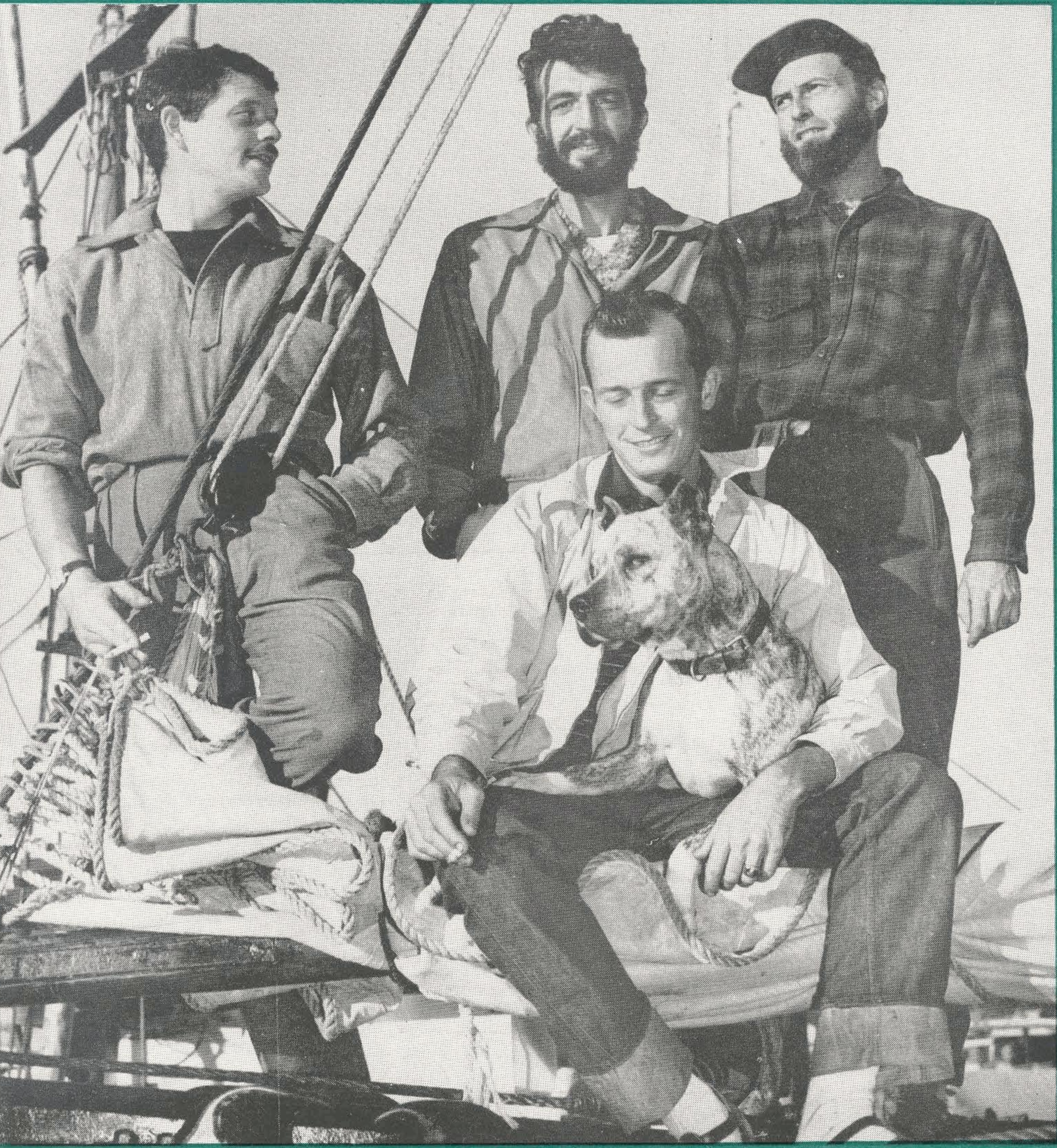
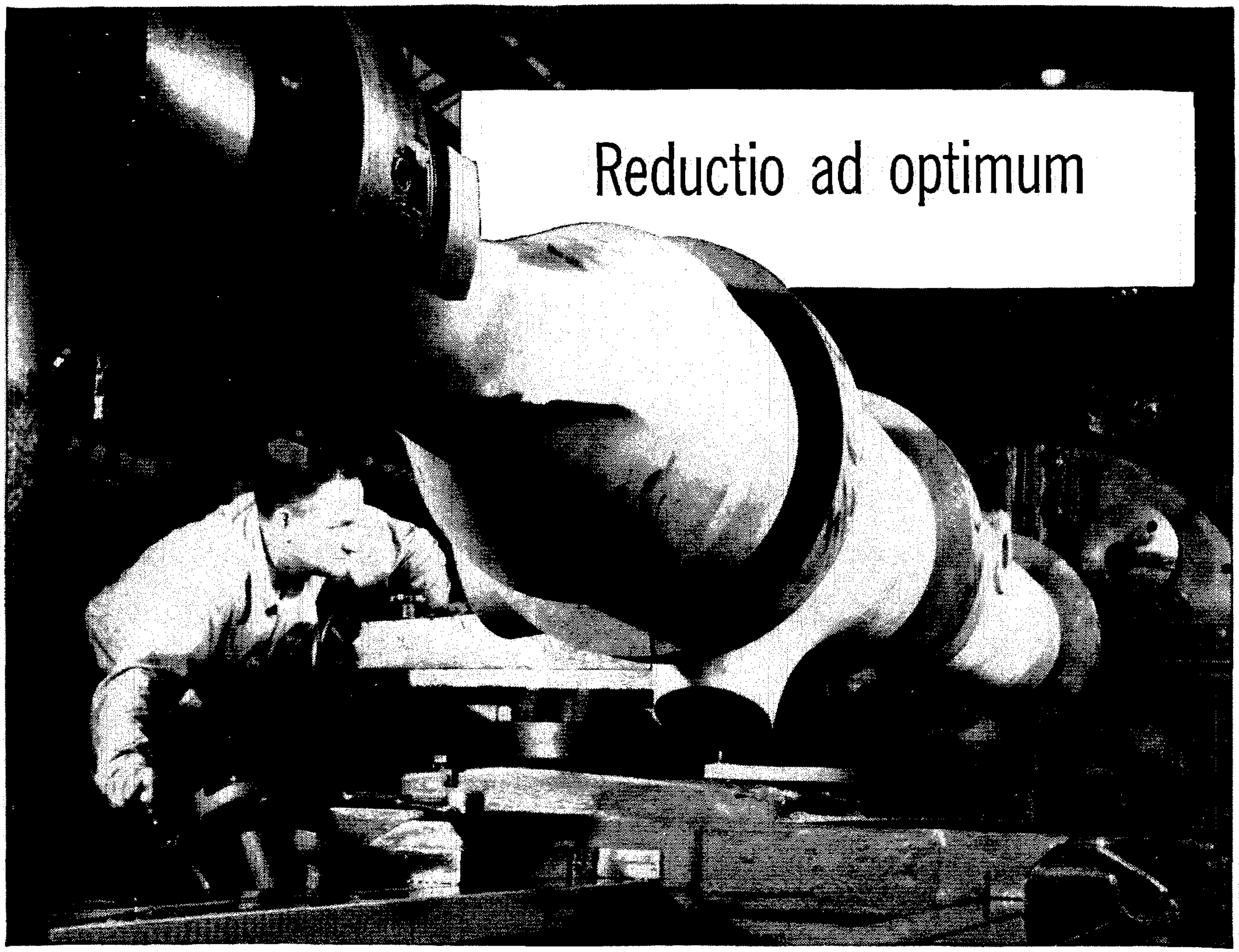
ENGINEERING AND SCIENCE

MARCH/1954

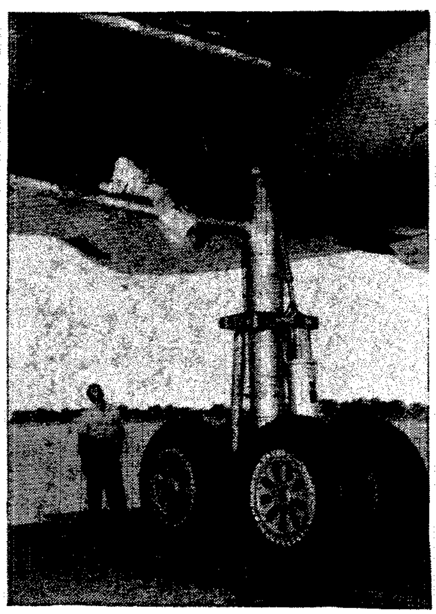


World travelers . . . page 9

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY



Reductio ad optimum



U·S·S CARILLOY electric-furnace aircraft quality steel meets every requirement for these vital parts. The precision machining and expert heat treatment it gets at Cleveland Pneumatic Tool Company complete the job.

● "Reduced to the most favorable degree" describes exactly what happens to the huge U·S·S CARILLOY steel ingots from which are formed the rugged main columns in the landing gears of *every* B-36.

To provide the tremendous strength and shock resistance required to safely cushion the landing impact of 179 tons of bomber weight—and, at the same time, to keep the weight of the landing gear as *low* as possible—calls not only for steel of the highest quality but also for unusual procedures in fabrication as well.

Consider these facts. The original ingot weighs approximately 37,500 lbs. From it are produced two cylindrical columns weighing only about 1200 lbs. apiece. Approximately 93% of the steel is removed by machining to proper contour and in hollow-boring the column. When finished, a mere 7% of the original ingot is left to do the job.

That U·S·S CARILLOY steel has been exclusively selected for this application—one of the most exacting in the aircraft industry—is, we believe, highly significant. The same care and skill, the same ability to meet requirements that are beyond the ordinary, go into every order of CARILLOY steel we make—whether it's an ingot of giant size or a few tons of special steel.

U·S·S CARILLOY is just one more example of the better steel products developed and produced by United States Steel. If you are interested in additional engineering training, why not investigate *your* opportunities with U. S. Steel? For more information, contact the Placement Director of your school, or write to United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

USS

UNITED STATES STEEL

ENGINEERING | AND | SCIENCE

MARCH 1954 VOLUME XVII NUMBER 6
PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

IN THIS ISSUE

On the cover this month is a hardy crew consisting of Steele Wotkyns, Hal McCann, Ward Vickers, and (holding the mascot, Scupper) Art Teets. The picture was taken on December 6, 1953, when the schooner *California* sailed into Los Angeles Harbor to complete a round-the-world cruise, begun approximately five years before.

Hal McCann, who was graduated from Caltech in 1946, tells the story of this remarkable trip on page 9 of this issue.

John R. Weir, Associate Professor of Psychology and the man responsible for the Caltech Alumni Survey, has been discussing the results of the survey in a series of monthly articles in this magazine. In this issue, with the fifth article in this series, Dr. Weir winds up the job. While previous articles have dealt with comparisons between Caltech alumni and U. S. college graduates in general, this article deals with comparisons made within the Caltech group—specifically, the differences between Caltech science majors and Caltech engineers.

The Challenge of Man's Future, on page 22 of this issue, has been adapted from a forthcoming book by Harrison Brown, Caltech Professor of Geochemistry. The book—*The Challenge of Man's Future*—is to be published on March 19 by the Viking Press.

PICTURE CREDITS

Cover	Los Angeles Times
p. 121	Byron Johnson, Jr. '56

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STAFF

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Staff Photographers.....Byron Johnson, Jr. '56
Tom Bergeman '56
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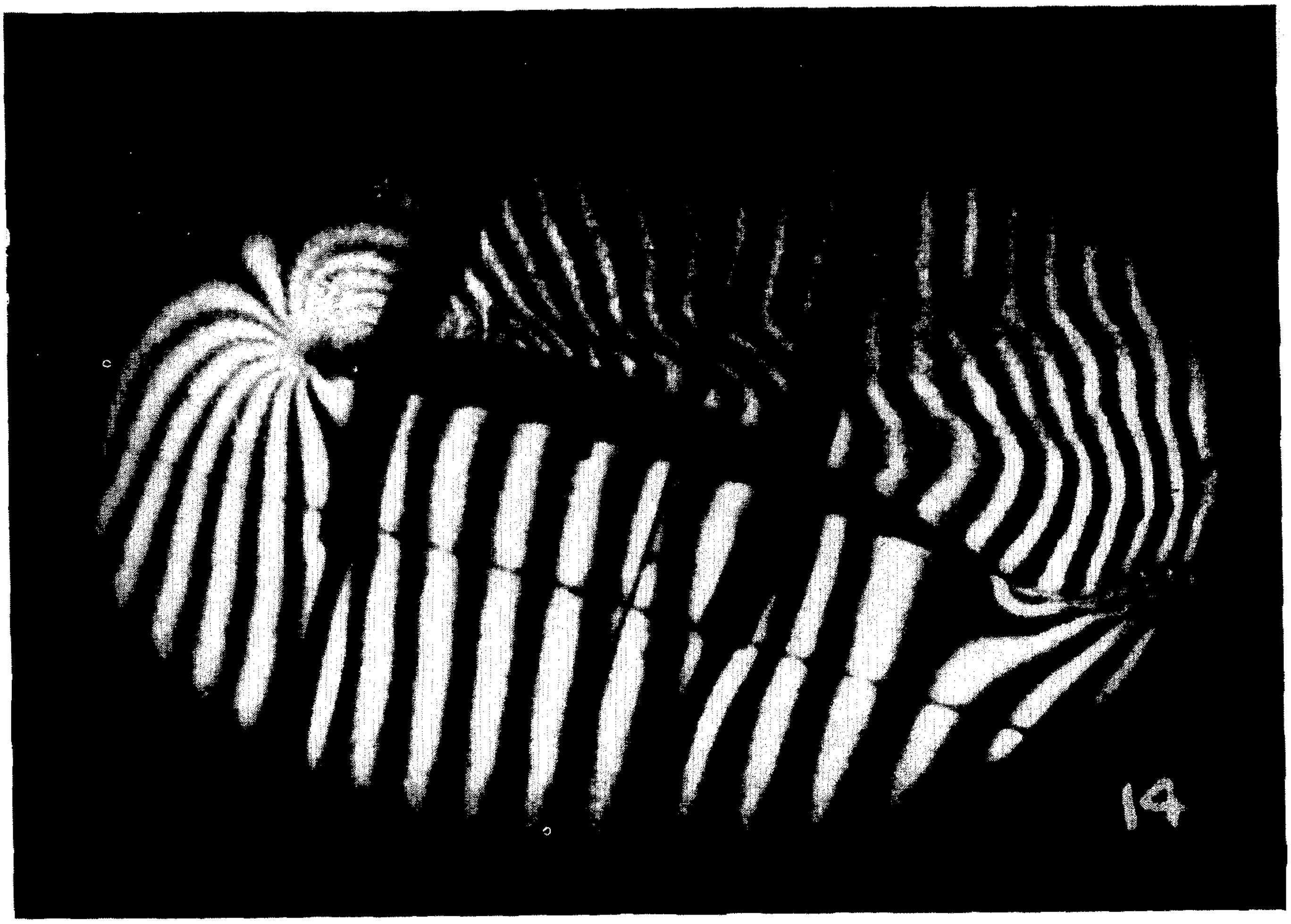
Editorial Consultant.....Professor of English George R. MacMinn

