higher education throughout the country, especially in public institutions, to provide space for the same or slightly larger fraction of the total college-age population as now, and at the same time improve our selection techniques to eliminate the loafers and incompetents.

2. Make more extensive use of the junior college as a means for providing the first two years at low cost for many students—thus delegating to those institutions some of the task of eliminating the unfit and preparing the better ones for upper-division work elsewhere.

3. Provide for all students of outstanding ability, whenever and wherever they appear, special attention, special encouragement and special incentives to go on beyond the routine work of the classroom; and encourage them, when it is appropriate, to transfer to other institutions where more adequate facilities or competition will be found.

4. While many institutions expand their facilities, a few schools around the country should be encouraged in their efforts to select only the most able students and provide them with a supremely challenging program.

We have such schools now—and many of them are facing a difficult dilemma. Shall they expand enrollment and make their excellent facilities available to more students—even at some loss in quality—or shall they put all available resources into higher and higher quality opportunities for a carefully selected few? Or can some, in fact, expand and raise quality also?

The select few

I would not presume to judge what the proper course is for any particular college—except my own. But I do suggest that those who do elect to give high-quality instruction to a select few be given encouragement and support—in spite of the fact that some segments of public opinion will brand such institutions as "undemocratic," a horrible distortion of the meaning of that word.

Faculty—Good scholars are very scarce. You would think, in fact, they would command the highest salaries of anyone in the community. But, instead, their salaries have always been low and, in purchasing power, they have been getting relatively lower as the years go by.

Our colleges and universities are being subsidized by their faculty members who, in the nation as a whole, forego a billion dollars a year in salary because they love to live in a university atmosphere. Now that is very generous and loyal of them—but the universities are courting disaster if they allow this contribution to continue.

Opportunities more remunerating, and in some ways equally rewarding, are available outside the universities for scientists and engineers—especially young ones not yet bitten with the university bug. The quality of our faculties will surely erode away if we do not find ways of keeping a very much larger fraction of these bright young men in the teaching profession.

The seed corn of the future is such a valuable resource that we must promptly begin to adopt more realistic methods of conserving it. The second report of the President's Commission on Education Beyond the High School flatly recommends that average faculty salaries be doubled in the next five to ten years. It is about the most sensible suggestion I have heard.

First-class faculty

To have first-class colleges we must have first-rate faculty and there is just no room for further argument on that point. We'll either get first-class talent and pay for it—or we will have second-rate universities. Again the decision rests with the American people.

But this is no easy task. To double the top salary levels of professors in the leading universities means bringing them from the present $10,000-$15,000 salary levels to $20,000-$30,000. Now $20,000 is the annual income on some $500,000 endowment, and $30,000 is the income on $750,000. A group of 100 top professors, then, will require an endowment of $50,000,000 to $75,000,000. Not more than 15 private institutions in the nation have that much endowment to cover all expense.

The Ford Foundation recently made munificent gifts totaling $250,000,000 to the accredited private colleges of the country—over 600 in number. This was about equal to one year's salary budget for these institutions. As an endowment, therefore, it provided about a 4 percent salary increase. To double the salaries in these same institutions would have taken an endowment gift of 6½ billion dollars! Impossible? Well, at least we must admit it won't be easy and we ought to get to work.

Leadership—The third qualitative criterion in university education is that of leadership; the leadership of the faculty, of the deans and other administrative officers, of the president and the trustees. Someone must set up the ideals which an institution seeks to achieve—and then keep the helm firmly fixed in that direction.

In 1908 a great scientist and scientific leader named George Ellery Hale became a trustee of a private manual training school in Pasadena. He persuaded the other trustees that southern California needed a technical university "second to none" in the nation. Fortunately, he
Bricks and mortar, steel and concrete are essential elements in a fine technical institution. We must have laboratories for teaching and research libraries where the knowledge of the past is readily accessible to the present; living, dining and recreation facilities conducive to a life of scholarship—these things are essential to students and faculty alike.

Hardheaded businessmen are inclined to criticize universities for making "inefficient use" of space. A classroom, they say, is used only 6 hours a day, 5 days a week, only 9 months a year. Why not 70 hours a week instead of 30? Why not 12 months a year?

Well, why do we use the bedrooms in our houses only 8 hours a day? Why not take turns sleeping and make one bedroom do the work of three? Also, why do automobile assembly lines operate only 40 hours a week—with 6 weeks off every fall to change models?

**Machines for men**

The answer is, of course, that machines are made for men—not men for machines. Buildings and laboratories are designed to make learning easier, not harder. The time of people—of students, of faculty, of other employees—is far more valuable than the building space they need. It is poor economy to impede the work of a $20,000 professor (in 1965, that is!) for many years for lack of a few thousand dollars' worth of space.

The entire capital cost of a university plant is often no more than 3 to 5 times the operating expenses for a year. And even if classrooms can stand being used 12 months a year, neither the teacher nor the student can.

What I have been saying may be briefly summarized:

1. One brilliant creative scientist or engineer may turn up with more new ideas than 100 ordinary ones. He may, in fact, need the help of the 100 in putting his ideas to use. Hence, while we are educating the 100 we should not fail to find and encourage and give special attention to the one.

2. Since we cannot always pick out "the one" at an early age, we must provide opportunities for many—and we will need the many, too.

3. Since we can, on the other hand, select some—even if not all—superior students at an early age, there should be a few places where those students can go for especially challenging opportunities.

4. Let us end up with first-rate students studying under second-rate professors, we must find ways of keeping more first-class professors in the universities.

5. A colossal task faces America in doubling our educational plant and staff during coming years and at the same time improving its quality. We may by 1972 have to spend twice as much for higher education as we do for cigarettes! If we can only make clear to the American people what the task is, I feel sure they will tighten their belts and make the sacrifice.

6. In higher education in America; even the best is none too good.
Today's classroom is no longer bounded by books and blackboards. For our children, school is big as the world of sight and sound itself.

RCA has sent the electron to school—in TV sets, radios, "Victrolas,"® records, tape recorders, film projectors. And with all this, valued help for teachers who must make fullest use of our overcrowded classrooms.

Picture a civics class listening to a vital debate in the UN... a youngster improving his diction with the help of a tape recorder... kindergartners dancing to folk music of a faraway country... interns watching an operation close-up on closed-circuit TV... The applications are endless.

Through its leadership in electronics, RCA contributes a great deal to the success of this new and broader kind of education. In fact, helping our oncoming generation to see, to hear... to understand... is one of the most important jobs we do.

WHERE TO, MR. ENGINEER?
RCA offers careers in research, development, design and manufacturing for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. For full information, write: Mr. R. Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.
This special periscope gives Pratt & Whitney Aircraft engineer a close-up view of combustion process actually taking place within the afterburner of an advanced jet engine on test. What the engineer observes is simultaneously recorded by a high-speed motion picture camera.

One indication of accomplishment in the combustion field: the J-57 engine, augmented by afterburner, provided the thrust which made supersonic flight practical for the first time.
Historically, the process of combustion has excited man's insatiable hunger for knowledge. Since his most primitive attempts to make use of this phenomenon, he has found tremendous fascination in its potentials.

Perhaps at no time in history has that fascination been greater than it is today with respect to the use of combustion principles in the modern aircraft engine.

At Pratt & Whitney Aircraft, theorems of many sciences are being applied to the design and development of high heat release rate devices. In spite of the apparent simplicity of a combustion system, the bringing together of fuel and air in proper proportions, the ignition of the mixture, and the rapid mixing of burned and unburned gases involves a most complex series of interrelated events — events occurring simultaneously in time and space.

Although the combustion engineer draws on many fields of science (including thermodynamics, aero-dynamics, fluid mechanics, heat transfer, applied mechanics, metallurgy and chemistry), the design of combustion systems has not yet been reduced to really scientific principles. Therefore, the highly successful performance of engines like the J-57, J-75 and others stands as a tribute to the vision, imagination and pioneering efforts of those at Pratt & Whitney Aircraft engaged in combustion work.

While combustion assignments, themselves, involve a diversity of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program—with other far-reaching activities in the fields of instrumentation, materials problems, mechanical design and aerodynamics—spells out a gratifying future for many of today's engineering students.
Prizewinner

The Caltech Camera Club, made up of employees and staff members of the Institute, held its annual photographic exhibit on the campus last month. This year’s show included the picture which was chosen Print-of-the-Year by the Southern California Council of Camera Clubs. Selected from a total of some 2500 entries, the shot was taken by William Kaup, who worked at Caltech during the war as a member of the visual presentation unit, turning out Air Force manuals dealing with long-range weather forecasting. Kaup, who is now copy chief at the Darwin H. Clark advertising agency in Los Angeles, took the prize with a picture called “Connoisseurs” (above), taken in front of the tile mural at the California State Teachers Association Building in Los Angeles.

Robert Knapp

Robert T. Knapp, professor of hydraulic engineering, died of a coronary attack on November 7. He was 58 years old.

A native of Loveland, Colorado, he was graduated from MIT in 1920 and came to Caltech as an instructor in mechanical engineering in 1922. He received his PhD here in 1929. He was widely known for his work in mechanical engineering, particularly in fluid dynamics and hydraulics.

CONTINUED ON PAGE 36
"For today's engineer, yes..."

"You are probably the most sought after young men in America today. Industries of all kinds want you. You've got a wide choice, so which field do you choose? "The way I look at it, the aircraft industry has the most opportunity for you. It combines more advanced engineering sciences than any other field...electronics, communications, propulsion systems, hydraulics and pneumatics, thermodynamics...all these and many others. With this variety, interesting careers can be had by specializing in one area or by moving from one to another.

"Obviously, you are going to want recognition for your work. You know that the aircraft industry pays well...but think about this: aviation is relatively young and its life-blood is young men with new ideas. Numerous important advances have been made just in the last few years. Who knows what new fields—and new opportunities—today's research will uncover?

"So, for today's engineer, yes, I would say that your best bet is the aircraft industry. Nowhere else can you find such opportunity, such challenge...and such compensation and added benefits. In my estimation, there is no place where you can put your college training to better use."

In the aircraft industry there is such a variety of engineering fields that a desire for virtually any one can be satisfied. As research continues more areas will be embraced and, as aircraft engineers pierce these barriers and solve today's problems, new challenges and opportunities arise. Northrop engineers have been meeting these challenges successfully for years. Airplanes such as the F-89 Scorpion, the new supersonic twin-jet Northrop T-38 trainer, and missiles such as the Snark SM-62 are examples of Northrop's engineering theory and capabilities.

In Northrop's new Engineering and Science Center, your training can be applied to top priority projects and your future will be made more secure by intensive on-the-job training. Regular reviews reward you for your capabilities and accomplishments, adding further financial security. The extra benefits at Northrop, such as company-paid insurance and over three weeks vacation with pay, are among the most generous in the entire industry.

Write now and ask us how your qualifications can be applied to a career at Northrop. Regardless of whether you are an upper-classman or not, we believe we can show you that Northrop offers you a great future. Address Manager of Engineering Industrial Relations, Northrop Division, Northrop Aircraft, Inc., 1032 East Broadway, Hawthorne, California.
As the world's largest manufacturer of communications equipment, our continued progress depends greatly on our engineers. They have a key role in the production of some 50,000 types of apparatus and component parts that Western Electric makes in a given year.

- To our engineers falls the monumental task of developing manufacturing operations and of planning the installation of telephone central office equipment across the nation. They devise the new machines, tools and methods needed to do our job. They also shoulder the major responsibilities in carrying out the defense contracts the government has asked us to take over - major projects like the Nike guided missile system and SAGE, the continental defense system.

- In the course of their technical work, engineers participate in such broad managerial functions as production, merchandising, installation, and many others. What's more, we have a record of promotions from within. It's not surprising, therefore, that fifty-five percent of the college graduates in our upper levels of management have engineering degrees.

- Naturally we do everything possible to encourage and speed the professional development of our engineers. Just recently, for example, we inaugurated a full-time off-the-job Graduate Engineering Training Program at special training centers, a program with few parallels in American industry.

- The new engineer moves into the first phase of this program, Introduction to Western Electric Engineering, four to six months after he joins us and devotes nine weeks of study to such technical subjects as communications systems, military electronic systems, product design principles. He takes part in the second phase, General Development, after the first year on the job. In this phase he devotes nine weeks to courses in human relations, semantics, engineering statistics, electronics, measurements and instrumentation, systems circuit analysis. The third phase, Advanced Development (4 weeks per year), is available to selected engineers and is geared to the individual to help develop his creative engineering abilities; goes deeply into such subjects as magnetics, computer applications, electronic switching, radar fundamentals, feedback control systems and technical paper writing.

- Besides this company-wide program, a number of our divisions offer individual engineering courses in their own specialties. We also sponsor a Tuition Refund Plan for out-of-hours study at nearby colleges. Open to all employees, this plan helps our engineers study for advanced degrees at Company expense.

- Truly there's an engineer's world here at Western Electric... one in which engineers in every field of specialization can expect to grow.

### Opportunities for Engineering Graduates

_Supervisory and administrative opportunities exist in each field_

**Analysis for manufacturing operations:**
- Machine and tool requirements—M.E., E.E.;
- Space requirements—M.E., I.E.;
- Test facility requirements—E.E.;
- Personnel requirements—I.E.;
- Electric power, light and heat requirements—E.E.;
- Raw material requirements—Chem. E., Met. E., Phy. Sc.;
- Procedures and processes—M.E., I.E.;
- Time and Motion Studies—I.E.;
- Investigation of manufacturing difficulties—M.E.;
- Quality control—M.E., E.E.

**Planning telephone central offices:**
- Equipment requirements—E.E.;
- Power and cable requirements—E.E.

**Development and design:**
- New machines and tools—M.E., E.E.;
- Material handling methods—M.E., I.E.;
- New equipment and processes—M.E., E.E.;
- Repair shop methods—M.E.;
- Testing facilities—E.E.;
- Testing methods—E.E.;
- Job evaluation studies—I.E.;
- Wage incentive studies—I.E.;
- Production control studies—I.E.;
- Improved chemical processes—Chem. E., Met. E., Phy. Sc.;
- New application for metals and alloys—Chem. E., Met. E., Phy. Sc.;
- Raw material test procedures—Chem. E., Met. E., Phy. Sc.;
- Service to military on electronic devices—E.E.

For further information write: Engineering Personnel, Room 1030, 195 Broadway, New York 7, N. Y.
hydro-dynamics and his investigations covered hydro-
dynamic problems of hydraulic turbines and centrifugal
pumps; wave and surge problems of beaches and har-
bors; the mechanics of cavitation and cavitation damage;
and problems of underwater ordnance, soil erosion,
drainage and irrigation. The Caltech hydrodynamics lab-
oration was his concept, and it was developed during the
war under his guidance.

In addition to his teaching and research at Caltech,
Dr. Knapp served during the war as Official Investigator
of the Office of Scientific Research and Development on
a study of air and water trajectories of rockets, bombs and
torpedoes. He was a consultant to the U.S. Army
Ballistic Research Laboratory, Aberdeen Proving Ground,
on hydrodynamic problems of fin and spin-stabilized pro-
jectiles.

Day Medal

Hugo Benioff, professor of seismology, received the
Arthur L. Day Medal of the Geological Society of Amer-
ica at the Society's annual meeting in Atlantic City this
month. The medal is awarded in recognition of outstand-
ing contributions to geologic knowledge through the
application of physics and chemistry to the solution of
geologic problems.

Dr. Benioff has been associated with the Seismological
Laboratory since 1924, and he has been a member of
the Caltech faculty since 1937, when direction of the
Seismo Lab was turned over to the Institute by the
Carnegie Institution of Washington.

A graduate of Pomona College in 1921, Dr. Benioff
received his PhD from Caltech in 1935. He has been
known as an authority on the design of earthquake
instruments since 1931, when the first Benioff seismo-
meter was put into service. These instruments are now in
operation at many stations in the United States, as well
as in Peru, India, South Africa, Australia and Europe.

In his current work as a member of the IGY Tech-
nical Panel on Seismology and Gravity, (E&S—October
1957), Dr. Benioff is directing studies in South America
with two fused quartz extensometer installations. Mea-
surements of secular strains, made at an adequate number
of stations, over a long-enough time interval, may give
sufficient information to provide a basis for the pre-
diction of earthquakes.

Tomatoes

Commercial varieties of tomatoes have always been
grown most successfully in California and in a nar-
row geographical band running from the Midwest east-
ward to New Jersey. These are the principal places in the
United States where night temperatures—which are crit-
ical to the tomato's flowering and fruit setting—stay with-
in a certain optimum range, around 64 degrees F.

Now, as a result of work done in the Caltech Earhart
Plant Research Laboratory, tomatoes of excellent pro-
cessing quality may soon be grown commercially in areas
as far south as Texas. This work was financed by the
Campbell Soup Company and was directed by one of the
company's plant breeders, Dr. Lester W. Schaible.

Some tomato plants grow in the far north and in the
tropics. Their fruit does not compare with the best Ameri-
can varieties in size, flavor and color, but they tolerate
night temperatures much lower and higher than ours do.
By crossbreeding domestic and foreign strains, the scien-
tists at Caltech produced plants combining the best qual-
ties of the American plants with the temperature toler-
ance of the others.

The work was begun early in 1956, after a year in
which unusually high night temperatures cut the eastern
American tomato crop by 80 percent. Upon his arrival at
Caltech, Dr. Schaible received from the Philippines the
seeds of a native tomato that set small but abundant fruit
despite the tropical night temperatures. He planted these
and also the seeds of the Rutgers tomato—a standard
American variety—and waited for them to flower. By
crossbreeding, he produced a fruit whose seeds contained
hybrid embryos. When these seeds were planted, they
produced hybrid tomatoes—half Philippine, half Rutgers.