Published monthly, October through June, at the Californa Institute of Technology, 1201 East California St., Pasadena 4, Calif., for the undergraduates, graduate students and alumni of the Institute. Annual subscription $3.50, single copies 50 cents. Entered as second class matter at the Post Office at Pasadena, California, on September 6, 1939, under the act of March 3, 1879. Manuscripts and all other editorial correspondence should be addressed to: The Editor, *Engineering and Science*, California Institute of Technology.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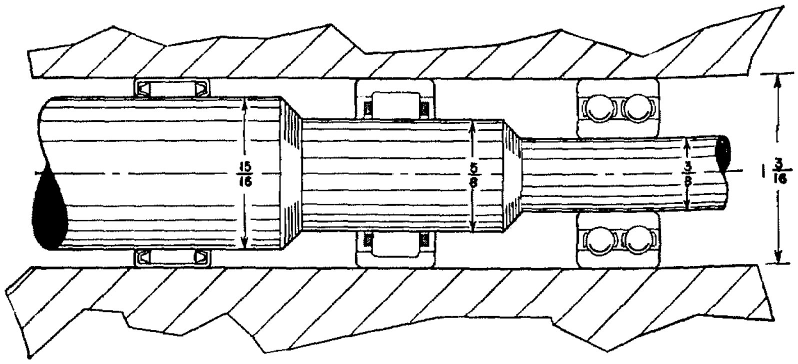
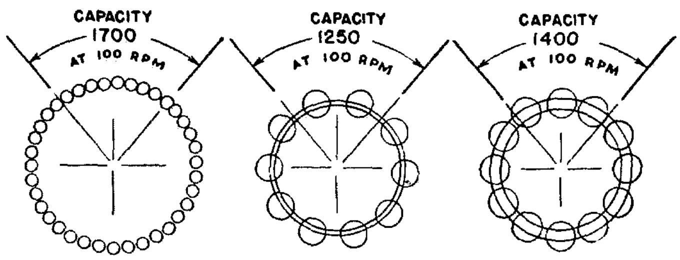
The Torrington Needle Bearing
is designed for high radial loads

The many lineal inches of contact provided by the larger number of small diameter rollers give the Torrington Needle Bearing an unusually high load rating. In fact, a Needle Bearing has greater radial capacity in relation to its outside diameter than any other type of anti-friction bearing.



1. *Illustrates the fact that for a given housing bore size, a larger and, therefore, stiffer shaft can be used with Needle Bearings than with a roller or ball bearing.*



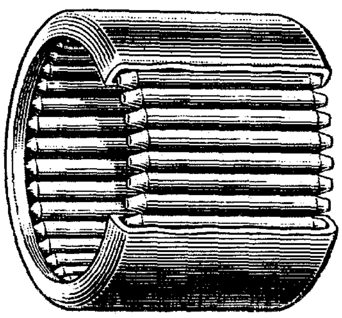
2. *Shows the greater number of lines of contact in the load zone of a Needle Bearing compared with a ball or roller bearing.*

Precision Manufacture and Unique Design

The exceptional load capacity of the Needle Bearing is the result of proper selection of steels, precision workmanship to close tolerances, and the application of modern anti-friction principles.

The one-piece shell, which serves as the outer raceway and retains the rollers, is accurately drawn from carefully selected strip steel. After forming, it is carburized and hardened. There is no further grinding or other operation that might destroy the wear-resistant raceway surfaces. The full complement of thru-hardened, precision-ground rollers is retained by the turned-in lips of the one-piece shell.

The small cross section of the Needle Bearing allows a large shaft which permits a rigid design with minimum shaft deflection, a factor of utmost importance to good bearing design.



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A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from A. C. Montieth, Vice-President
in Charge of Engineering and Research,
Westinghouse Electric Corporation,
Queen's University, Kingston, Ontario, 1923

The second most important decision in your life

Now, as you near graduation, you are about to make a decision—second in importance only to choosing your life's partner.

I'm talking, of course, about that all-important first job. Which company will it be? I wouldn't presume to answer that question for you. But I would like to emphasize the importance of this decision.

You have a lot at stake. The direction your career takes will most certainly be influenced by the company with which you cast your lot. May I offer a few personal suggestions.

Choose a company not for its bigness or smallness, but for how it will treat you as an individual. Choose it not only for its engineering activities alone, but also for how it is set up to help its engineers develop themselves professionally. Choose your company with an eye on the opportunities ahead—and an eye on the future of the company itself. Above all, select a company that has a definite program to help you determine the work for which you are best fitted.

Only you can make this vital decision. Whatever it may be—good luck! G-10275

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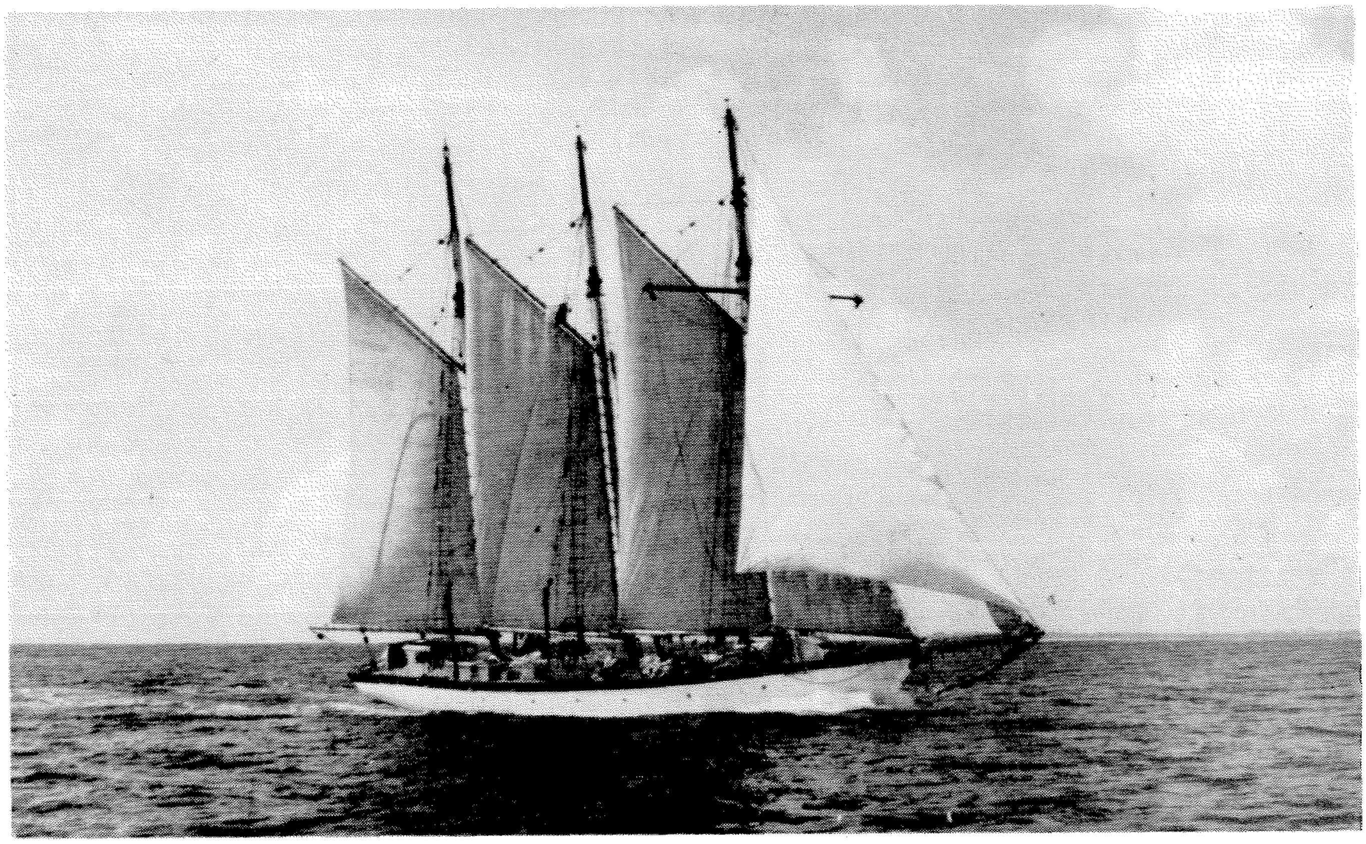


THE CRUISE OF THE CALIFORNIA

Ever dream of knocking off work and sailing around the world? Who doesn't? But here's the story of some men who really did it.

by HAL McCANN

On Sunday, March 20, 1949, the schooner *California* left Wilmington for a cruise around the world. The boat was a clutter of unstowed gear, the crew was completely green, and waterfront experts gave us only a fair chance of making the breakwater—but on December 6, 1953, four years and ten months later, we were back in the L. A. harbor with a complete circumnavigation behind us.

Ward Vickers (who attended Caltech in 1943) had given considerable thought to a world cruise and, upon his discharge from the Marine Corps in 1948, he and a friend, Nelson McCrady, bought the boat after looking on both coasts for a suitable cruising vessel. She was at that time fitted out as a fishing boat, and her new owners recovered a good percentage of their investment by fishing albacore off the Mexican coast in 1948.

The *California* is a three-masted flush-decked schooner. She has a clipper bow, an elliptical stern, and is

Six-man crew of the schooner California, as she set out from Wilmington on March 20, 1949, for a cruise around the world—Yvor Smitter, Hal McCann, Nelson McCrady, Gerald Fitzgerald, Ward Vickers, and Art Teets.

equipped with a diesel auxiliary. She is 63 feet on deck, draws $8\frac{1}{2}$ feet, and has a beam of 14 feet, 3 inches.

Gathering a crew

The gathering of a crew was an extended and discouraging affair. Everyone who heard of the projected voyage thought it was a great idea; but when it came to quitting jobs, leaving families and girl friends, and putting up cash, the enthusiasts dropped out one by one. I heard about the trip around Christmas 1948, and immediately decided it was the chance of a lifetime. A week later I went aboard, shook hands around, and was invited to a general meeting in the fish hold. The following points were decided, all of which would make a true sailor shudder:

1. We would leave March 20, regardless of the condition of the boat, since she would obviously never be completely ready.
2. Those aboard that day would be the crew.
3. We would have no skipper. All duties on board would rotate, with the man on watch giving orders in emergencies. Major decisions would be made by vote.
4. Each man would buy an equal share in the *California*, but should he for any reason leave, all he would take with him would be his toothbrush.

That day was the beginning of a non-stop campaign to get the *Cal* ready for sea. On March 20 she was sound, possible to live in, and reasonably well stored. We sailed.

Aboard were Ward Vickers, Nelson McCrady, Gerald Fitzgerald, Yvor Smitter, Art Teets, and myself. Ward, known as "Vic," had been a V-12 at Tech in 1943 who had transferred to V-5 and finished off as a Marine Corps pilot. He was living at Long Beach and going to school at UCLA. "Julio" McCrady was a flying buddy of Vic's, living in Burbank. Fitzgerald was out of college, ex-Navy, and living in Pasadena. Up to the time we left he was driving a tractor for his uncle's contracting company. Yvor was an ex V-12 ensign going to Cal, Berkeley. His home was in Flintridge. Art was an electrical engineer (V-12 Caltech '45) who had taken his Master's at Stanford Business School. He was working in L.A. and living in Santa Monica. I was a Caltech civil engineer (V-12 '46) with a Master's from USC. My job was also in L. A., and I was living in Long Beach.

Blundering down the coast

Our average age was 23, and our knowledge of boats and the sea was almost zero. Moreover, with the exception of Vic's and Julio's long friendship, we were barely more than just acquaintances. Under the circumstances it was hardly surprising that our families were somewhat concerned for our safety.

With stops at Magdalena Bay, Acapulco, Puntarenas, and Golfito we blundered our way down the coast to Panama. Now, as I look back on that leg of the cruise, I realize it was uncomfortable, hazardous, and poorly executed. However, having no experience, we thought at the time that conditions and foulups were normal. There is no doubt that ignorance can be an advantage under such circumstances.

Being somewhat disappointed with cruising and anxious to go fishing, Gerald and Julio signed off in Panama. This was not good—but our financial condition was even worse. Briefly, the boat needed about $3,000 worth of repairs, additions, and stores; and we had only $200 aboard. We started job hunting the day after our arrival in Panama, and within a week we were all employed.

Triangulation in the jungle

Vic, Yvor, and I went to work for Inter-American Geodetic Survey. We spent our time doing first-order triangulation in the Darien jungle and the Colombian Andes. The work was uncomfortable, but it paid well. The most necessary requirements were strong legs and a resistance to tropical disease. We had sold ourselves as geodesists, and managed to learn enough to do a competent job before we were required to show much skill.

Art stayed in the Canal Zone as an auditor for the Air Force. In his off time he supervised work on the *Cal*, paying for the job with our joint incomes. After ten months of this we had a sound, comfortable, and well-fitted-out boat; $4,000; three cases of malaria; one man (Yvor) struck by lightning; and one case of amoebic dysentery. At this point we decided to start the cruise in earnest while we were still healthy enough to move and young enough not to know better.

From May 1949 to August 1951 we cruised the Pacific. During that time we spent from two weeks to four months in each of the following places: Galapagos, Marquesas, Tuamotus, Societies, Cooks, Phoenix, Tokelaus, Samoas, Tongas, Fijis, New Hebrides, Solomons, and finally New Guinea.

Hal McCann and sextant. Duties on board rotated—with the man on watch giving orders in emergencies.

Off the coast of Mexico, outbound: McCrady, Smitter and Vickers are at ease; Fitzgerald is at the banjo.

Our next leg was to Singapore, with stops at Thursday Island, Banda Neira, Amboina, Makassar, and Soerabaja. We dropped the hook at Singapore in October 1951. After a two-week layover we sailed up to Bangkok for the holidays. On the return passage we caught the tail end of a typhoon and were forced to stop again at Singapore for three weeks for repairs before attempting the Indian Ocean.

Drafted from Ceylon

Between Singapore and Colombo we stopped at Penang and the Nicobars, arriving in March, 1952. At Ceylon Yvor was drafted. This was the hardest blow of the trip. After three years of extreme ups and downs, we were closer than brothers and a highly efficient boat-operating team. Moreover, the prospect of crossing the Indian Ocean and sailing (our engines had died in Singapore) three-handed up the Red Sea was not inviting. Several self-professed sailors offered themselves. But we had by this time discovered that technical ability was the least important requirement and we found no one that we trusted to fit into the pattern of our lives.

We sailed three-handed to Egypt, calling at Aden and Port Sudan. The hazardous and uncomfortable Red Sea passage reduced the boat and crew to a shabby appearance, but the thrill of accomplishment was more than sufficient reward for our beating and efforts. The three boats previous to ours on that passage had (1) gone aground and been stripped by Yemenite Arabs, (2) lost the rudder and been carried to Port Tewfik on a steamer, and (3) sunk.

At Port Saïd we were joined by Steele Wotkyns, an old friend of Art's from Santa Monica. He is a graduate of Cal, Berkeley, and had been practicing architecture in Sweden. Enlisted by mail from Colombo, he flew to Cairo to join us. He knew nothing about boats, but after a brief adjustment period for all hands he proved to be a completely successful addition to the crew.

We entered the Mediterranean in July 1952—on the day of Farouk's departure—and began our zigzag course to Gibraltar. Our stops were at Beirut, Cyprus, Kastellarosso, Rhodes, Crete, Thira, Malta, Syracuse, Naples (where we left the boat for a three-month tour of Europe), Sardinia, and Almería, Spain. That passage was marked by extreme temperature changes and high-velocity, short-lived winds.

On May 29, 1953, we sailed from Gibraltar for Panama, calling at Tenerife, Barbados, St. Lucia, St. Vincent, and Curacao. The actual circumnavigation was completed on July 28, 1953. Crossing the Atlantic in the trades is a simple and monotonous procedure. Between Balboa, Canal Zone, and San Pedro we stopped at Puntarenas, Acapulco, Cedros, and San Diego.

The foregoing is a brief outline of the cruise. It is *impossible to include our adventures in anything* short of a book. Besides, I somehow feel that this is not the place for tales of the jungle, sea, dancing girls, brawls and pirates. I will, however, attempt to answer the questions most frequently asked us.

Why do it?

This, though the most obvious question, is the most difficult to answer. My own ideas were that my interests and education were too narrow and that I had never really been tested. I never doubted that it was the right thing to do.

What was the hardest part?

Leaving, and living without friction. Also high on the list is the restraint required when some cocktail party acquaintance says, "You're so lucky to be able to do it."

How did you stand each other for five years?

Having no skipper made for situations that don't normally arise at sea. The experts to a man claimed the scheme wouldn't work, and one skipper even offered us medals if we made it. (We haven't collected yet.) To carry your load without direction or friction is not easy, but if accomplished yields the greatest reward of cruising. The requirements are an open mind, moderate intelligence, strong senses of trust and responsibility, the ability to differentiate between the trivial (no matter how maddening) and the important, a cool head in a jam, and the knowledge of how and when to keep your mouth shut. A man's characteristics ashore are a poor indication of his popularity and efficiency on small boats, since personalities tend to warp considerably under the stresses of cramped living and emergent siuations. Crew trouble is by far the major cause of cruise failures.

How did you spend your time at sea?

We stood a single watch, which kept each man on the wheel 7 hours in 24, except for the cook, who stood no daytime watch. The cook was required to turn our three square meals a day and to keep the below-decks spaces clean. We generally ate better aboard than we did in port. The cook's job was the hardest, with engine repair placing second. We installed and maintaained three diesels during the cruise.

With watches and routine duties the average day was about ten hours long. Most leisure time was spent reading books from our own large library.

Did you hit many storms?

The average was one bad blow per year. We caught our worst ones in the Gulf of Siam (5 days at 50 knots), the Tyrrhenian Sea (30 hours at 40 knots, 16 hours at 70 knots, and 3 days at 40 knots) and the Straits of Gibralter (24 hours at 65 knots). We considered ourselves lost only once, caught in 70 knots with the rocky Sardinian coast one-half mile to leeward.

How did you finance it?

After buying the boat and provisioning her, we had about $400 apiece. This lasted to Panama, where we worked for ten months. After that it was pretty much scratch and scrape. Occasionally we sold a magazine article. Exclusive of the original investment and money spent playing ashore, our expenses averaged $1.20 per man per day, including food, haulouts, and sails. This low expenditure was due to the fact that we did *everything* ourselves. Also, the generosity and friendliness of people the world over were beyond our greatest expectations. With regard to the latter, the Royal Navy has earned our highest respect and gratitude.

The boat was sold for approximately the same price we paid. We are in the process of preparing two books and a colored motion picture.

What use was it?

I know from experience that prospective employers don't consider the cruise of any value to them in their business. However, I feel that the broadened outlook, the sense of accomplishment, the acquisition of a realistic sense of values, and the knowledge of how I will react to extreme conditions are well worth the time, shocks, effort, and money.

What now?

Contrary to popular predictions, we seem to be fitting back into normal society with little difficulty, although I don't necessarily consider this desirable. A belaying pin feels more assuring than a slide rule. Does anybody want a civil engineer who can navigate and speak Malay?

THE MONTH AT CALTECH

Lucas Medal

DR. BRUCE H. SAGE, Caltech professor of chemical engineering, has received the American Institute of Mining and Metallurgical Engineers' Anthony F. Lucas Gold Medal Award for 1954.

At the annual banquet of the A.I.M.M.E. in New York last month the Award Committee presented Dr. Sage the medal "for his distinguished achievements in research on the phase behavior and thermodynamics of petroleum hydrocarbons; for the development of ingenious techniques and equipment for the study of these materials under petroleum reservoir conditions; for the resourceful application of mathematics in extending the range of prediction of the behavior of hydrocarbons over a wide range of pressure and temperature; and for his marked contribution to the present-day concepts of good petroleum engineering practice."

A native of State College, New Mexico, Bruce Sage was graduated from New Mexico State College and received his MS and PhD degrees from Caltech (in 1931 and 1934 respectively). He became a Caltech research fellow in 1934, has been professor of chemical engineering since 1944.

During the war he supervised the Propellant and Interior Ballistics Section of the Caltech rocket project and his investigations and contributions earned him the U.S. Medal for Merit in 1948.

He received the American Chemical Society's first Precision Scientific Company Award in Petroleum Chemistry in 1949. In 1952 he was presented a Certificate of Appreciation by the American Petroleum Institute for his contributions to its project, supported at Caltech since 1927, on the behavior of fluids in petroleum reservoirs. New Mexico State College awarded him an honorary Doctor of Engineering degree last year.

NACA

FOUR CALTECH FACULTY members have been reappointed to the National Advisory Commitee for Aeronautics. Professors Clark B. Millikan, Hans W. Liepmann, Ernest E. Sechler, and Frank E. Marble received 1954 appointments to NACA committees and subcommittees as did Dr. A. J. Stosick, division chief at the Jet Propulsion Laboratory.

These men, who serve in a personal and professional capacity without compensation, are selected because of their technical ability, experience and leadership in a special field.

They provide material assistance in the consideration of problems related to their technical fields, review research in progress both at NACA laboratories and in other organizations, recommend research projects to be undertaken, and coordinate research programs.

Professor of aeronautics and director of the Guggenheim Aeronautical Laboratory at Caltech and of the Southern California Cooperative Wind Tunnel, Dr. Millikan was reappointed chairman of the subcommittee on fluid mechanics and to the committee on aerodynamics.

Dr. Liepmann, professor of aeronautics, was appointed to the subcommittee on fluid mechanics.

Dr. Sechler, professor of aeronautics, will continue as a member of the subcommittee on aircraft structures.

Dr. Marble, who is associate professor of jet propulsion and mechanical engineering, was reappointed to the subcommitee on combustion. Dr. Stosick was reappointed to the special subcommittee on rocket engines.

Telescope Study

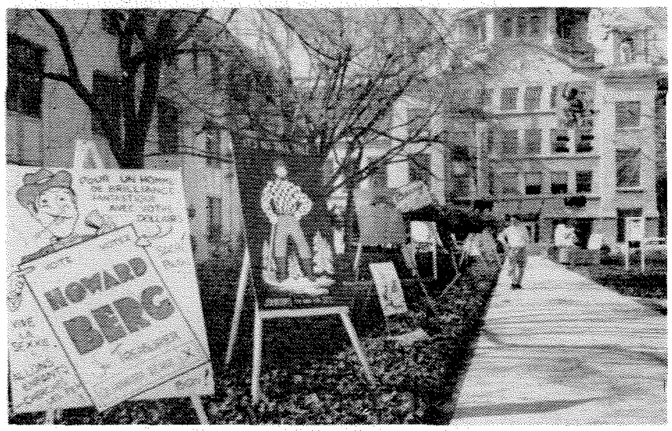
CALTECH AND the Mount Wilson and Palomar Observatories share in a new $50,000 grant from the Carnegie Institution of Washington to study methods of increasing the range of telescopes.

The program will apply particularly to adapting the techniques of electron microscopy to boosting the range of the larger telescopes. Scientists will participate from the U. S. Naval Observatory, the National Bureau of Standards, George Washington University, and the Carnegie Institution's own Department of Terrestrial Magnetism. When instruments developed under the research program reach the testing stage they will be tried out at the Mount Wilson and Palomar Observatories.

Honor Medal

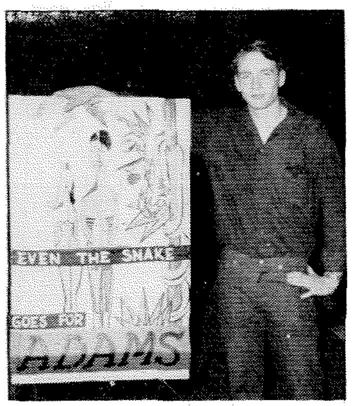
CALTECH'S INDUSTRIAL Relations section was awarded a George Washington Honor Medal last month by the Freedoms Foundation for its "aid in the training and development of supervisory and executive personnel in order to improve employer-employee relations through improved understanding of our profit and loss system."

The Freedoms Foundation is a nonprofit, nonpolitical, nonsectarian organization set up in 1949 to make annual awards to American for outstanding contributions to a better understanding of freedom.



Billboard Lane

SOME NOTES ON STUDENT LIFE



President Adams

Succcessful candidate

SPRING CAME EARLY to southern California this year—right in the middle of February. But the true spirit of spring didn't really come along with the unseasonable weather. A few students reluctantly broke away from their books to bask in the sun at the beach, but most couldn't even find the energy to get a good water fight going around the houses.

The glad hand of the politician

February was the big month for all aspiring politicians. As usual, there was plenty of glad-handing from beaming individuals before the ASCIT nominations assembly, and as usual, at the assembly itself, there were more people on the stage than in the audience. The candidates were duly nominated and, amazingly enough, they accepted. Someday maybe some non-conformist will decline. As it was, the only surprise on this year's program was a scintillating speech putting a sage senior in nomination for the office of God. The nominee modestly refused to run unopposed.

Campaign managers and devoted supporters then took the forefront along with the candidates, plagiarizing Pogo, Dennis the Menace and other cartoon characters to extol the virtues and qualifications of their men along Billboard Lane, alias the Olive Walk. Politicians made speeches to sway the rabble, entertained the troops and then sat back to await the word of the voters.

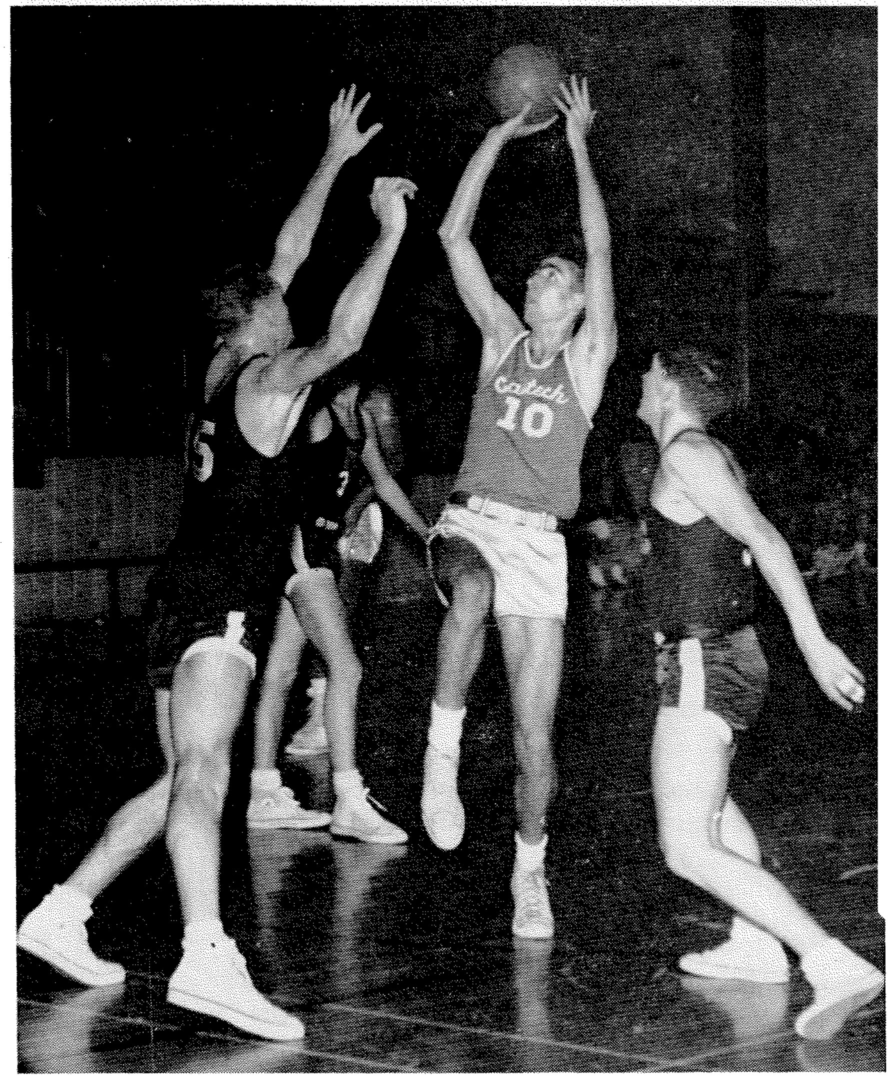
Jim Adams, past publicity manager of the ASCIT, was elected president, while Vince Marinkovitch took over as vice-president.