Dr. Schaible next inbred the hybrids. The resulting
fruit contained seeds which, when planted, produced a
second generation of tomato plants that showed all possi-
ble re-combinations of characteristics of the original
parent plants. Some, like the original Rutgers, bore large
fruit abundantly at low temperatures; some, like the first generation
plants, were hybrid in their product; a few combined the
worst characteristics of both parents; and a few com-
bined the best characteristics of both.

Selecting several plants of these last and best strains,
Dr. Schaible inbred them for the production of more
seeds. These, in turn, produced excellent tomatoes, in
abundance, at night temperatures as high as 80 degrees F.
The same strains, field tested in the south, have consist-
ently performed as well as their laboratory prototypes.

One tomato plant normally yields enough seeds to
plant an entire acre. Thus, within another five years, the
field test plants should produce enough seeds so that these
extraordinary tomato strains can be grown over many
hundreds of acres in warm sections of the country. They
may also help to stabilize the yield where tomatoes are
grown commercially now.

Long-range consequences may be even more important.
Dr. Schaible has shown that in the tomato plant, genes
governing temperature tolerance and genes governing
fruit size are independently inherited. If this is true of
other plants, then the possibilities of developing special
strains of food crops—tailored to climatic conditions—
may be vastly increased.
go where
engineers don’t get lost
in the crowd

One of the many hurdles that can slow down your progress as an engineer is getting lost in the crowd. It can happen in smaller companies as well as in big ones.

That’s because size itself is not the villain. The thing to watch out for is the kind of company organization that swallows you up and erases your individual identity.

Boeing is one company that takes steps to see that engineers don’t get lost in the shuffle. Boeing engineers, for instance, work in small integrated teams where initiative and ability get plenty of visibility. Each engineer gets a personal merit review every six months—assuring you a continuing opportunity for individual recognition. In addition, Boeing engineers are eligible for advancement at any time between reviews.

There are many other advantages to careers at Boeing—including assignment to exciting missile and jet-age projects, high starting salaries, liberal retirement and company-paid graduate study programs.

There are family advantages, too. One is a choice of three sections of the country in which to live. In each Boeing community you’ll find good housing and schools, a youthful spirit, and abundant recreational facilities for the whole family.

Boeing has openings for engineers, and for physicists and mathematicians—openings with a world of opportunity for advancement.

Now is the time to start planning ahead. Consult your Placement Office, or write:

JOHN C. SANDERS,
Staff Engineer, Personnel Administrator,
Boeing Airplane Co., Seattle 24, Washington

R. J. B. HOFFMAN,
Chief of Engineering Personnel,
Boeing Airplane Co., Wichita 1, Kansas

BOEING
Aviation leadership since 1916
Seattle, Washington Wichita, Kansas Melbourne, Florida
Texas Instruments engineers are building portable electronic timing devices to uncanny accuracies with interval variations to infinity. They allow applications never before practical because of previous size, weight, power drain, and maintenance limitations... particularly in airborne installations. Essentially binary counting and storage devices, these TI timers present an entirely new concept in time measurement... a result of the new design freedom allowed by transistors... of which TI is also the world's largest commercial manufacturer.

At engineer-managed Texas Instruments, recognition of individual achievement has contributed to TI's twentyfold growth in the last ten years — to a current $70 million volume. Advanced personnel policies include company-sponsored educational assistance, profit sharing, insurance, and retirement programs.

Texas Instruments plants are within Dallas, yet away from downtown traffic... within 5 minutes of fine residential areas, churches, and public and private schools. Your home will be within 15 minutes of year-around recreational, amusement and cultural activities.

Here are the major products and programs you can work with at TI:

**SEMICONDUCTORS & OTHER COMPONENTS**—Transistors, diodes, rectifiers, resistors, and panel meters.

**ELECTRONIC & ELECTROMECHANICAL APPARATUS**—Radar, sonar, infrared, navigation, magnetics, telemetering, communications, computers, transformers, and instruments.

**RESEARCH**—Semiconductor materials and devices, ferromagnetics, infrared, optics, high speed data reduction, etc.

**ADMINISTRATION**—Production, planning, purchasing, cost analysis, etc.

Texas Instruments

INCORPORATED

6000 LEMMON AVENUE - DALLAS 3, TEXAS
You want a job

PLUS

... plus the chance to get ahead
... plus the chance for recognition
... plus the chance to keep learning

As a leader in many fields, Union Carbide offers a handsome assortment of plus factors with its jobs. It's a top producer of petrochemicals—and U. S. output of petrochemicals has roughly doubled every five years since World War II. It's a leading producer of oxygen—and new steelmaking methods use such vast quantities of oxygen that consumption in '57 is expected to be double that of '55. And these are only two of the expanding fields in which Union Carbide is a leader.

In terms of jobs with plus, this growth means Advancement with a capital "A." As our markets expand, we need more people to handle the development, production, and sale of our products.

Representatives of Divisions of Union Carbide Corporation, listed below, will be interviewing on many campuses. Check your placement director, or write to the Division representative. For general information, write to V. O. Davis, 30 East 42nd Street, New York 17, New York.

BAKELITE COMPANY  Plastics, including polyethylene, epoxy, fluoroethylene, vinyl, phenolic, and polystyrene. J. C. Older, River Road, Bound Brook, N. J.

ELECTRO METALLURGICAL COMPANY  Over 100 ferro-alloys and alloying metals; titanium, calcium carbide, acetylene. C. R. Keeney, 137—47th St., Niagara Falls, N. Y.

HAYNES STELLITE COMPANY  Special alloys to resist heat, abrasion, and corrosion; cast and wrought. L. E. Denny, 725 South Lindsay Street, Kokomo, Ind.

LINDE COMPANY  Industrial gases, metalworking and treating equipment, synthetic gems, molecular sieve adsorbents. P. I. Emch, 30 East 42nd Street, New York 17, N. Y.

NATIONAL CARBON COMPANY  Industrial carbon and graphite products. Prestone anti-freeze, Eveready flashlights and batteries. S. W. Orne, P. 0. Box 6087, Cleveland, Ohio.

SILICONES DIVISION  Silicones for electrical insulation, release agents, water repellents, etc.; silicone rubber. P. I. Emch, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE CHEMICALS COMPANY  Synthetic organic chemicals, resins, and fibers from natural gas, petroleum, and coal. W. C. Heidenreich, 30 East 42nd St., New York 17, N. Y.

UNION CARBIDE INTERNATIONAL COMPANY  Markets Union Carbide products and operates plants overseas. C. C. Scharf, 30 East 42nd Street, New York 17, N. Y.


VISKING COMPANY  A pioneer in packaging—producer of synthetic food casings and polyethylene film. Dr. A. L. Strand, 6733 West 65th Street, Chicago, Ill.

IT'S ABOUT A WEEK before the beginning of school and the student houses are recovering from their summer stupor. Noise in the courtyards, lights in the hallways, disorder in the lounges, are sure signs of returning life. First back are the football players and the summer residents, who lived on campus all through the vacation period. This group really appreciates the solid stoniness of the houses after the wooden emptiness of the Old Dorm.

Soon others return, and the nightly mass excursions to local restaurants begin. Everyone's glad to see at least some of his schoolmates, and conversations are long and lurid with summer experiences. Speculation runs high on one topic: the entering freshmen. What will they be like—neat guys or trolls? Past experience gives the edge to trolls, say the upperclassmen.

Then the freshmen begin to arrive. Of course they're not all neat, and they're not all trolls; they're a tremendously varied group, from all parts of the country and from almost all social classes.

The few days before Freshman Camp present a weird social scene. The upperclassmen are friendly to the point of strain. There's a good reason for this; later each freshman will choose a house, and the houses will choose the freshmen they want. Naturally, each house wants the best of the crop, but in these first days it's hard to judge, so everyone tries to be everyone's friend.

The freshmen react differently to this enforced friendliness. The loud ones get louder, since there's no one to shut them up. Each seems to know a thousand bad jokes, and tells every one of them. There are always a few well-trained upperclass laughers around to prevent embarrassing silences. Most of the under-confident frosh get even more shadowy as they see their aggressive classmates seemingly win the approval of the upperclassmen.

Freshman Camp comes as a relief to all concerned. Up to the mountains go the frosh, a group of faculty members, and a collection of 25 "upperclass leaders." The air is clean, the nights are cold, and there's nothing to do but meet people. This lack of escape is the main advantage of Student Camp. Informality is determinedly enforced, as the faculty members attempt to undo a year's aloofness in two days. While the professors try to prove they're human, the freshmen try to prove they're professors. The upperclassmen just try to be neat.

Speeches during the day provide a pleasant break between volleyball games. At night Dr. Feynman plays his bongos and there are more speeches. President DuBridge's talk on "Your $900 Bargain" is the best given and the best received by the frosh, though upperclassmen who remember "Your $750 Bargain," and "Your $600 Bargain," are less enthusiastic.