Bentknapped

February was also the month for autographs as Tau Bate pledges went scurrying around for signatures. The pledges only had to procure a measly 40 signatures instead of the 140 required in past years, but they com-

—including campus politics, a bent-knapping, and a historic sports victory

Traffic stopper



Captain Fred Anson of the SCIC championship basketball team

plained bitterly of their duties, as usual. They also failed to keep the big wooden Bent, sacred symbol of the society, from being "bentknapped" off the front steps of Throop in broad daylight.

The captors have already led the rightful owners on a scavenger hunt around the campus and presently are teasing the best heads in the school with an impossible cryptogram that ostensibly holds the key to the Bent's hiding place.

Aglow with victory

February turned out to be much more exciting than first appearances indicated. Before the month was up Caltech won the SCIC basketball championship, for the first time in history. It was Tech's first major sport victory in twelve years, so the troops really had something to crow about. Actually, if the Occidental Tigers had not wiped out the other two first-place contenders, Whittier and Redlands, Tech would probably not have won an undisputed first.

Despite such technicalities however, the troops turned out to celebrate with a big bonfire in the middle of the intersection of the campus. Although a passing patrolman had warned the boys not to start a conflagration, they soon had a cozy fire going. Passing motorists skirted the blaze with some difficulty, particularly while freshman Mike Bleicher was leading a series of victory yells out in the middle of the street.

Inevitably, a miffed motorist turned in the fire alarm which brought a big pump wagon. The firemen were somewhat annoyed because they had to break away from a hot cribbage game, but they mellowed as Bleicher led the mob in fifteen rahs for the courageous fire-fighters. Then everybody pitched in to help clean up the mess.

—Jim Crosby '54

THE CALTECH ALUMNI

V. The Major Makes a Difference

by JOHN R. WEIR

PREVIOUS ARTICLES in this series have been concerned with comparisons between the Caltech alumni and U. S. college graduates as described by Havemann and West in the book. *They Went to College.* This article will deal with comparisons made within the Caltech group, between those who majored in science and those who majored in engineering. Basically, our scientists and engineers are much alike. but there are some noteworthy differences. even though relatively small.

According to the survey returns. about two-thirds of our alumni are engineers. Alumni were asked to list their undergraduate major and—if they had an advanced degree—their graduate major. Twenty-nine percent of the undergraduate majors were in science. 71 percent in engineering. Thirty-three percent of the graduate majors were in science, and 59 percent in engineering. (These figures are in close agreement with the actual number of degrees granted by the Institute, thus providing further evidence for the validity of the alumni sample. This is true for the sum of all registrations, but today the proportion of scientists to engineers is growing larger. The ratio over the past four years is 40 scientists to 60 engineers out of every 100 undergraduate degrees. The graduate degrees in science have increased to 43 for every 57 engineering degrees.)

There is no significant difference in age between these two groups. A third of both the scientists and the engineers are under 30; 40 percent are between 30 and 39. It should. however. be borne in mind that over 50 percent of our alumni got their degrees since World War II. so both our scientists and engineers are comparatively young.

Work and play

As might be expected, more scientists (32 percent) than engineers (17 percent) report getting "mostly A's." Conversely. more engineers (32 percent) than scientists (20 percent) report getting "mostly C's."

The scientists studied harder while in school, and played less. Fifty-eight percent of the scientists participated in two or more extra-curricular activities; 63 percent of the engineers did so.

The engineers seem the more convinced of the desirability of such preparation. Seventy percent of the engineers who participated in these activities thought they were of value after college; 63 percent of the scientists thought so. Of those who did not participate, 57 percent of the engineers now regret it, and would participate if they had it to do over again. Only 38 percent of the scientists hold this view.

Education's a good thing

Both groups think that their education helped them a lot in their present occupation (scientists—91 percent; engineers—85 percent), although some wish they had majored in another field (scientists—13 percent; engineers—17 percent).

It is interesting that the fields most frequently mentioned by these "dissatisfied" alumni are, for the scientists—some field of engineering; for the engineers—a different branch of engineering. It is a rare Caltech alumnus who wishes he had majored in an entirely different field. such as law, business administration, or the humanities. All the same, some of our alumni have left science and engineering to work in other fields—and this is true for more of the engineers (18 percent) than for the scientists (12 percent).

Attitudes and opinions

As has already been noted (in Part III of this series), Caltech alumni are more "Pro-New Deal," more "Internationalist," and more "Tolerant" in their attitudes and opinions than U. S. college graduates in general.

Within our alumni group, similar consistent differences emerge. The Caltech scientists are more "Pro-New Deal," more "Internationalist," and more "Tolerant" than their engineering brothers. As the chart below shows, the U. S. graduates tend to fall between our engineers and our scientists. Only in the opinions we labeled "Tolerant" is this tendency missing; the Caltech engineers are considerably more "Tolerant" than the U. S. graduates—and the Caltech scientists are even more "Tolerant" than the engineers.

They have to lead

In this highly technical age a person with a specialized education and an advanced technical understanding is constantly faced with the need for communication and leadership skills. The importance of this problem is implied in the very large percentages of our alumni who have other people responsible to them. As the following table shows, practically all of our graduates are apt to have other people responsible to them at some time in their careers.

How Many People Responsible to You?

	Caltech Science Majors	Caltech Engineering Majors	Caltech Total
None	32%	19%	20%
1 through 5	30	26	28
6 through 19	18	24	22
20 through 199	16	24	23
200 and over	4	7	7

The need for training in leadership is clear. Inasmuch as 55 percent of the engineers have more than five people responsible to them, compared with 38 percent of the scientists, the need appears to be greater among the engineers.

Previous articles have commented on the importance of our highly educated alumni's participating in civic activities, and have presented data demonstrating their apparent failure to do so. As pointed out, this matter of civic affairs participation becomes very significant in terms of income; later in this article there is a discussion of how this significance applies to scientists and engineers.

In the matter of degree of activity, there is a tendency for the engineers to assume more civic responsibility than the scientists, although the difference is not great. Thirty-nine percent of the graduates who majored in engineering participated in five or more civic activities, whereas only 32 percent of the science majors did. These tendencies can be related to employer-employee relationships, and an equal case might be made for the demands made on our graduates to be effective in any group relationship. It is highly improbable that the highly trained scientist or engineer will find many situations in which he can function socially and emotionally isolated from others.

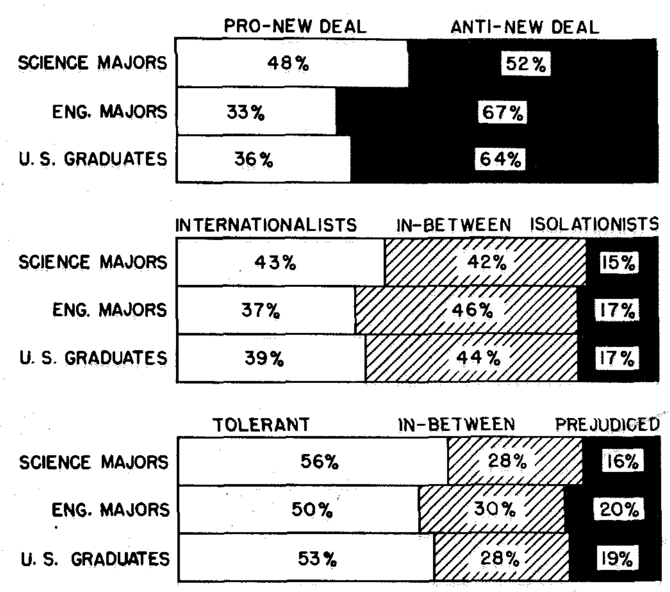
The scientist and the engineer

All of the differences mentioned so far are consistent in their support of the generally held characterization of our scientists and engineers. The scientist is more absorbed in his studies, in scholarly work within his field; he is more preoccupied with objects and things. The engineer places more emphasis on extra-curricular activities, social and civic endeavors, and is more concerned with his relationships with people.

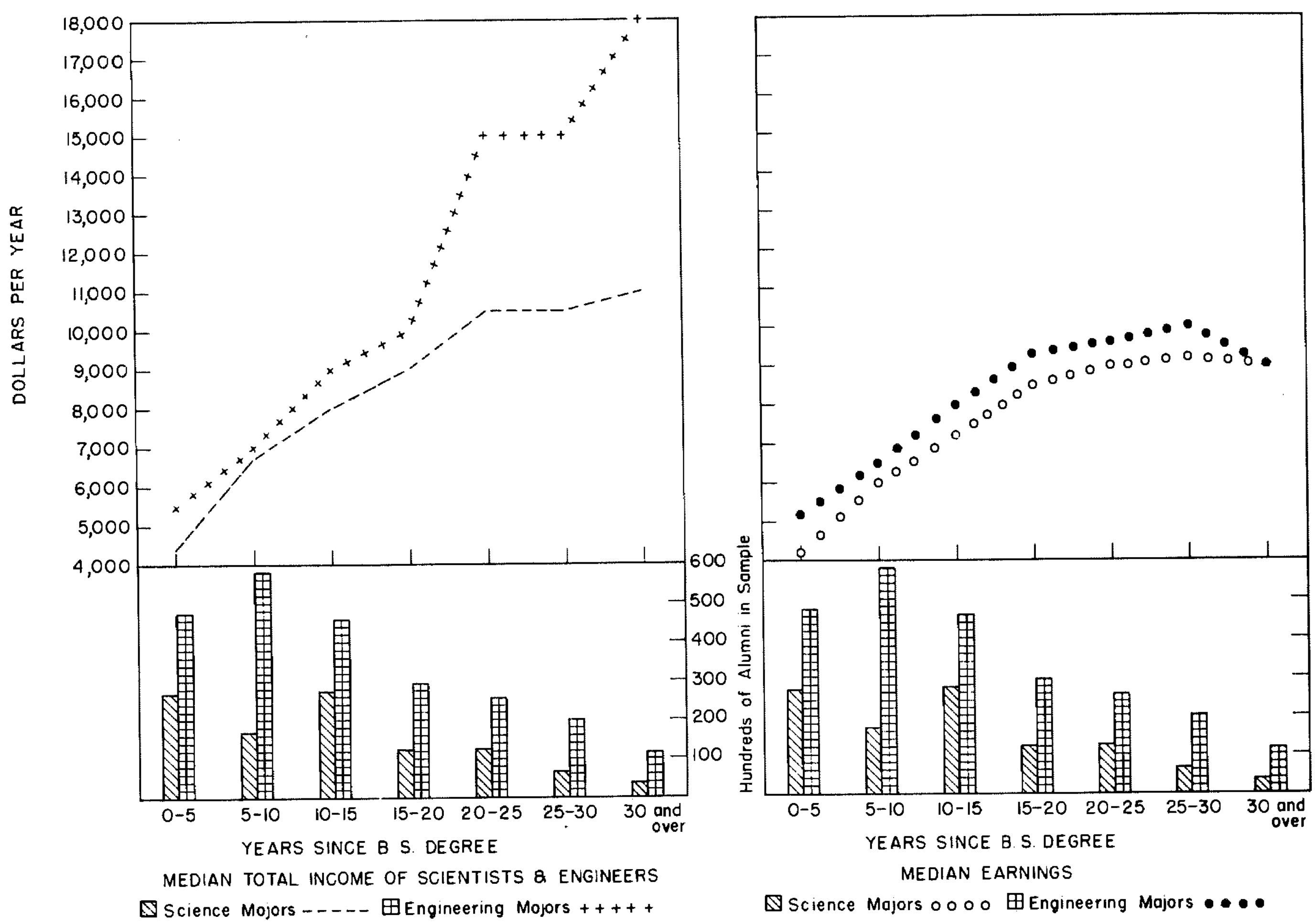
The scientist is somewhat less concerned with social and political affairs, is more inclined to ignore or avoid them, and prefers working with a small number of people. The engineer is more often in close contact with social and political affairs, appears to be more willing to accept and participate in them, and is more likely to have many people responsible to him.

ATTITUDES AND OPINIONS

Of Caltech science majors, Caltech engineering majors, and U. S. college graduates



TOTAL INCOME AND MEDIAN EARNINGS
of Caltech Scientists and Engineers



Earnings and income

The chart at the right, above, shows the median *earned* income, by years out of BS degree, for scientists and engineers. It shows an increase with years out of school that is similar for both groups, with the engineers reporting consistently larger earnings at each age.

The average difference between the two groups is $640 per year—a fairly small amount. However, when we add income from consulting activities and from other sources, such as business investments and royalties, the relationship is quite different.

The chart at the left, above, shows the median *total* income for scientists and engineers, by years out of BS. The engineers report increasingly higher total income with advancing age and experience. The average difference between these medians for total income is $2,770 per year. The engineer makes more money than the scientist, but he doesn't do it by working for someone else. He does it by consulting, and by his business and royalty income.

If we characterize the scientist as seeking basic knowledge, and the engineer as applying this knowledge for the increased comfort and convenience of society, then it appears that society considers the latter function the more commendable.

Major field vs. civic activities

In Part IV of this series of articles we considered the relationship between income and participation in civic affairs. It turned out to be an extremely important one. The relationship appears to be equally important when we make comparisons between the earned income medians of our science and engineering majors.

Income and Civic Activities

	Median Earnings		Median Total Income	
	Science Majors	Engineering Majors	Science Majors	Eng. Majors
No civic activities	$5,000	$5,400	$5,000	$6,600
1 to 4 activities	6,000	7,000	6,600	7,400
5 or more activiites	8,000	8,400	9,000	9,600

Consider first the figures for *earned* income. The science major with no civic activities earns $5,000 a year. the engineer $5,400—a difference of only $400. The science major with five or more activities earns $8,000 a year, the engineer $8,400. The difference between scientist and engineer is still only $400—*but* the difference between the men with no civic activities and those with five or more is $3,000. The difference, in other words, is seven and a half times as great as the difference between science and engineering.