Meanwhile, the ASCIT board is going through the difficult and self-designated process of choosing first-term freshman class officers. The board members rush about, trying to meet everyone. Naturally they can't, so they concentrate on the people who look good on their "activities sheet," filled out the previous summer. Caltech probably attracts more Math Club presidents than any other school in the country. Math Club presidents don't get chosen. As the final hours of camp approach, the Board is left with about twice as many names as it can use. From this point on, a wrong smile or a misplaced word can eliminate a freshman from the running. At last the new officers are decided upon, announced, and everyone goes home.

Beginning of classes is also the beginning of formal rotation. The freshmen move from house to house, eating lunch and dinner for two days in each. Naturally, there are speeches, but the main influencing work goes on at an individual level—for by this time the houses think they know who's neat and who's not. Groups of upperclassmen form continuously around a desirable frosh, while the less-neats and trolls are left alone. The houses really are different, but the desirables seldom get a chance to find this out in the sop of all-surrounding friendliness. It's the less-neats (but not the trolls) who generally go into the house that's best for them. Later, some of the less-neats turn out to be the really-neats.

With rotation over and the freshmen sorted into the various houses, initiation begins. The upperclassmen are no better at sustained meanness than they are at being universally friendly, so the freshmen have to initiate themselves. This they do with water fights and curse-shouting sessions. Finally initiation ends, too, and the freshmen are left alone to mature into upperclassmen. Within a few months they'll be fully ready to greet next year's freshman class with fine fake smiles and misleading information.

—Brad Efron '60
THE LOCKHEED MISSILE SYSTEMS

Advanced Study Program for

M.S. and Ph.D. DEGREES

in science and engineering

University of California at Los Angeles • University of Southern California
University of California at Berkeley • Stanford University

The Graduate Study Council offers an Advanced Study Program to enable
qualified individuals to obtain M.S. or Ph.D. degrees. Under this program the
participants are employed in their chosen fields of research and development
at Lockheed Missile Systems while concurrently pursuing graduate study.

Eligible students must be U.S. citizens holding M.S. or B.S. degrees
in fields of Engineering, Mathematics and Science applicable to missile
systems research and development.

Students are invited to contact their Placement Officer for additional information
or write:

COLLEGE RELATIONS DIRECTOR

Lockheed MISSILE SYSTEMS

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE • VAN NUYS • CALIFORNIA
Petroleum, in addition to being the world’s most important source of energy, is also a vital raw material for thousands of petrochemicals. Keeping pace with the increasing demand for oil and natural gas, the petroleum industry is a leader among the nation’s growth industries. And Phillips Petroleum Company is the fastest growing of the ten largest oil companies.

Phillips rapid and continuing expansion offers excellent opportunities for technical graduates to choose careers in such varied fields as research, exploration, production, manufacturing, transportation and marketing. And in addition to petroleum fuels and lubricants for automotive, aircraft and industrial use, we produce and market a wide variety of petrochemicals, and operate Government-owned rocket fuels and atomic energy installations.

Thus, no matter what your interests are, you will find a challenging opportunity in some phase of our operations. Write to our Technical Manpower Division today for your copy of our new brochure, “Career With A Future.” And be sure to arrange for an interview with the Phillips representative when he visits your campus.

D. R. McKeithan, Director
Technical Manpower Division
PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma
IBM engineers needed a small steel tube—a memory unit for a computer—whose whirling surface would pick up thousands of complicated figures as magnetic impulses, retain and, years later, read them back instantly. This called for the cleanest, most uniform quality steel that could be produced. IBM consulted Timken Company metallurgists, who recommended a certain analysis of Timken® fine alloy seamless steel tubing. IBM found the steel so clean that when properly plated it accurately recorded up to 100,000 electro-magnetic impulses. So strong it withstood the centrifugal forces of 12,000 rpm without distortion or damage. It's another example of how Timken Company metallurgists solved tough steel problems.

WANT TO LEARN MORE ABOUT STEEL OR JOB OPPORTUNITIES?
To learn more about electric furnace fine alloy steel, send for "The Story of Timken Steel Quality". And for help in planning your future, write for "Career Opportunities at the Timken Company". We will reply promptly. The Timken Roller Bearing Company, Canton 6, Ohio.

See the next Timken Televent hour, "The Innocent Years" over NBC-TV, Thursday night, November 21st.
ROBERT POE, a freshman from San Jose, California, is the fourth Caltech student to receive an Alumni Scholarship. The award—a four-year, full-tuition grant, made by the Caltech Alumni Association through contributions to the Alumni Fund—has been given each fall since 1954.

In 1954 Robert Poe was just a freshman in high school, but even then he knew he wanted to come to Caltech. His older brother Bill applied for admission to four colleges that year—including Caltech—and the whole Poe family (with the possible exception of the youngest of the three brothers, who was 2 at the time) spent every waking moment discussing the relative advantages of the four institutions. The more they discussed, the more they were all convinced that Caltech was the best possible choice. Ironically, Bill was turned down by Caltech—at the same time as he was offered scholarship honors by the three other schools. But Bob has been determined to come here ever since.

Bob will be 17 this month. His main interest now is in theoretical physics and mathematics, and his present intention is to pursue his education as far, and for as long, as circumstances permit. His father is a partner in a children's wear business in Santa Clara. His brother Bill, now a senior at the University of Chicago, will be going to medical school next year.

At Lincoln High School in San Jose, Bob ranked second in a class of 264, and got A's almost without exception through his high school years. He was active in debate and speech, dramatics, basketball, swimming and wrestling, and he was manager of the varsity football and basketball teams.

At Caltech he not only has an Alumni Scholarship, but two others he won with his writing talents in high school—a $400 scholarship in an essay contest sponsored by the National Safety Council and the American Teamsters Union, and a $100 bond in an essay contest sponsored by the San Jose Real Estate Board. (The subjects of these contests were safe driving and the advantages of home ownership, respectively, and it may be interesting to note that Bob Poe (a) has no driver's license and (b) doesn't own his own home.)

A red-headed, soft-spoken, serious minded young man, Bob Poe is a fine example of the well-rounded freshman Caltech keeps searching for—as you can tell at a glance at this abbreviated list of his recent reading:

Macbeth
Playing the Piano for Pleasure
The Night Life of the Gods
Lucretius—De Rerum Natura
MacDougall on Dice and Cards
Collected Poems of T. S. Eliot
Plain Talk to Men Under 21
Melvin Janes, a friendly, sandy-haired man in his early forties, may well be the world's only trackwalker with a doctor's degree. Since 1953, Dr. Janes has trudged many a mile along railroad tracks from Maine to Texas. His mission: to check with his own eyes the killing power of a unique railroad-bed weed destroyer.

Weeds are a menace to railroad men. They are a fire hazard; wheels slip on them; they hold moisture which rots the ties and undermines the roadbed; they make maintenance difficult. More than 50 kinds of weeds grow along the tracks. Some die easily and stay dead—but many are too tough for ordinary weed killers.

When Mobil scientists developed a promising new oil-based killer—AGRONYL—Dr. Janes took to the tracks to check it out. It killed the weeds, all of them. Moreover, it's heavy and doesn't blow on to adjacent farmland. It leaves a film that discourages new growth (and also helps keep the tracks from rusting).

Chemical research is only one of many professions represented on the world-wide roster of Mobil personnel. We also employ nuclear physicists, geologists, mathematicians, engineers of every type, marketing analysts, marketers... people prepared to handle more than 100 different positions.

If you qualify, the Mobil companies offer you an opportunity to build a career through training that will utilize your talents to the fullest... constantly challenge your ingenuity... reward you with a lifetime of richly satisfying work.

For more information about your opportunity with the world's most experienced oil company, see your College Placement Officer.

SOCONY MOBIL OIL CO., INC.
NEW YORK 17, N. Y.

Leader in lubrication for 91 years

AFFILIATES:
General Petroleum Corp., Los Angeles 54, California
Magnolia Petroleum Company, Dallas 21, Texas
Mobil Oil of Canada Ltd., Calgary, Alberta, Canada
Mobil Overseas Oil Company, New York 17, N. Y.
Mobil Producing Company, Billings, Montana
Socony Mobil Oil Company de Venezuela and other foreign producing companies
Absolutely none—but they did get readership! We know that from our readership survey reports.

Actually, they weren't written to create a heavy response. They were designed to acquaint you with our name and to give you thumbnail sketches of historical figures, both real and mythical, noted for their integrity and durability. Just as Kerite has been noted since 1854. Our name has been the standard of quality in the industry for all these years. We are not the largest cable manufacturer. Our products may not be the lowest priced. But experienced engineers will agree: when quality and long life are a must, specify Kerite.

Meanwhile we would value your reaction to these ads—particularly constructive criticism. Won't you drop us a line?

The value and service life of a product can be no greater than the integrity and craftsmanship of its maker.