The figures for *total* income are similar, suggesting that the increased earnings do not come from extra business contacts made as a result of this civic activity. If that were the case, the differences within the *total* income figures would be much greater.

These results again suggest that the willingness and capacity to participate in civic affairs and to assume civic leadership are accompanied by the capacity to earn increased income. What you *do*, in other words, is more important than what you *know*.

The cost of teaching

Part IV in this series showed the great financial sacrifice that our alumni must accept if they choose to go into the teaching profession. This sacrifice occurs in both engineering and science.

The median income for teaching engineers is $6,400 a year, and for non-teaching engineers it is $7,500—a difference of $1,100 a year. Comparable figures for the scientists are $6,000 and $7,000—a difference of $1,000 a year.

The difference between teaching and non-teaching is twice as great as the difference between scientist and engineer. (This holds for all degrees. If we consider only PhD's, then the scientists lose about $2,000 a year, and the engineers about $3,000 a year if they go into teaching.)

Within the teaching field, the engineer PhD makes $800 a year more than the science PhD. Among the non-teachers, the engineer PhD makes $1,500 a year more than the science PhD.

All these figures point in the same direction. The engineer consistently makes more money than the scientist; the non-teacher consistently makes more money than the teacher—and the latter difference is two to three times as large as the former.

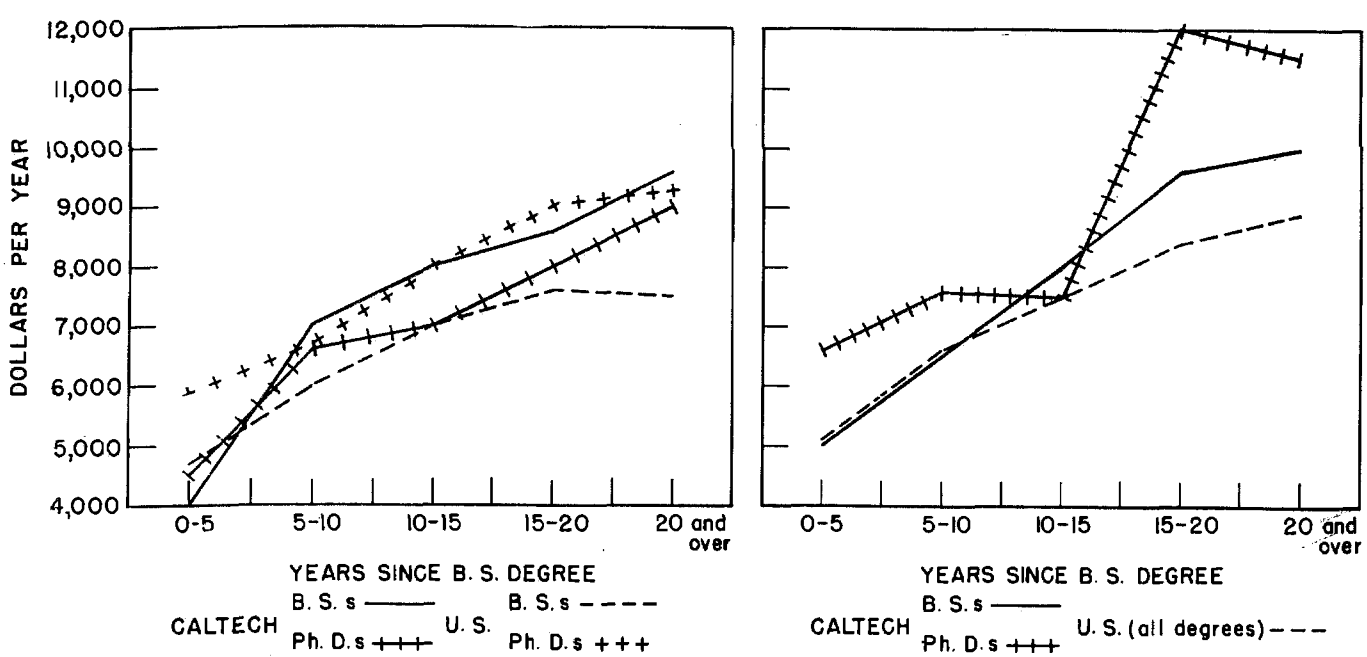
Strictly from the standpoint of earned income, it appears to be of minor importance whether one goes into science or engineering. It is more important whether or not one decides to go into teaching. And it is most important whether or not one is able and willing to participate in civic activities.

Income comparisons with other groups

Some data are available for comparing the earnings of Caltech alumni with other groups of scientists and engineers. While these figures are derived from samples which are not exactly identical with our alumni (there

MEDIAN EARNINGS

Caltech Science Majors and U. S. Scientists **Caltech Engineering Majors and U. S. Engineers**



are differences in age, occupation, and geographical location), the figures are roughly comparable and sufficient to justify their use here.

Scientists

The following table compares median earnings for scientists in terms of degree and years out of BS. The U. S. figures are obtained from the 1952 National Survey of Professional Scientific Salaries, compiled by the Los Alamos Scientific Laboratory of the University of California.

Yearly Earnings of Scientists

Years Out of BS	BS's CIT	BS's US	PhD's* CIT	PhD's* US
0-5	$4,000	$4,700	$5,000	$5,900
5-10	7,000	6,000	7,000	6,700
10-15	8,000	7,000	8,000	8,000
15-20	8,600	7,600	9,000	9,000
Over 20	9,600	7,500	9,600	9,600

* Does *not* include teaching PhD's

Both the Caltech BS and PhD start off making less than the U. S. scientist. However, by ten years out of BS the Caltech man is making as much or more, and maintains this position for the rest of his career.

Engineers

A similar comparison may be made for engineers by using the figures published in the 1952 Professional Engineers Income and Salary Survey.

Yearly Earnings of Engineers

Years Out of BS	Caltech BS's	Caltech PhD's	U.S. BS's & PhD's
0-5	$ 5,000 (264)*	$ 6,600 (11)*	$5,120
5-10	6,500 (253)	7,600 (68)	6,580
10-15	8,000 (203)	7,500 (51)	7,510
15-20	9,600 (153)	12,000 (29)	8,390
20-25	9,500 (136)	9,600 (28)	8,590
25-30	10,000 (150)	15,000 (22)	8,990

* Number of alumni included

Earnings by occupation

These figures can also be broken down according to occupational field—as they are in the table at the bottom of this page.

From these figures it appears that the Caltech engineer may start out somewhat lower than the typical U. S. engineer, but by the end of ten years out of BS he will be making more and will maintain this advantage for the rest of his career.

The trend in these figures is similar for both scientists and engineers. A plausible explanation for this fact might be that the Caltech graduate is trained in the fundamentals of his discipline at the Institute, but must learn the specifics of his profession on the job. It is only after this has been done that he reaches his full earning potential. (This would be least true for the PhD scientists, and they are just the group that deviates from the trend we are considering.) Apparently the Caltech emphasis on fundamentals produces alumni ultimately capable of superior professional competence.

There's a difference

In sum, any difference between the scientist and engineer is probably a reflection of the general trends in twentieth century American culture. Basically, our science and engineering alumni are much alike. Those differences that do occur would appear to be the result of the difference in the social appreciation of contemplation as opposed to application. The more thoughtful scientist is less gregarious and puts less emphasis on material gain; he receives his chief satisfaction from the conviction that he is adding to our basic knowledge of the world. The more outgoing engineer achieves tangible results in the substance of his work, in his contacts with his fellows and his community, and in his material reward.

This is the fifth—and last—of a series of articles discussing the results of the Caltech Alumni Survey.

Yearly Earnings by Occupational Field for Caltech Graduates and U. S. Graduates

Years Out of BS	Administration CIT	Administration US	Design CIT	Design US	Production & Operation CIT	Production & Operation US	Research & Development CIT	Research & Development US
0-5	$ 6,000	$ 6,290	$5,200	$5,070	$5,000	$5,120	$5,500	$4,810
5-10	6,600	7,720	6,500	6,500	7,000	7,000	7,500	6,310
10-15	10,000	9,020	7,800	7,110	8,000	7,280	8,500	7,670
15-20	10,000	10,070	8,100	7,640	9,500	8,500	10,000	8,210
20-25	12,000	9,700	8,500	7,800	10,000	8,530	9,500	9,280
25-30	10,900	10,500	8,000	7,990	8,000	8,160	9,200	8,630

CONSPICILLA.
Inuenta conſpicilla ſunt, quæ luminum Obscuriores detegunt caligines.

A SIXTEENTH CENTURY SPECTACLE SHOP

by E. C. WATSON

SOMETIME DURING the last decade of the sixteenth century (the exact date is uncertain) a set of 20 beautifully engraved plates entitled *Nova Reperta*, and illustrating the most important discoveries and inventions of the Middle Ages was executed at Antwerp by Philipp Galle from designs painted or sketched by Joannes Stradanus.

One of these plates, reproduced above, showed the shop of a spectacle maker, with his stock of spectacles and their use by various people. This engraving not only makes it clear that spectacles were in general use in Europe before 1600 (actually they came into use in Italy near the end of the thirteenth century—*E&S*, February 1954), but it is also of special interest because of the place (Antwerp) and the time (about 1600) at which the original was executed. For it was in Middleburg, less than 50 miles from Antwerp, in just such a spectacle-maker's shop, that in 1590, or thereabouts, a lens-grinder named Zacharias Jansen combined two spectacle lenses to form the first compound microscope. And it was in a neighboring shop in the same town, in 1608, that another spectacle-maker, Hans Lippershey, combined two other lenses to produce the first practical telescope.

This legacy from Stradanus and Galle enables us to understand at a glance how the practical discovery of both the compound microscope and the telescope came to be made.

Lippershey, while holding two lenses, one in each hand, happened to direct them towards the steeple of a neighboring church and was astonished, on looking through the nearer lens, to find that the weathercock appeared closer and more distinct. Subsequently he fitted the lenses into a tube in order to adjust and preserve their relative distances.

It is not surprising, of course, that once a telescope of this kind was made, the discovery was claimed for many people. The surprise is rather that it was not made in clean-cut fashion much earlier.

One of a series of articles devoted to reproductions of prints, drawings and paintings of interest in the history of science—drawn from the famous collection of E. C. Watson, Professor of Physics and Dean of the Faculty of the California Institute.

THE CHALLENGE OF MAN'S FUTURE

by HARRISON BROWN

Industrialization of the underdeveloped areas of the world is one of the most formidable tasks confronting mankind today. We have the ability to do it. Do we have the vision and the will?

This article—the second of two parts—has been adapted from the concluding chapter of the book, The Challenge of Man's Future, by Harrison Brown, to be published March 19, 1954, by The Viking Press.

INDUSTRIALIZATION of the underdeveloped areas of the world is perhaps the most formidable task confronting mankind today. We must now ask: Can we visualize ways and means by which existing primitive agrarian societies can be transformed reasonably rapidly and smoothly into modern industrial societies?

Thus far we have discussed primarily the importance of family limitation as a necessary feature of such a transition. But we must recognize that even if family-limitation techniques should receive widespread acceptance, the path of industrialization would still be extremely difficult, and it would still be fraught with innumerable dangers.

An industrialization program must possess many interlocking features, no one of which can be divorced from the others. The ultimate goal of such a program would be to manufacture goods in sufficient quantity so that every person would have adequate housing, clothing, education, medical and public health facilities, and at the same time receive adequate nutrition.

In order to accomplish this end, factory buildings and production machines must be built, building materials must be produced, machines must be fabricated which in turn can be used to fabricate machines, metals must be produced, ores must be mined, fuels must be obtained, and transportation systems must be extended. Men must be trained to build and to operate the factories and transportation systems. These men must come from the farms, but they cannot leave the farms until food production per man-hour has been increased without decreasing crop yields—otherwise there would be a lowering of food production and more widespread starvation. In turn, a significantly increased food production per man-hour requires mechanization of farms. Mechanization of farms in turn requires machines, which in turn require a certain degree of industrialization if they are to be

manufactured and properly maintained. Thus, in a sense, the inhabitants of underdeveloped areas find themselves in a vicious circle which cannot easily be broken.

Industrialization requires enormous investments of materials and labor before goods can actually be produced, transported, and used. Obviously, if all persons in a given society must spend all of their working hours producing food for their own composition, accumulation of a surplus becomes impossible. We have seen that if a surplus of food can be produced, some members of the society can engage in occupations other than farming and can manufacture goods. But unless a mechanism is available whereby a part of the effort can be channeled into the production of capital goods such as machines and factory buildings, which are not consumer items but which will later enable greater production of such items, industrialization cannot expand.

In other words, mechanisms must be available which enable persons to deprive themselves of consumer goods and instead to use a part of the surplus food and goods which they have produced for the purchase of capital items which are not immediately useful but which will eventually result in increased consumer production. Translated into terms of money, this process means that persons must refrain from spending all the money they derive from the sale of goods and other services, and the "savings" must be invested in capital goods that will result in increased production.

Capital investment

We can obtain some idea of the amount of capital investment that is required in a highly industrialized society by examining the capital resources of the United States. Prior to World War II, the real capital resources, exclusive of land, amounted to about 250 billion dollars, corresponding to an average of 2000 dollars for every person in the country. At the same time the average per capita income in the United States amounted to about 550 dollars per year. Simultaneously, the average per capita income in the underdeveloped areas of the world amounted to little more than 40 dollars per year.

If all underdeveloped areas at their existing population levels were to possess the per capita capital investment enjoyed by the United States immediately prior to World War II, the total investment in those countries would amount to about 3600 billion dollars. It has been estimated that a sum corresponding to about one-seventh that amount—about 500 billion dollars—would suffice over a 50-year period to switch about one-fourth of the labor force and their families from agricultural to industrial and commercial occupations. This would give them an economic situation similar to that which existed in prewar Japan.

In view of the low incomes of underdeveloped areas, it is clear that industrialization requires either outside financing during the initial stages, or forced savings well above the voluntary rate, similar to the compulsory savings in the Soviet Union. However, even with strict totalitarian regimes of the Russian type, industrialization would necessarily proceed slowly in the absence of help from the outside, largely as the result of the unfavorable population-land-resource situations in most underdeveloped areas.

The most difficult part of an industrialization program is that of getting started. Once industrialization is well under way and goods begin to flow in increasing quantity, both per capita incomes and savings can increase rapidly. Substantial help from the outside can contribute greatly toward overcoming the initial hurdles and can accelerate the whole industrialization process.

Chances of success

It seems likely that, given concerted efforts of both the underdeveloped areas and the industrialized regions of the world, the standards of living of the underprivileged two-thirds of humanity could be raised significantly in about 50 years, and standards of living characteristic of the industrialized West of today might be attained in an additional 50 years without resorting to totalitarian methods. But it is equally likely that in the absence of concerted efforts and vigorous application of imagination and ingenuity to the problem, the programs would be doomed to failure. The chance of success is much greater for a vigorous program than for a half-hearted one.

Let us assume for the purpose of discussion that a degree of industrialization in the underdeveloped areas equivalent to that which existed in prewar Japan could be attained with an investment of about 500 billion dollars over a 50-year period. Let us assume further that an additional 100 billion dollars would be required for increasing agricultural production to the point where all persons would receive adequate nutrition. The average annual investment would then be somewhat over 10 billion dollars, of which perhaps one-half could be furnished over the entire period by the underdeveloped regions. During the initial years the domestic savings would provide only a small proportion of the required sums, but, as incomes increased in the underdeveloped regions, they would be able to provide an increasing proportion of the investment. On this basis, foreign investments averaging about 5 billion dollars annually over the 50-year period would be required. The annual requirement for foreign investments might be less than this during the initial years because of the limited existing capacity of most underdeveloped areas to absorb new capital. But the requirements for outside financing would rise rapidly. After about 30 years the require-

ments for foreign investment would begin to decrease as the result of increased local savings.

If the industrialized areas of the world were to join in recognizing the overwhelming importance of the problem, and would agree to take common action to speed the industrialization of the underdeveloped areas, the problems of financing would not be prohibitive. Largely because of the risk involved and the uncertain profits to be gained, it is difficult to visualize large amounts of private capital from Western nations contributing substantially to the development program. For this reason it seems likely that the greater part of the outside funds, at least during the initial stages, must be public funds.

On the basis of a policy of investing in proportion to ability to pay, the United States would at first carry the greater part of the financial burden—perhaps as much as three-quarters of the international investment during the first decade. But as the economic situation of Western Europe improves, the share from the United States might well decrease appreciably.

Comparative costs

The average cost to the United States of a world development program over a 50-year period might amount to between 4 billion dollars and 5 billion dollars annually. When we compare this figure to our national income, to our present federal budget, to the funds required for armament, and to the cost of waging war, the amount required does not appear to be excessive. When we compare it to the potential gains that can result from a successful development program, it appears even smaller. And when we compare the cost to that of inaction and to the consequences of attempting to maintain the status quo, it is indeed insignificant.

It is clear that the nations of the West possess sufficient resources and productive capacity to catalyze a successful world development program at the present time. Our physical ability to bring about successful transition is not one of the unknowns. We have the ability to do it; whether we have the vision and the will is another matter.

If industrial civilization eventually succumbs to the forces that are relentlessly operating to make its position more precarious, the world as a whole will probably revert to an agrarian existence. In such an event history will continue for as long a time as man exists. Empires, republics, and military states will rise and fall. There will be wars, migrations, and revolutions. Art, music, and literature will flourish, wane, then flourish again. As in the histories of the past and of the present, there will be unceasing change. Yet, looked upon over a period of thousands of years, history will have a sameness like the repeated performances of a series of elaborate epic plays in which, over the centuries, the actors change, the languages change, the scenery changes, but the basic plots remain invariant.

But if industrial civilization survives—if wars are eliminated, if the population of the world as a whole is stabilized within a framework of low death rates and low birth rates—will there continue to be human history? The terms "stability" and "security" imply predictability, sameness, lack of change. And these terms further imply a high degree of organization—universal organization to avoid war, local organization to produce goods efficiently—and organization in turn implies subjugation of the individual to the state, confinement and regimentation of the activities of the individual for the benefit of society as a whole.

Today we see about us on all sides a steady drift toward increased human organization. Governments are becoming more centralized and universal. In practically all areas of endeavor within industrial society—in our systems of production, in fields of labor, capital, commerce, agriculture, science, education, and art—we see the emergence of new levels of organization designed to coordinate, integrate, bind, and regulate men's actions. The justifications for this increasing degree of organization to which man must accommodate himself are expressed in terms such as "stability," "security," and "efficiency."

The end result of this rapid transition might well be the emergence of a universal, stable, efficient, industrial society within which, although all persons have complete personal security, their actions are completely controlled. Should that time arrive, society will have become static, devoid of movement, fixed and permanent. History will have stopped.

To what purpose?

Here we indeed find ourselves on the horns of the dilemma. To what purpose is industrialization if we end up by replacing rigid confinement of man's actions by nature with rigid confinement of man's actions by man? To what purpose is industrialization if the price we pay for longer life, material possessions, and personal security is regimentation, controlled thought and controlled actions? Would the lives of well-fed, wealthy, but regimented human robots be better than the lives of their malnourished, poverty-stricken ancestors? At least the latter could look forward to the unexpected happening—to events and situations which previously had been outside the realm of their experiences.

In a modern industrial society the road toward totalitarianism is unidirectional. In days gone by men could revolt against despotism. People could arise against their governments in the absence of legal recourse, and with muskets, sticks, knives, and stones as their weapons they could often defeat the military forces of the central

authorities. But today our science and our technology have placed in the hands of rulers of nations weapons and tools of control, persuasion, and coercion of unprecedented power. We have reached the point where, once totalitarian power is seized in a highly industrialized society, successful revolt becomes practically impossible. Totalitarian power, once it is gained, can be perpetuated almost indefinitely in the absence of outside forces, and can lead to progressively more rapid robotization of the individual.

Thus we see that, just as industrial society is fundamentally unstable and subject to reversion to agrarian existence, so within it the conditions which offer individual freedom are unstable in their ability to avoid the conditions which impose rigid organization and totalitarian control. Indeed, when we examine all of the foreseeable difficulties which threaten the survival of industrial civilization, it is difficult to see how the achievement of stability and the maintenance of individual liberty can be made compatible.

Reducing the pressures

The view is widely held in our society that the powers of the machine will eventually free man from the burden of eking out an existence and will provide him with leisure time for the development of his creativity and enjoyment of the fruits of his creative efforts. Pleasant though this prospect may be, it is clear that such a state cannot come into existence automatically; the pressures forcing man into devising more highly organized institutions are too great to permit it. If he is to attain such an idyllic existence for more than a transitory period he must plan for that existence carefully, and in particular he must do everything within his power to reduce the pressures that are forcing him to become more highly organized.

One of the major pressures that give rise to the need for increasing numbers of laws, more elaborate organization, and more centralized government is increase of population. Increase of numbers of people and of population density results in greater complexities in day-to-day living and in decreased opportunities for personal expression concerning the activities of government. But even more important, as populations increase and as they press more heavily upon the available resources there arises the need for increased efficiency, and more elaborate organizations are required to produce sufficient food, to extract the necessary raw materials, and to fabricate and distribute the finished products. In the future we can expect that the greater the population density of an industrial society becomes, the more elaborate will be its organizational structure and the more regimented will be its people.

A second pressure, not unrelated to the first, results from the centralization of industrial and agricultural activity and from regional specialization in various aspects of those activities. One region produces textiles, another produces coal, another automobiles, another corn, and another wheat. Mammoth factories require mammoth local organizations. Centralized industries must be connected, and this requires elaborate transportation systems. Regional localization of industries gives rise to gigantic cities, which in turn give rise to elaborate organization for the purpose of providing the inhabitants with the necessary food, water, and services. All of these factors combine to produce vulnerability to disruption from the outside, increased local organization and regimentation, more highly centralized government, and increasing vulnerability to the evolution of totalitarianism.

A third pressure results from increasing individual specialization and the resultant need for "integration," "coordination," and "direction" of activities in practically all spheres of vocational and leisure activity. It results in the placing of unwarranted trust in "integrators," "coordinators," and "directors." Early specialization results in lack of broad interests, lessened ability to engage in creative activities of other individuals, and lessened abilities to interpret events and make sound judgments. All of these factors combine to pave the way for collectivization, the emergence of strong organization, and, with it, the great leader.

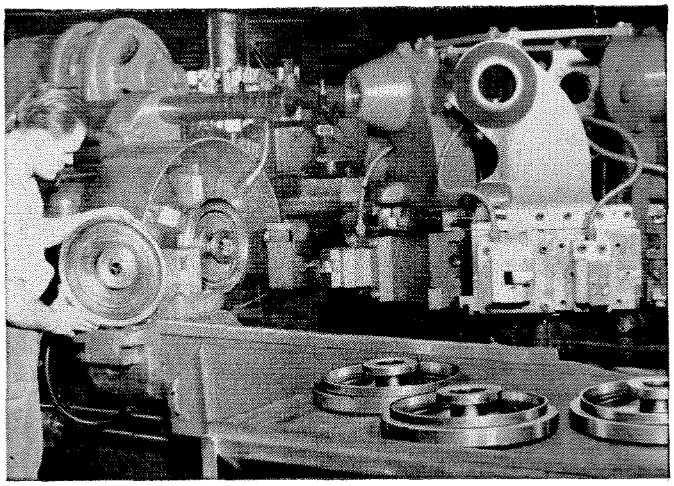
Strong arguments can be presented to the effect that collectivization of humanity is inevitable, that the drift toward an ultimate state of automatism cannot be halted, that existing human values such as freedom, love, and conscience must eventually disappear.

Industrial civilzation and human values

Certainly if we used the present trends in industrial society as our major premises, the conclusion would appear to be inescapable. Yet is it not possible that human beings, recognizing this threat to the canons of humanism, can devise ways and means of escaping the danger and at the same time manage to preserve those features of industrial civilization which can contribute to a rich, full life? Is it really axiomatic that the present trends must continue and that in the long run industrial civilization and human values are incompatible? Here, in truth, we are confronted with the gravest and most difficult of all human problems, for it is one that cannot be solved by mathematics or by machines, nor can it even be precisely defined. Solutions, if they exist, can arise only in the hearts and minds of individual men.

The machine has divorced man from the world of nature to which he belongs, and in the process he has lost in large measure the powers of contemplation with

Another page for **YOUR BEARING NOTEBOOK**

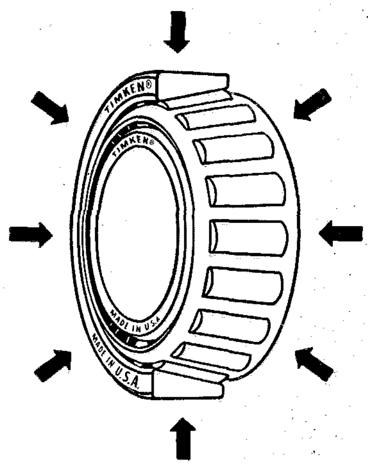


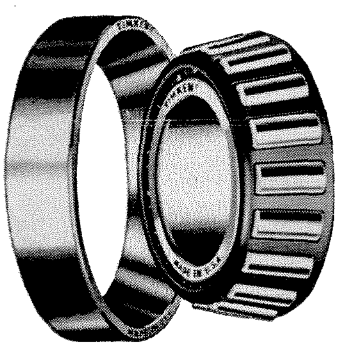
How to speed production of high precision jet engine parts

Engineers had the problem of designing a turret lathe that would machine a stainless steel jet engine part having a very complicated shape. And the part had to be produced in volume—yet with extreme precision. Naturally, they had to be sure the lathe spindle would be held rigid. *To solve their problem, they mounted the spindle and* gear train on Timken® tapered roller bearings, eliminating spindle vibration and chatter, insuring high precision.

Here's how TIMKEN® bearings maintain spindle rigidity

Timken bearings hold spindles in rigid alignment because line contact between rollers and races gives spindles wide, rigid support. Because the tapered design of Timken bearings lets them take radial and thrust loads in any combination, deflection is minimized, end-play and chatter eliminated. Spindles maintain their accuracy, year after year.





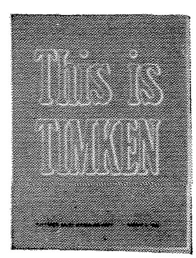
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

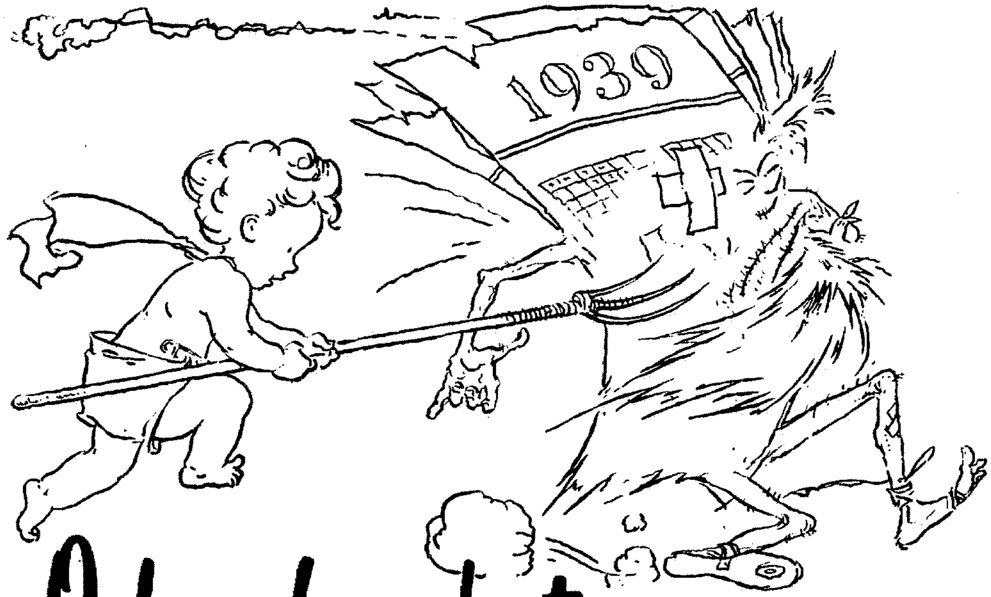
TAPERED ROLLER BEARINGS

Want to learn more about bearings or job opportunities?