**KERITE CABLE**

THE KERITE COMPANY—30 Church St., New York 7, N. Y.
Offices also at 122 S. Michigan Ave., Chicago; 562 Market St., San Francisco; 3901 San Fernando Rd., Glendale 4, Calif.; 31 St. James Ave., Boston; 4101 San Jacinto, Houston 4, Texas; 1030 Euclid Avenue, Cleveland 17, Ohio; 29 West Lancaster Avenue, Ardmore, Pa.
Marquardt Means Opportunity

The Marquardt Aircraft Company was founded in November, 1944 to conduct research, development, and manufacturing operations in ramjet propulsion. From the beginning, the principle company objective was to establish and maintain a high level of competence in engineering.

Both because of the national need and the inclination and experience of the key people, Marquardt has continued to pioneer the development of products containing a high content of scientific and engineering newness. Prominent examples are the supersonic ramjet, providing cruise power for the Boeing Bomarc interceptor missile and the Lockheed X-7 Test Vehicle; ram air auxiliary power packages, on the Chance Vought F-8U and the Lockheed F-104A; thrust reversers; afterburners; and a wide range of ramjet and turbojet controls and accessories.

Since the technical areas available to a company specializing in advanced controls and propulsion work are numerous, you will find a broad range of engineering opportunities at Marquardt. Check your Placement Office for dates when Marquardt representatives will visit your school, or write Dock Black, Professional Personnel, Marquardt Aircraft Company, Van Nuys, California.
CHALLENGING ASSIGNMENTS at FTL for America's Finest Graduate Engineers

Radio Communication Systems
Electronic Countermeasures
Air Navigation Systems
Antennas * Missile Guidance
Transistors and other Semiconductor Devices
Computers * Telephone and Wire Transmission Systems

These interesting assignments at Federal Telecommunication Laboratories offer unlimited opportunities to outstanding ability . . . under FTL's "small-company" project system and continuing program of expansion. FTL is a top spot to launch and continue your career . . . congenial, inspiring, with finest facilities, dynamic leadership . . . only minutes from New York City's wealth of advantages.

Get the full FTL-ITT story before you make the "big decision."


E. Dale Barcus, tall service transmission engineer with the Pacific Telephone Company, is now vice chairman of the Los Angeles section of the American Institute of Electrical Engineers.

1925 Thomas P. Simpson is now general manager of manufacturing of the Socony Mobil Oil Company, Inc., in New York. He had been vice president and director of manufacturing for the General Petroleum Corporation in Los Angeles since January, 1955.

1931 Raymond A. Peterson, PhD '35, vice president of the United Geophysical Corporation in Pasadena, writes that "I spend my time between the lab and the field in developing new instruments and techniques for geophysical exploration. Next February will make my 20th year with the company. About our three children: Dianne is a sophomore at Trinity University in San Antonio, Texas; Linda is a senior in high school; and Lowell, 14, has his sights set on Caltech."

1932 James C. Mouzon, PhD, professor of electrical engineering at the University of Michigan, is also a research physicist at the Willow Run laboratories of the University's Engineering Research Institute. The Mouzons have two daughters—Betsy, who is married and lives in Bethesda, Maryland; and Peggy, 16.

E. Bryant Fitch is now director of the Westport (Connecticut) Laboratories of Dorr-Oliver, Inc. He had been serving as research director.

Avin J. Tlleker is head of the guidance and control division at the Naval Ordnance Test Station in Pasadena. He joined NOTS in 1951, after working for three years at Northrop Aircraft on their SNARK missile.

David Y. K. Wong, MS'33, is now an authorized architect in Hong Kong. He writes: "Right after I got my MS in 1933 I was married to Lillian Chung of Los Angeles and we returned to China. My first job was as junior engineer in the Public Works Department in Canton, and in 1935-36 I taught in the College of Engineering at Kwangsi University. "Just before World War II, I was called to work in the Ministry of Communications in the interior of Free China. For 13 years I stayed in the government service—working on such jobs as the building of the Burma Road, Yunnan-Burma Railway, and the Land-Lease Airfields for the U.S. Air Force in Kweilin, Liuchou and Lushien. In 1945 I was awarded, along with a few others, a citation and medal from Generalissimo Chiang Kai-Shek for our work in airfield construction. The University of Redlands, from which I graduated in 1931 with a BA, awarded me the Alumni Achievement Award in 1947. Since June, 1949, I have been in Hong Kong, reestablishing myself as a structural engineer. "Our daughter was graduated from San Francisco State College last year. She is now married and lives in San Francisco. Our son is studying in high school in Hong Kong."

Patrick B. Lyons is now superintendent of Western Electric's manufacturing plant in St. Paul, Minnesota.

Mott Prudames, manager of retail plant and equipment in the domestic marketing operating department of the Socony Mobil Oil Company in New York, writes that "life began at 40 plus when I got married three years ago to Ida Freeman. Then, after living in southern California all our lives, we moved to Riverside, Connecticut. To make things more complete, our son, John Mott, was born in August, 1956—so we are starting out on a family at a time when many of my fellow alumni are well along toward completing the raising of their own. Wouldn't have missed it for the world—even at this late date."

Charles M. Harsh is head of the Human Engineering Branch of the Human Factors Division of the U.S. Navy Electronics Laboratory in San Diego. He was formerly professor of psychology and director of graduate research at Pomona College in Claremont.

1933 Arthur N. Prater, MS, PhD '35, is now vice president of Consolidated Foods Corporation in Los Angeles.

L. Jackson Laslett has returned to the department of physics at Iowa State College after a two-year leave of absence spent at the Midwestern Universities Research Association.

1935 Howard G. Gluckman is in charge of a design group at the L. A. Department of Water and Power, and also teaches engineering at Valley Junior College. The Gluckmans have a daughter who is now married.

1936 Sherwood K. Haynes, PhD, professor of physics at Vanderbilt University in Nashville, Tennessee, is now professor and head of the department of physics and astronomy of Michigan State University in East Lansing. He had been on the Vanderbilt faculty since 1945.

CONTINUED ON PAGE 52
Education is the springboard for your future. Couple it with the proper engineering experience, such as you receive at Garrett, and you have the ingredients for a successful career in engineering fields which will be expanding for years.

At Garrett, specific opportunities in aircraft, missile and technological fields include: system electronics; computers and flight instruments; gas turbine engines and turbine motors; prime engine development; cryogenic and nuclear systems; pneumatic valves; servo control units and air motors; industrial turbochargers; air conditioning and pressurization and heat transfer.

In addition to direct assignments, a 9-month orientation program is available to aid you in selecting your field of interest. This permits you to survey project, laboratory and administrative aspects of engineering at Garrett. With company financial assistance you can continue your education at outstanding universities located nearby.

Project work is conducted by small groups where the effort of each individual is more quickly recognized and where opportunities for learning and advancement are greatly enhanced. For complete information, write to Mr. G. D. Bradley.

In the field of cryogenics, where temperatures approach absolute zero, design problems multiply. Garrett mechanical, chemical and metallurgical engineers worked together to produce this fan which rotates at 10,000 rpm at —420°F . . . without lubrication!
To engineering undergraduates in a whirl about the future...

AT DOUGLAS, YOUR ASSIGNMENTS HAVE THE SCOPE THAT LETS YOU PROGRESS AT YOUR OWN PACE!

Going around in circles? Chances are you're wondering what your future holds. At Douglas, long-range projects of tremendous scope assure a constant variety of assignments...and the opportunity to expand your responsibilities. Douglas is headed by engineers who believe that promotion must come from within. They'll stimulate you to build a rewarding future in your field.

For important career opportunities, write:

C. C. LaVENE
DOUGLAS AIRCRAFT COMPANY, BOX 6101-F
SANTA MONICA, CALIFORNIA

Go further with DOUGLAS
FIRST IN AVIATION
Now! A New Standard for the Handling of Air...

New Airfoil Centrifugal Fans!...the new standard in a complete line

Westinghouse Airfoil Blading has proved its effectiveness in six years of operation by two hundred customers in Mechanical Draft, Industrial Process, and High Pressure Air Conditioning.

Westinghouse now obsoletes conventional flat blading and brings you the efficiency and quietness of Airfoil Blading for ALL PURPOSE applications in a complete standard line of Centrifugal Fans, covering every requirement up to 700,000 CFM...Up to $16\frac{3}{4}''$ total pressure.

Westinghouse Airfoil Centrifugal Fans now give you...

- **Lowest Operating Costs...**
  - High Efficiency — Low Horsepower!

- **Quiet Operation...**
  - Airfoil Blading — Streamlined Air Flow!

- **Capacity Protection...**
  - Steep Pressure Curve — Minimum Capacity Variation!

- **Non-Overloading Power Feature!**
  - Full Load at Motor Rating—No Overload!