Many of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of *"This Is Timken"*. The Timken Roller Bearing Company, Canton 6, Ohio.



NOT JUST A BALL ○ NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION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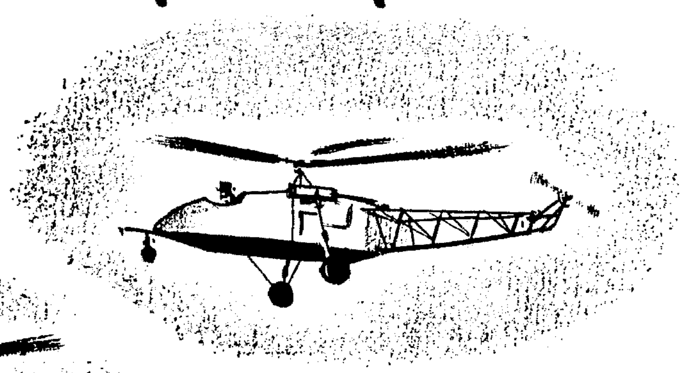
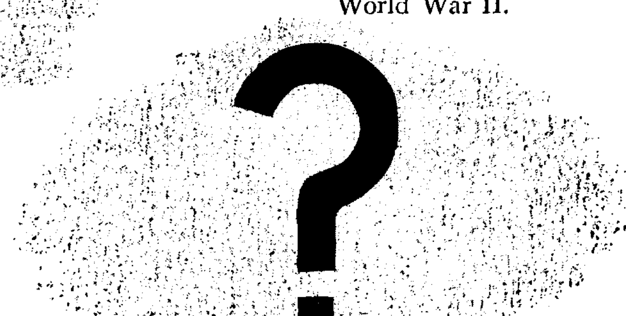
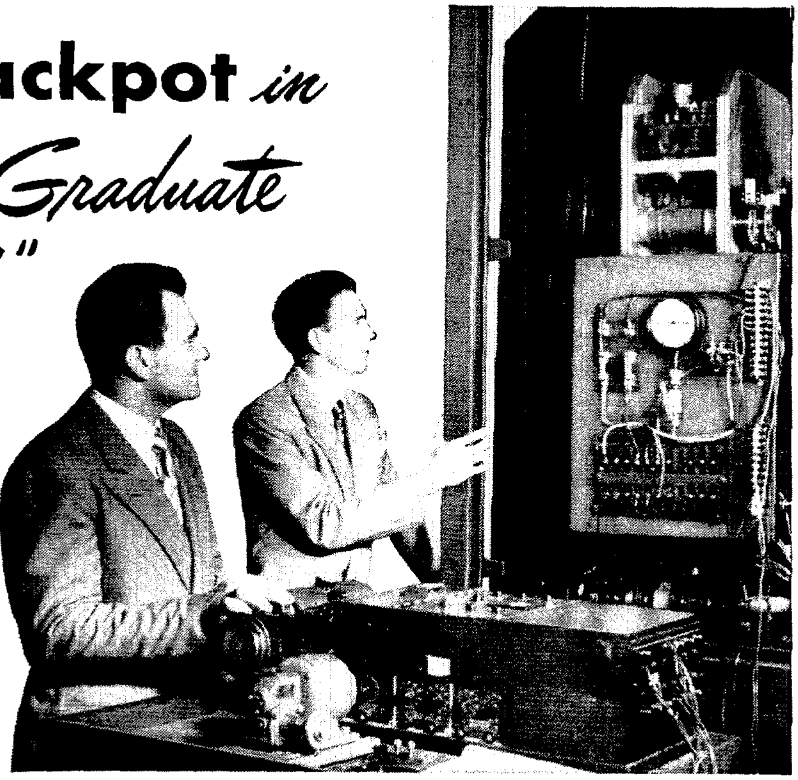




"We Hit the Jackpot *in Allis-Chalmers Graduate Training Course!*"



say N. W. MORELLI

Oregon State College, B.S.,M.E.—1950

and

E. R. PERRY

Texas A. & M., B.S.,E.E.—1950

WHILE taking the course, two engineers developed a revolutionary new circuit breaker mechanism.

"Our experience shows what *can* happen if you work with people open to suggestion. We found men of this kind at Allis-Chalmers, and it has given us a special pleasure in our job.

"We started out like most other graduates with a hazy idea of what we wanted to do. After working in several departments, we requested that part of our training be at the Boston Works of Allis-Chalmers, where circuit breakers are made."

New Design Principle

"Circuit breakers soon became an obsession with us, and we got the idea of designing a hydraulic operator and triggering mechanism for these breakers. Most operators for big breakers are pneumatic.

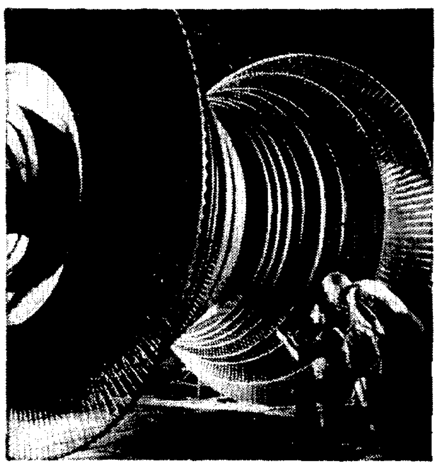
"Unsuccessful attempts had been made in the past by all circuit breaker manufacturers to build hydraulic operators. The important thing is that no one at Allis-Chalmers said, 'Don't try it—it won't work.' "

Start New Era

"To make a long story short, our study of the problem led us to the hydraulic accumulator and high speed valves being used by the aircraft industry. These had not been available when earlier attempts were made to build a hydraulic operator. With these highly developed devices to work with, we were able to build an operator that combined the best features of pneumatic and hydraulic operation. We call it the *Pneu-draulic* operator. Engineers are saying it starts a new era in circuit breaker actuation.

"This fact is important to us, but it is even more important to know that Allis-Chalmers Graduate Training Course is full of opportunity . . . and as we found out, there's opportunity right from the start."

Pneu-draulic is an Allis-Chalmers Trademark.



Low-pressure spindle for a 120,000 kw steam turbine generator. Said to be one of the largest ever built in the United States, this spindle is nearing completion in the Allis-Chalmers West Allis shops.

Facts You Should Know About the Allis-Chalmers Graduate Training Course

1. It's well established, having been started in 1904. A large percentage of the management group are graduates of the course.

2. The course offers a maximum of 24 months' training. Length and type of training is individually planned.

3. The graduate engineer may choose the kind of work he wants to do: design, engineering, research, production, sales, erection, service, etc.

4. He may choose the kind of power, processing, specialized equipment or industrial apparatus with which he will work, such as: steam or hydraulic, turbo-generators, circuit breakers, unit substations, transformers, motors, control pumps, kilns, coolers, rod and ball mills, crushers, vibrating screens, rectifiers, induction and dielectric heaters, grain mills, sifters, etc.

5. He will have individual attention and guidance in working out his training program.

6. The program has as its objective the right job for the right man. As he gets experience in different training locations he can alter his course of training to match changing interests.

For information watch for the Allis-Chalmers representative visiting your campus, or call an Allis-Chalmers district office, or write Graduate Training Section, Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

C-5675

MAN'S FUTURE . . . CONTINUED

which he was endowed. A prerequisite for the preservation of the canons of humanism is a reestablishment of organic roots with our natural environment and. related to it. the evolution of ways of life which encourage contemplation and the search for truth and knowledge. The flower and vegetable garden, green grass, the fireplace. the primeval forest with its wondrous assemblage of living things. the uninhabited hilltop where one can silently look at the stars and wonder—all of these things and many others are necessary for the fulfillment of man's psychological and spiritual needs. To be sure. they are of no "practical value" and are seemingly unrelated to man's pressing need for food and living space. But they are as necessary to the preservation of humanism as food is necessary to the preservation of human life.

I can imagine a world within which machines function solely for man's benefit. turning out those goods which are necessary for his well-being, relieving him of the necessity for heavy physical labor and dull, routine, meaningless activity. The world I imagine is one in which people are well fed, well clothed and well housed. Man, in this world, lives in balance with his environment, nourished by nature in harmony with the myriads of other life forms that are beneficial to him. He treats his land wisely, halts erosion and over-cropping, and returns all organic waste matter to the soil from which it sprung. He lives efficiently, yet minimizes artificiality. It is not an overcrowded world; people can, if they wish, isolate themselves in the silence of a mountaintop, or they can walk through primeval forests or across wooded plains. In the world of my imagination there is organization, but it is as decentralized as possible, compatible with the requirements for survival. There is a world government, but it exists solely for the purpose of preventing war and stabilizing population, and its powers are irrevocably restricted. The government exists for man rather than man for the government.

Create a world

In the world of my imagination the various regions are self-sufficient, and the people are free to govern themselves as they choose and to establish their own cultural patterns. All people have a voice in the government, and individuals can move about when and where they please. It is a world where man's creativity is blended with the creativity of nature, and where a moderate degree of organization is blended with a moderate degree of anarchy.

Is such a world impossible of realization? Perhaps it is, but who among us can really say? At least, if we try to create such a world there is a chance that we will succeed. But if we let the present trend continue it is all too clear that we will lose forever those qualities of mind and spirit which distinguish the human being from the automaton.


THE DU PONT
DIGEST

ALUMNI NEWS

New Board Members

The Board of Directors of the Alumni Association met as a nominating committee on February 23, 1954, in accordance with Section 3.04 of the bylaws. Five vacancies will occur on the Board at the end of the current fiscal year, one vacancy to be filled from the present Board and four members to be elected by the Association. The present members of the Board and the years in which their terms of office expire follow:

W. E. Baier '23........1955	F. M. Greenhalgh '41..1954
R. R. Bennett '45........1955	D. G. Kingman '28......1955
F. H. Felberg '42........1954	C. V. Newton '34........1955
G. P. Foster '40..........1954	A. A. Ray '35. 1951
K. F. Russell '29..........1954	

The four members of the Association nominated by the Directors are:

H. C. Carter '49	W. F. Nash, Jr. '38
Philip Cravitz '29	C. P. Strickland '43

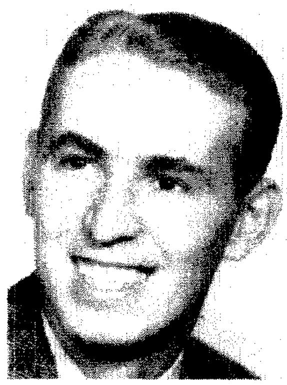
Section 3.04 of the bylaws provides that the membership may make additional nominations by petition, signed by at least ten (10) regular members in good standing, provided the petition is received by the Secretary not later than April 15. In accordance with Section 3.05 of the bylaws, if further nominations are not received by April 15, the Secretary casts a unanimous ballot for the members nominated by the Board. Otherwise a letter ballot is required.

Statements about the nominees of the Directors are presented in this issue of *Engineering and Science.*

—*Donald S. Clark, Secretary*

The Nominees

Philip Cravitz received his BS in civil engineering in 1929, and his MS in 1931. For the next seven years he was engaged in designing hydraulic structures for the Los Angeles Flood Control. He entered the contracting field by becoming an estimator for contracting engineers in 1938, then moved on to the Zoss Construction Co. as general manager through the war years, from 1941 to 1945. Phil formed his own company in 1946, known as Coronet Construction Co., Inc., and has built several thousand homes since that time. He has one son finishing Loyola law and one studying engineering at Harvard. Another one, seven years of age, attends television.



Hugh C. Carter received his BS in mechanical engineering in 1949. After graduation he worked for a year in the Division of Architecture for the State of California. From 1950 to 1953 he was employed by the Bechtel Corporation as an engineer and estimator in the power division at Vernon. In the spring of 1953 he returned to the State Division of Architecture in Los Angeles, as senior mechanical estimator. Hugh has served as member and chairman of the program committee for the Alumni Seminar Day, and is Seminar chairman for 1954.

William F. Nash, Jr. received his BS in mechanical engineering in 1938, an MS in 1939, and a PhD in 1942. He was instructor in physical metallurgy at Caltech from 1941 to 1945. From 1945 to 1947, he was with the Naval Ordnance Test Station, where he headed all metallurgy work, both at Inyokern and Pasadena. In 1947, Bill joined C. F. Braun & Co., in Alhambra, as metallurgy consultant. Since then he has been welding engineer, head of the inspection department, factory superintendent, and head of the manufacturing division. He is now one of the six men on the administrative group that directs the operations of the company.

Charles P. Strickland, Jr. received his BS in applied chemistry in 1943. He was ASCIT president in his senior year, and won three-year letters in basketball and tennis. From 1943 to 1946 he served in the Navy—including one year as B division officer on an aircraft carrier in the Third and Fifth Fleets, and a year at the Postgraduate School of the Naval Academy in Annapolis. He joined the York Corporation as a trainee in 1948 and is now industrial sales engineer in the Los Angeles office. Charlie was chairman of the annual Alumni Dance in 1951 and 1952, and of the Alumni Dinner in 1953 and 1954.

PERSONALS

1922

R. M. Bozorth, PhD, writes from Murray Hill, New Jersey, where he's still working for Bell Labs, to bring us up to date on his activities for the past four years. In 1950, he reports, he gave a paper at the international conference on magnetism in Grenoble, France. In 1951 he gave several lectures at Caltech and published a book on ferromagnetism. In 1952 he was program chairman of an international conference in Washington, D. C. In 1953 he attended a conference on physics in Japan, and went around the world on his way home.

Dick is now chairman of the AIEE Committee on Basic Science, and chairman of the National Research Council Committee on Permanent Magnets. Having started out with two daughters, he's now acquired a couple of sons-in-law and three grandchildren.

1926

J. C. Huang is the newly elected president of the Chinese Institute of Chemical Engineers, organized under charter from the Nationalist Chinese government on November 12, 1953, at a meeting of more than 230 chemical engineers in southern Formosa. He is also vice-president of the Taiwan Sugar Corporation in Formosa.

1929

Philip G. Murdock, PhD '32, research professor of chemical engineering at Texas A&M until recently, has now joined the Texas division of the Dow Chemical Company in Freeport.

A. J. Larrecq writes that he's still doing *business at the same stand—which means* he's president of Power Generators Inc. and also of Design Engineering Corporation. Both companies specialize in the design and development of rotating machinery, ordnance, heat transfer apparatus, and electro-mechanical devices. He's married, has two children, and is living in Trenton, New Jersey.