- **AMCA (NAFM) Standard Sizes!**

**Westinghouse Air Handling**

You can be sure...if it's Westinghouse.
here is a new and different idea designed by an engineering professor to work simple problems. Completely masculine and conservative, it is a perfect gift for the engineer. This unique conversational item is also available in quantity lots to industrial firms, with monogram if desired. For special quantity prices, write Uniquest at the address below. For individual orders use the convenient order blank, enclosing $2.75 for each tie bar ordered. Your slide rule tie bar will come neatly boxed, and complete satisfaction is guaranteed.

UNIQUEST
Box 2372
Tulsa, Oklahoma

Please send............. Slide Rule Tie Bars to:
Name...........................................
Street.......................... City & State

Enclosed find my check or M.O. for $.............

John R. Austin is now superintendent of the forge division of the Ingersoll-Rand Corporation plant in Philadelphia, Pennsylvania. Formerly assistant superintendent of the division, John has been with the company since 1937.

Harold F. Wiley, MS, has been appointed director of the new analytical and control instrument division of the Consolidated Electrodyernamics Corporation. The new unit will be housed in the company's main plant facilities in Pasadena. Harold has been director of the company's technical services department for the past four years. He was one of the 13 men who comprised the original working force of Consolidated, and has been with the company since 1937.

George W. Sinclair is now plant manager at the Tucson, Arizona, facility of the Hughes Aircraft Company. He's been with the company since 1949. The Sinclairs have three children—George, 12; Zerilda, 10; and Rowena, 6 months.

John F. Black, formerly associate director of the Hughes guided missile laboratories in Culver City, California, has been named assistant plant manager at the Tucson plant. The Blacks have two sons; Brian, 7, and Kersey, 5.

W. C. House, who was chief engineer of the liquid engine division of the Aerojet-General Corporation in Azusa, California, is now manager of the division. He's worked at Aerojet since 1949.

Harold S. Mickley, MS ’41, associate professor of chemical engineering at MIT, became a full professor in July.

William F. Chopin is now chief process engineer at the Fluor Corporation plant in Houston, Texas.

Fred W. Billmeyer, Jr., research chemist in the Du Pont Company's polychemicals department in Wilmington, Delaware, is now a senior research chemist for the company. This is a new classification set up to reward "outstanding performance in execution of research programs."

William L. Rogers is now manager of operations at the Azusa plant of the Aerojet-General Corporation. He's been with Aerojet since 1942 and has been assistant general manager for the past five years.

Carol M. Verona, head of the engineering department of Sperry Rand's electronic tube division in Gainesville, Florida, writes that "on September 16, our daughter, Cheryl June, arrived. We're very happy to round out our family with a girl after two fine boys—Bill, now 11 years old, and Chris 5."
MECHANICAL ENGINEERING

One of a series of interviews in which Bechtel Corporation executives discuss career opportunities for college men.

QUESTION: Mr. Thompson, some engineering graduates seem to believe their first jobs might include little more than filing papers. Would that be true at Bechtel?

THOMPSON: It would not. When the young man joins the Refinery Division, if he is a structural engineer he starts immediately to do structural design work, under proper supervision. An electrical engineer would join our electrical group, working on electrical systems for refineries, doing some design work, taking off materials and working on instrumentation.

QUESTION: What about mechanical engineers?

THOMPSON: Mechanical and chemical engineers may either go right into the process department, where they would do calculations, or into the project group where they would do routine designing and write specifications for pumps, exchangers, vessels, piping, instrumentation, insulation, etc.

QUESTION: There’s certainly no sign of “paper shuffling,” is there?

THOMPSON: No. The training period is interesting right from the start. After a few months, we like to send the young engineer out into the field so he can see the end result of what he has been doing.

QUESTION: What has been your experience as to the length of time required to train a man?

THOMPSON: That will vary according to the man, so it’s impossible to generalize. The young man will have some responsibility right from the start, but it may well be a matter of several years before he can actually take full responsibility for running a job.

Bechtel Corporation (and its Bechtel foreign subsidiaries) designs, engineers and constructs petroleum refineries, petrochemical and chemical plants; thermal, hydro and nuclear electric generating plants; pipelines for oil and natural gas transmission. Its large and diversified engineering organization offers opportunities for careers in many branches and specialties of engineering — Mechanical... Electrical... Structural... Chemical... Hydraulic.

Bechtel Corporation (and its Bechtel foreign subsidiaries) designs, engineers and constructs petroleum refineries, petrochemical and chemical plants; thermal, hydro and nuclear electric generating plants; pipelines for oil and natural gas transmission. Its large and diversified engineering organization offers opportunities for careers in many branches and specialties of engineering — Mechanical... Electrical... Structural... Chemical... Hydraulic.

Write for new brochures showing the wide variety of projects Bechtel builds throughout the world.

Address: John F. O'Connell, Vice President, Industrial Relations
220 Bush Street, San Francisco 4, Calif.

BECHTEL CORPORATION
SAN FRANCISCO
Los Angeles • New York • Houston

NOVEMBER, 1957
**Mars Pencils**
**Sponsors Tomorrow's Designs**

MARS OUTSTANDING DESIGN SERIES—featured in the current advertising of J. S. Staedtler, Inc.—has attracted widespread attention among the users of fine drafting pencils. It has fulfilled our expectation that the men who appreciate the finest working tools are those with a lively creative interest in new designs, new projects, new ideas.

Concerned with unusual projects—*designs of the future*—Mars Outstanding Design Series provides a "showcase" for originality, for interesting work of engineers, architects, and students which so often lies buried. To stimulate you to send in your designs, Mars Pencils will pay you $100 for any design accepted. This $100 is paid you simply for the right to reproduce your project in the Mars Outstanding Design Series. There are no strings attached. You will be given full credit. (See ad on this page—one of the ads in the current series.) All future rights to the design remain with you. You can reproduce it later wherever you like and sell or dispose of it as you wish.

The subject can be almost anything—aviation, space travel, autos, trains, buildings, engineering structures, household items, tools, machines, business equipment, etc. It should be a project that appeals to design-minded readers, be of broad interest, and be attractively presented. Do not submit a design that has been executed. As a matter of fact, the project does not need to have been planned for actual execution. It should, however, be something that is either feasible at present or a logical extension of current trends. It cannot be unrealistic or involve purely hypothetical alterations of natural laws.

There is no deadline for entries but the sooner you send yours in, the greater the probability of its use as one of the subjects in the 1958 Mars Outstanding Design Series.

<table>
<thead>
<tr>
<th>It is Simple To Submit a Design</th>
<th>For Mars Outstanding Design Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Just mail in an inexpensive photostat or photocopy of the subject—one you can spare, since it cannot be returned. If your entry is accepted, we will ask you to send in a sharp photograph of the design, or the design itself, so that we can make a sharp photograph suitable for reproduction—after which it will be returned to your promptly.</td>
<td></td>
</tr>
</tbody>
</table>

Send your entry to:

**J.S. STAEDTLER, INC.**
**DICAROLIS COURT, HACKENSACK, NEW JERSEY**

---

**3 stages to space**

The designs that will make news tomorrow are still in the "bright idea" stage today—or perhaps projects under development like this three-stage, two-man space ship. Drawn by Fred L. Wolff for Martin Caidin's "Worlds in Space," the rocket craft would start out as shown in the reverse drawing at left, shed its propulsion boosters in two stages as fuel is exhausted, and end up as the trim plane-like ship at right. Ship is planned to orbit a hundred miles above earth, return safely after one to two days.

No one knows what ideas will flower into reality. But it will be important in the future, as it is now, to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars—sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and — last but not least — the Mars-Lumochrom, the new colored drafting pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.

---

The 2886 Mars-lumograph drawing pencil, 19 degrees, EXE to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EX to 9H. Mars-Lumochrom colored drafting pencil, 24 colors.

---

**J.S. STAEDTLER, INC.**
**HACKENSACK, NEW JERSEY**

At all good engineering and drawing material suppliers

ENGINEERING AND SCIENCE
ENGINEER YOUR FUTURE AT BENDIX

Your future success as an engineer depends on a variety of circumstances, some of which you may influence, others which you cannot. Fortunately, the odds are heavily in favor of those who plan intelligently and well. That is why we urge you to give your future the same painstaking study and thought you would accord any difficult engineering problem. We believe you will make a wise decision if you plan your engineering future with Bendix. And here is why:

Bendix is one of the nation's largest and most diversified engineering-research-manufacturing firms. The creative ability and ambition of Bendix engineers have contributed importantly to this growth.

Then, too, Bendix is decentralized—with twenty-four semi-autonomous divisions located throughout the country. Nine of these have been created or acquired since 1950. They offer a broad range of opportunities for personal recognition and rapid advancement in a wide variety of interesting technical fields.

Opportunities await the young engineer qualified in such diverse fields as electronics, electromechanics, ultrasonics, systems, computers, automation and controls, radar, nucleonics, combustion, air navigation, hydraulics, instrumentation, propulsion, metallurgy, communications, combustion, solid state physics, aerophysics and structures. Working with the country's leading engineers, you will have chances aplenty to develop your talents to the limits of your capability.

Make it a "must" to meet the Bendix representatives when they visit your campus, or write today for further information concerning Bendix' progressive personnel policies, broad educational assistance program, and other personal benefits. See your college placement director or address your inquiry to Dr. Gerald A. Rosselot, Director of University and Scientific Relations, Bendix Aviation Corporation, 1106 Fisher Building, Detroit 2, Michigan.

A thousand products a million ideas

NOVEMBER, 1957
1943
John Cushing, PhD, associate professor of bacteriology at the University of California in Santa Barbara, spent the summer at the Woods Hole Marine Biology Laboratory in Massachusetts on a research grant from the American Philosophical Society. He was also recently appointed a member of an American Association for the Advancement of Science international planning committee for a conference in marine biology to be held in the fall of 1959.

Charles McGee is now doing operations research work in the catalog circulation department of Sears Roebuck & Company in Elmhurst, Illinois. The McGees' fourth child, Joan, arrived in August.

1944
Maurice Rattray, Jr., MS'47, PhD'51, is now associate professor in the Oceanographic Laboratories of the University of Washington in Seattle. The Rattrays have three children-Julie, 3½, Maurice III, 2, and Gordon, 6 months.

Walter H. Amster, MS '47, AE '48, is now a staff member of the guided missile research division of the Ramo-Wooldridge Corporation in Los Angeles. He was formerly a senior associate of the Planning Research Corporation.

William E. Lockwood is now plant manager at the Continental Can Company's manufacturing installation in San Pedro, California. The Lockwoods and their two children live in Long Beach.

Eric Weiss is now staff engineer with the new systems division of Daystrom, Inc., in La Jolla, California. He's responsible for all digital computer activities.

1946
George W. Barton is working at the University of California Radiation Laboratory in Livermore as a chemist in inorganic mass spectroscopy. He writes that he intends to stay as long as possible because he likes the climate, the countryside and his job. The Bartons and their three children-Stephen, 5, Janet, 3, and Peter, 2—are living in Danville.

R. Bruce Foster, MS, is now chief application engineer at the Denver division of the Sundstrand Machine Tool Company. He was formerly chief preliminary design engineer of the rockets division of the Bell Aircraft Corporation in New York.

Harold Comlossy, Jr., project engineer at the Emsco Manufacturing Company in Los Angeles, now has a fourth child, Gail, born on August 20.

1947
Robert E. Smith was discharged from the Army in June after spending two years in Alaska. He's now doing graduate work in biophysics at the School of Medicine at the University of Washington in Seattle.

1955
Gerald E. Hooper is back in the United States after 21 months as communications officer of the 56th Comm. Squadron in Weisbaden, Germany. The Hoopers have a daughter, Sheryl Diane, born on July 19.

1956
Leon M. Keer, graduate student in mechanical engineering at Caltech, announced the arrival of a daughter, Patricia, on August 3.

Donald W. Lewis spent the summer working for the Pure Oil Company at Amarillo, Texas, and has now returned to Northwestern University in Evanston, Illinois, to complete work on his MS in geology.

1957
Ted Lang, back at Caltech and working on his MS, recently won first prize in a satellite essay contest sponsored by the Martin Company of Baltimore, Maryland. His paper, "An Equilibrium Trajectory for a Satellite Powered by Solar Pressure," won a $5,000 cash award for Ted and a $5,000 matching award for Caltech.

1958
When it's your responsibility to specify the right lighting, remember SMOOT-HOLMAN is your dependable Western source for greater efficiency... modern beauty... simple installation... and easy maintenance! It's dependable performance developed in our laboratories to meet Western conditions!

Think of SMOOT-HOLMAN when it's your turn to choose TOMORROW'S LIGHTING... TODAY! SMOOT-HOLMAN Co., Inglewood, Calif.
Facts on food colors

What about those headlines on food colors? And the stories that some certified food colors are toxic? Is there anything to the Food and Drug Administration's recent delisting of three previously acceptable colors?

Here are a few facts behind the headlines.

The practice of coloring food is centuries old. Though the early colors were of natural origin, they have been replaced in the coloring of many foods by superior synthetic colors — the certified "coal-tar" colors. The Food and Drug Administration has been certifying a number of these colors for use in food since the early 1900's. You're probably aware of some of the foods commonly colored today: ice cream, soft drinks, baked goods, candies, processed cheese, gelatin desserts, orange skins, margarine, butter.

Why then have some food colors been "delisted" and why are others being considered for delisting?

The controversy centers on the meaning of a single word in the Federal Food, Drug and Cosmetic Act: "harmless."

The Food and Drug Administration's definition: incapable of producing harm in any quantity or under any circumstances.

The food color industry's: incapable of producing harm under normal conditions of use.

It is the industry's view that FDA animal tests of certified colors have made use of quantities of color unrelated to — and far in excess of — quantities normally ingested by humans. A newspaper interview quoted the Commissioner of Food and Drugs as saying that he "conceded that three coal-tar dyes recently banned were harmless as used, but explained that their use was [a] technical violation of the law as now worded."

The absolute FDA standard seems to find support in the popular tendency to regard synthetics as inherently inferior to natural products. Yet, many fresh vegetables we eat every day contain small but tolerable quantities of naturally occurring poisons which, if judged as food colors are now being judged, would lead to the elimination of a large part of our vegetable diet.

What the food color industry asks is an amendment to the present law which would clearly grant power to the FDA to set quantitative limits on the use of colors in food. Such limits would safeguard public health, permit maintenance of our food color supply, and encourage research in the field.

Two articles — one supporting the industry's position, the other detailing manufacture and quality control of food colors — have been prepared by Allied's National Aniline Division, the leading food color producer. You can get them by checking the coupon at right.

Aerosol mold release

Remember the line that went, we could have some ham and eggs if we had some ham . . . and some eggs. Stretch your imagination a good deal, and it has some relevance in the business of molding.

Low-molecular weight polyethylene is a superior mold release.

There's hardly a more convenient way to dispense liquids than with an aerosol spray.

Ham and eggs: POLY-LEASE 77, a low-molecular weight polyethylene in a mixed solvent system, supplied in aerosol form. The spray's push, by the way, is from Allied's GENETRON propellants.

Here's how it works. When hot or cold mold cavities or other objects are sprayed, a smooth, relatively hard film forms quickly on the surface. This film provides efficient release with a minimum number of spray applications, resulting in faster cycle time, reduction of rejects and consequent lowering of production costs.

POLY-LEASE 77 will be of interest to molders of rubber, plastics (epoxies, polyesters, phenolics, alkyd, urea, melamine), powdered metal.

Chromium chemicals

The authoritative collection of chromium chemical technical bulletins has been published, appropriately enough, by the leading producer of chromium chemicals.

The books describe Allied's MUTUAL chromium chemicals and their applications in leather tanning, corrosion control, and anodizing of aluminum.

We'd be pleased to send either a brochure describing 49 bulletins available, or the bulletins in your field of interest.

POLY-LEASE 77, GENETRON and MUTUAL are Allied Chemical trademarks

Creative Research

These examples of product development work are illustrative of some of Allied Chemical's research activities and opportunities. Allied divisions offer rewarding careers in many different areas of chemical research and development.

ALLIED CHEMICAL
61 Broadway, New York 6, N.Y.
WHAT ABOUT YOUR FUTURE?
—in Chemical, Electrical or Mechanical Engineering

If you are planning a career in chemical, electrical, or mechanical engineering, we believe you will be interested in evaluating opportunities at Food Machinery and Chemical Corporation—a nationwide company that puts ideas to work, through creative research and practical engineering, in many diversified fields.

An FMC representative will be on the campus to tell you about these career opportunities and to answer your questions. Your college placement office has the date and will arrange an appointment for you.

In the meantime, we invite you to write for our brochure, "Putting Ideas to Work," which graphically describes FMC's many product lines.

Address: Industrial Relations Dept., Food Machinery and Chemical Corporation, P.O. Box 760, San Jose, California.

FOOD MACHINERY AND CHEMICAL CORPORATION
New Engineering Opportunities Created as Ryan Projects Mushroom

Ryan Automatic Navigator Guides Global Flight

An advanced system of aerial navigation, designed for high speed, long range flight, has been developed by Ryan electronics engineers, working under sponsorship of the Navy's Bureau of Aeronautics. Designated AN/ANP-67, the new navigator is the lightest, most compact, self-contained electronic navigator in production. Developed to meet military needs, it will also meet commercial jet flight requirements.

The system provides pilots and navigators with continuous information on longitude, ground speed, ground mileage, drift angle and ground track. It is accurate and instantaneous. Requires no computations, ground facilities or wind data.

New Engineering and Research Center To Meet Ryan's Expansion


The new facility will provide additional quarters for many of the 1000 employees in Ryan's fast-growing engineering division. It will also house complex, new chemical, metallurgical, instrumentation, environmental and autopilot equipment.

With one in six Ryan employees in engineering, this division has tripled in three years. Its mushrooming growth reflects Ryan's increased importance as a research facility in aerodynamics, propulsion and electronics.

Vertical Flight Probed with New VTOL Cockpit

Shortest way into the sky is straight up—in the Ryan Vertijet. To probe this new realm of flight without becoming airborne is a trick performed daily by Ryan engineers. Their secret? A rotatable cockpit connected with electronic computers.

Ryan's flight simulation laboratory is a prime tool in the test of new aircraft designs. Both the Vertijet and the subsonic, turboprop-driven Vertiplane are put through their paces via earthbound flight test. Ryan leadership in this revolutionary new concept of flight is based upon 2¼ million manhours of VTOL research and development. It is another example of how Ryan builds better.
ALUMNI EVENTS

November 15 Homecoming
January 16 Dinner Meeting
February 22 Dinner-Dance
April 12 Annual Seminar
June 11 Annual Meeting
June 28 Annual Picnic

ATHLETIC SCHEDULE

FRIDAY EVENING DEMONSTRATION LECTURES

LECTURE HALL, 201 Bridge, 7:30 P.M.

November 16—
November 15—
November 15—
November 22—
November 22—
November 26—
November 23—
November 23—
November 15—
November 19—
November 22—
November 23—
November 15—
November 23—
November 22—
November 19—
November 23—

ALUMNI ASSOCIATION OFFICERS

PRESIDENT 
Willis R. Donohue, '34

SECRETARY 
Donald S. Clark, '29

VICE-PRESIDENT 
Edward P. Fleischer, '43

TREASURER 
George B. Holmes, '39

BOARD OF DIRECTORS

Edward P. Fleischer, '43

Frank C. Bumb, '51

L. Fort Etter, '35

John R. Fee, '51

ALUMNI CHAPTER OFFICERS

NEW YORK CHAPTER

President 
E. Morton Holland '36

Vice-President 
A. A. Edwards & Sons, 501 Lexington Avenue, New York 17

Secretary-Treasurer 
Albert E. Myers '29

WATER POLO

November 19—

CROSS COUNTRY

November 15—

Pomona College

at Caltech

November 22—

Pasadena College

at Caltech

November 26—

Caltech at Whittier

November 23—

November 23—

Long Beach State

at Caltech

November 22—

Thanksgiving Recess, no lecture

November 20—

November 15—

Homecoming

November 16—

UCR at Caltech

November 23—

Pomona at Caltech

November 23—

La Verne at Caltech

November 23—

UCR at Caltech (Rose Bowl)

November 15—

Occidental at Caltech

November 15—

Pasadena College

at Caltech

November 15—

Dr. Peter Fay

Pomona at Caltech

la Verne at Caltech

November 22—

November 15

Homecoming

November 19—

at Caltech

November 26—

Nuclear Power

November 29—

Long Beach State

November 22—

Thanksgiving Recess, no lecture

December 6, 1957—

Nuclear Power

Dr. Harold Lerie

Nuclear Power

Dr. Harold Lerie

SIT BACK AND RELAX

Let Calmec Manufacturing Company
Worry About
Your Metal Parts and Products

We have the most modern facilities and most complete plant to give you the maximum of service, whether it is a small part, a large part, or a product from your ideas to the shipped article direct to your customers, under your name, from our plant.

CALMEC MANUFACTURING CO.

Robert A. McIntyre, M.S. '38
5925 District Blvd.
Los Angeles 22, Calif.

Klmball 6204

Worry About

Your Metal Parts and Products

We have the most modern facilities and most complete plant to give you the maximum of service, whether it is a small part, a large part, or a product from your ideas to the shipped article direct to your customers, under your name, from our plant.

Let Calmec Manufacturing Company

Worry About

Your Metal Parts and Products

We have the most modern facilities and most complete plant to give you the maximum of service, whether it is a small part, a large part, or a product from your ideas to the shipped article direct to your customers, under your name, from our plant.

CALMEC MANUFACTURING CO.

Robert A. McIntyre, M.S. '38
5925 District Blvd.
Los Angeles 22, Calif.

Klmball 6204

Let Calmec Manufacturing Company

Worry About

Your Metal Parts and Products

We have the most modern facilities and most complete plant to give you the maximum of service, whether it is a small part, a large part, or a product from your ideas to the shipped article direct to your customers, under your name, from our plant.

CALMEC MANUFACTURING CO.

Robert A. McIntyre, M.S. '38
5925 District Blvd.
Los Angeles 22, Calif.

Klmball 6204
PHOTOGRAPHY AT WORK
No. 30 in a Kodak Series

Pepsi-Cola International Panorama, a magazine of places and people, reaches people around the world, builds recognition for Pepsi-Cola as a product associated with the better, happier side of life.

Photography speaks in every language

What better way to say people take naturally to “Pepsi” whether in Leopoldville or Lichtenstein?

To tell its story in 75 countries, Pepsi-Cola puts pictures to work to add meaning to the product’s global billing as “the refreshment of friendship.”

To build up an atmosphere of friendliness and understanding in markets around the world, Pepsi-Cola International publishes “Panorama”—and gives the brunt of the job to photography.

Photography knows no language barrier. It is clear to young and old alike—appeals to everyone. With photography, people are real; situations authentic, convincing. This is what makes photography such a powerful salesman.

Large businesses and small can use this powerful salesmanship—can also use photography to cut costs and save time in many other ways. It can help with problems of product design—can watch quality in production. It trains. It cuts office routine. You’ll find that it can work for you, too.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

CAREERS WITH KODAK

With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design and production.

If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.
Interview with General Electric’s
Hubert W. Gouldthorpe
Manager—Engineering Personnel

Your Salary

Although many surveys show that salary is not the prime factor contributing to job satisfaction, it is of great importance to students weighing career opportunities. Here, Mr. Gouldthorpe answers some questions frequently asked by college engineering students.

Q. Mr. Gouldthorpe, how do you determine the starting salaries you offer graduating engineers?
A. Well, we try to evaluate the man's potential worth to General Electric. This depends on his qualifications and our need for those qualifications.

Q. How do you evaluate this potential?
A. We do it on the basis of demonstrated scholarship and extra-curricular performance, work experience, and personal qualities as appraised by interviewers, faculty, and other references.

Of course, we’re not the only company looking for highly qualified men. We’re alert to competition and pay competitive salaries to get the promising engineers we need.

Q. When could I expect my first raise at General Electric?
A. Our primary training programs for engineers, the Engineering Program, Manufacturing Program, and Technical Marketing Program, generally grant raises after you’ve been with the Company about a year.

Q. Is it an automatic raise?
A. It’s automatic only in the sense that your salary is reviewed at that time. Its amount, however, is not the same for everyone. This depends first and foremost on how well you have performed your assignments, but pay changes do reflect trends in over-all salary structure brought on by changes in the cost of living or other factors.

Q. How much is your benefit program worth, as an addition to salary?
A. A great deal. Company benefits can be a surprisingly large part of employee compensation. We figure our total benefit program can be worth as much as 1/6 of your salary, depending on the extent to which you participate in the many programs available at G.E.

Q. Participation in the programs, then, is voluntary?
A. Oh, yes. The medical and life insurance plan, pension plan, and savings and stock bonus plan are all operated on a mutual contribution basis, and you’re not obligated to join any of them. But they are such good values that most of our people do participate. They’re an excellent way to save and provide personal and family protection.

Q. After you’ve been with a company like G.E. for a few years, who decides when a raise is given and how much it will be? How high up does this decision have to go?
A. We review professional salaries at least once a year. Under our philosophy of delegating such responsibilities, the decision regarding your raise will be made by one man—the man you report to; subject to the approval of only one other man—his manager.

Q. At present, what salaries do engineers with ten years’ experience make?
A. According to a 1956 Survey of the Engineers Joint Council*, engineers with 10 years in the electrical machinery manufacturing industry were earning a median salary of $8100, with salaries ranging up to and beyond $15,000. At General Electric more than two thirds of our 10-year, technical college graduates are earning above this industry median. This is because we provide opportunity for the competent man to develop rapidly toward the bigger job that fits his interests and makes full use of his capabilities. As a natural consequence, more men have reached the higher salaried positions faster, and they are there because of the high value of their contribution.

I hope this answers the question you asked, but I want to emphasize again that the salary you will be earning depends on the value of your contribution. The effect of such considerations as years of service, industry median salaries, etc., will be insignificant by comparison. It is most important for you to pick a job that will let you make the most of your capabilities.

Q. Do you have one salary plan for professional people in engineering and a different one for those in managerial work?
A. No, we don’t make such a distinction between these two important kinds of work. We have an integrated salary structure which covers both kinds of jobs, all the way up to the President’s. It assures pay in accordance with actual individual contribution, whichever avenue a man may choose to follow.

* We have a limited number of copies of the Engineers Joint Council report entitled "Professional Income of Engineers—1956." If you would like a copy, write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.

LOOK FOR other interviews discussing: Advancement in Large Companies Qualities We Look For in Young Engineers Personal Development.

GENERAL ELECTRIC