1930

Paul William Douglass, Ex., has spent over ten years with the Douglas Aircraft Company—at the Santa Monica plant until January, 1952, and then at the Tulsa, Oklahoma plant. Paul worked in the engineering department for the first seven and one-half years, and then transferred to spectrographic work. In January, 1952, he was put in charge of the spectrographic laboratory at the Douglas Tulsa plant. The Douglasses' son, Paul William, Jr., is now seven years old.

1937

Lt. Col. John H. Blue was recently promoted to his present rank while serving as executive officer of the 2nd Armored Amphibian Battalion at the Marine Corps Base, Camp Lejeune, in North Carolina. He served with the 1st Marine Division in Korea and was awarded the Letter of Commendation for his "excellent service" there.

George M. Dorwart, MS '39 PhD '41, died suddenly of a heart attack last December 14. He was 39 years old. After working as a petroleum engineer for the Union Oil Company in the Whittier office, he joined Standard Oil of California in Bakersfield in 1950, and remained there until the time of his death. He is survived by his widow, Doris, and his daughter, Ann.

1938

Brig. Gen. Thomas S. Moorman, Jr., MS, now deputy commander, will become commander of the Air Weather Service at Andrews Air Force Base in Maryland this

PERSONALS . . . CONTINUED

spring. The Air Weather Service provides the Air Force and Army with global meteorological service with its approximately 250 weather stations located in 26 countries.

1940

Robert C. Brumfield, PhD '43, has been named to coordinate one session of the hydroballistics seminar, sponsored jointly by the British Admiralty and the U. S. Navy Department, to be held in Teddington, England, next September. The session will be on "Underwater Propulsion and Hydrodynamic Noise." Bob has been head of the undersea warfare research division at the Naval Ordnance Test Station in Pasadena, but recently resigned to become an engineering research specialist at the North American Aviation Corporation.

Keith Anderson is working in ground water projects in connection with the Bureau of Reclamation at Boise, Idaho. The Andersons made a short Christmas visit to California last year.

1941

Russall L. Biddle, PhD, who lives in Teaneck, New Jersey, reports that he was recently reelected to the Board of Education there for another three years. Great interest was shown in the election due to a proposed $3,000,000 building program which was passed by a 2-1 vote. Russall has also been made a member of the Bergen County Federation of Boards of Education.

1943

Frederick W. Bollinger, MS, writes that he's enjoying life in a new home in Rahway, New Jersey, and has a new eight-month-old son named Bruce (his brothers are 6 and 3) He is still senior chemist for Merck and Company, Inc. in Rahway. Fred has been assigned to the U. S. Air Force standby reserve, along with *Loren W. Crow* '42, and *Clarence E. Erickson* '42.

Peter Dehlinger, MS., PhD '50, is in charge of theoretical and interpretive geophysical research for the Continental Oil Company, and has been living in Ponca City, Oklahoma, since August '53. Their two children think Ponca City is wonderful, and the Dehlingers all "enjoy being even this far west—considerably closer to the Rocky Mountains than our previous home in Columbus, Ohio." Last summer they vacationed in Yellowstone Park, and

look forward to many more vacations in that area.

John R. Spencer has been promoted to assistant chief reservoir engineer for the Continental Oil Company in Ponca City, Oklahoma. John has been with Conoco since 1951. Prior to joining the company, he was assistant professor of geology at the University of Texas.

W. Lawson Jones married Janet Schrack on December 12. She is a graduate of the California College of Arts and Crafts in Oakland and is a practicing artist, having had several one-man shows. Lawson is technical copy supervisor for Walther-Boland Associates in San Francisco.

1944

W. M. Swanson, MS '48, says he's still at the Case Institute of Technology in Cleveland—and still wishing he were back in California.

Clifford Oliver, MS, operates a public accounting business of his own, and is also office manager and accountant for the Campbell Housfeld Company in Harrison, Ohio. He and his wife and two children (six-year-old daughter and four-year-old son) live in Cheviot, Ohio, where Cliff is president of the Junior Chamber of Commerce.

David R. Jones is a research engineer for the California Research Corporation in San Francisco. He reports two more children since his last news item in *E&S,* making a total of five—a boy 8½, a boy 7, a girl 3½, another girl 2 and a girl 8 months. Dave and his wife visited the campus recently, on their way to Palm Springs for a short vacation.

1946

Lawrence D. Hindall, MS, PhD '49, according to a brief report which reached the alumni office, died of a heart attack on February 4. He lived in Santa Barbara, where he was employed in a research center.

Lt. Cdr. William C. Wilburn, MS, Engr. '47, writes that he is still in the regular Navy, currently at Wright Field in Dayton, Ohio, doing liaison work with the Air Force. He is also in charge of administering contracts in connection with Navy aircraft development in the Mid-West. The Wilburns have three children.

James W. Glanville, MS, CE '48, has been a petroleum engineer with the Humble Oil Refining Company in Houston since 1948. Jim is married to Nancy Hart, a 1949 graduate of Scripps College.

1948

Bruce A. Worcester has moved from Dayton, Ohio—where he represented the Hughes Aircraft Company—to Pacific Palisades, Calif. He's now working for Litton Industries.

Paul Fullerton is with the Southwestern Computing Service in Tulsa, Oklahoma. He and Charles Oliphant, also of Tulsa, described their new method of correlating stratigraphic sections by using punch-card calculating machines at the Tulsa Geological Society meeting recently. Paul worked with analog computers in the first control apparatus used by the Air Force in the last war, and has also done work in electrical engineering at Syracuse University.

1949

William R. Muehlberger, PhD '54, completed the requirements for his doctorate—to be awarded this June—then packed up his family and belongings and moved deep in the heart of Texas, to Austin. Bill's an assistant professor of geology at the University of Texas, principally teach-

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North American Aviation, designers and builders of the world-famous F-86 *Sabre* Jet and the new ***F-100 Super Sabre***, needs engineers with vision and imagination . . . men with a solid technical foundation who will be ready to help design and build the better *aircraft of tomorrow*. Other fascinating careers are also open in North American's guided missile, jet, rocket, electronic and atomic energy programs. Projects that are years ahead to keep America's security strong.

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organization, facilities and experience keep **North American Aviation** years ahead

in aircraft . . . guided missiles . . . electronics . . . atomic energy . . . research and development ing structural geology as well as a section of the freshman beginning course. He writes that people there complain about a few days of dust from West Texas and the rest of the Dust Bowl—but says they haven't seen anything until they've lived with SMOG.

1950

Carel Otte, MS, PhD '54, has a job with the Research Division of the Pure Oil Company in Crystal Lake, Illinois. Before starting work, Carel and his wife. Mary, visited his family in Holland and travelled through Europe.

Milner D. Quigley, Engr., is a geological and geophysical engineer with the Sinclair Research Laboratory, Inc. in Tulsa, Oklahoma. He transferred there from the Sinclair Oil and Gas Company in May, 1952. His work involves the study of new and at present unorthodox methods of geological and geophysical exploration. The Quigleys' family has now increased to three: Gary 9, Karen 7, and Dale 1½.

1951

Ray D. Bowerman, MS '52, married Barbara Ann Huff on January 23 in Arcadia. Barbara is a senior at the Huntington Memorial Hospital School of Nursing, and Ray works at Caltech as a research engineer.

George I. Smith, MS, and Patsy Beckstead were married last October. G. I. has been working for the U. S. Geological Survey for the last few years.

1952

Lt. Col. William H. Wyatt, MS, is the detachment commander of the weather station at Kirtland Air Force Base in Albuquerque, New Mexico. The Wyatts plan to visit southern California this spring.

George H. Blount, MS, says their first child, Martha Marie, is now seven months old. George has just recently been made head of the USNAMTC wind tunnel instrumentation at Point Mugu, Calif. The Blounts are living in Camarillo.

1953

Robert H. Alexander, MS, is working for the Shell Oil Company in Ventura, Calif.

Robert Hunt, MS, is working for the California Company in New Orleans, La.

John L. Howell is doing geophysical work in San Antonio, Texas.

Eugene B. Muehlberger is a graduate student at the University of Kansas.

George P. Rigsby, PhD, is with the Snow, Ice & Permafrost Research Establishment in Wilmette, Illinois.

Donald K. Norris, PhD, is working for the Canadian Department of Mines in Coleman, Alberta, Canada.

John D. Gee was drafted last October, spent eight weeks training at Fort Bliss, Texas, and is now serving as instructor in one of the Corps of Engineers Schools at Fort Belvoir, Virginia. John says Washington, D.C., is a great town and over-all duty there is fairly pleasant. He's still single.

John C. Wilson is a graduate assistant at the University of Kansas.

Henry Sturtevant is in the Army, stationed at Fort Ord, Calif.

Robert J. Stanton spent last summer in Venezuela working for Socony-Vacuum. He is now married and studying at Harvard on a National Science Foundation Fellowship.

Thomas R. Slodowski is a graduate assistant in geology at Princeton University.

Theodore D. Sheldon is a geologist with the Seaboard Oil Company of Delaware, in Los Angeles.

Robert H. Morrison, MS., is working for the Shell Oil Company in Albuquerque, New Mexico.

SEVENTEENTH ANNUAL ALUMNI SEMINAR - SATURDAY, APRIL 3, 1954

8:30-9:15 A.M.—REGISTRATION
Dabney Hall of the Humanities

MORNING PROGRAM

9:30-10:20 A.M.
Your choice of the following:

A. FALLING APPLES TO SPLITTING ATOMS

Thomas M. Smith, Assistant Professor of the History of Science

Five hundred years ago most educated people accepted the philosophical view that the earth was at the center of the universe and that all matter was constituted of four basic elements. Today, few people seriously question the Newtonian view of the world established by science. Professor Smith will discuss the change in view that occurred and ask how final it is.

B. ANALOGING THE EARTHQUAKE

George W. Housner, '34, Professor of Civil Engineering and Applied Mechanics

The use of computers continues its growth in the engineering field with an interesting application in studying the effects of earthquakes. Replacing the costly and unreliable results obtained by shaking machines and models, the computer now makes it possible to evaluate a structure's motions under major earthquake conditions. The empirical equations developed and the range of application will be discussed from the structural designer's view.

10:20-10:50 A.M. COFFEE TIME
10:50-11:40 A.M.
Your choice of the following:

A. ALL FLESH IS GRASS

A. W. Galston, Associate Professor of Biology

The green plant stands between man and oblivion because of its unique ability to store radiant energy released in the sun's thermonuclear conversion of hydrogen to helium. Our knowledge of the mechanisms of photosynthesis is increasing rapidly, providing hope that we shall one day, utilizing artificial photosynthetic devices, equal or even surpass the green plant's efficiency. Dr. Galston will discuss current developments in this field.

B. THE WHYS OF TRANSISTORS

William Shockley '32, Visiting Professor of Physics, Co-Supervisor, Solid State Physics Group, Bell Telephone Laboratories

Certain electron characteristics of semi-conductors have led to the development of the modern point-contact transistor. The effectiveness of these transistors depends upon minute concentrations of controlled imperfections in otherwise perfect crystals. Dr. Shockley will discuss the present status of transistor development.

11:55 A.M.-12:45 P.M.
Your choice of the following:

A. EUROPE LOOKS EAST AND WEST

George K. Tanham, Assistant Professor of History

The attitudes of Western Europe toward the U. S. and the U.S.S.R. are chief concerns to the Free World. Many viewpoints have been expressed on this subject, but none are more interesting or provocative than those reported from "first-hand" information. Dr. Tanham has made three extensive tours of Western Europe—the first with General Patton's Armored Division during World War II; the second on a Belgian-American Foundation scholarship; and the third on a Ford Foundation scholarship last year.

B. MOLECULAR DISEASES

Linus Pauling, '25, Chairman, Division of Chemistry and Chemical Engineering

Dr. Pauling and his coworkers have recently discovered that malformed protein molecules are the cause of certain types of hereditary anemia. He will discuss the present knowledge of the nature of the abnormal molecules and the molecular diseases, as well as the electrophoretic and other techniques used in the work.

1:00-2:00 P.M. LUNCH—STUDENT HOUSES

AFTERNOON PROGRAM

2:30-3:20 P.M.
Your choice of the following:

A. THE SELECTION AND PURCHASE OF GEM STONES or What to do Until the Appraiser Arrives

Richard H. Jahns, '35, Professor of Geology

What makes a gem valuable? Is the price an index of its true worth? Is it "the real thing," or is it glass or some other substitute? Is it natural, synthetic, or "reconstituted"? These and other questions will be discussed by Dr. Jahns, who also will describe the conditions under which crystals of gem quality are formed in nature or in the laboratory.

B. ODDITY TO QUANTITY

William H. Corcoran, '41, Associate Professor of Chemical Engineering

Plasma extenders, or less accurately, blood substitutes, are of vital importance in war or peace. Today they have assumed major roles in planning against atomic disasters. Dextran is one of the plasma extenders in a group including oxypolygelatin, polyvinylpyrollidone, and gelatin. Dr. Corcoran has had considerable experience in bringing the production of these substances into commercial quantity. He will show the contribution of the chemical engineer in this most important work.

3:30-4:20 P.M.
Your choice of the following:

A. DESERT FLOWERS

Fritz Went, Professor of Plant Physiology

It is difficult to realize that plants actually survive in the desert where existence is subjected to known terrific environmental change. Color slides will be shown depicting recognizable effects of variations in temperature, rainfall, and soil salinity on the amazing and colorful "belly" plants. Because these plants adapt themselves to sudden and severe changes so nicely and effectively, their life history provides a basis for discussing some problems of evolution.

B. SCIENCE OF CHOICE

H. Fredric Bohnenblust, Professor of Mathematics

"Operations Research" and the "Theory of Optimum Probability" are terms of growing familiarity in the engineering field. The progression of logistics from the simple theories of winning games or making maneuvers to a fascinating, complicated art has been achieved by the increasing use of mathematics. Dr. Bohnenblust will describe this progress and the mathematical tools used.

4:30-6:30 P.M.
Relax and meet your friends at the Elks Club, 400 West Colorado Street, Pasadena. The newly decorated dining room and bar are available.

EVENING PROGRAM

6:30 P.M.—DINNER
Elks Club—400 West Colorado Street, Pasadena
Dress—Informal for men and women

AFTER DINNER
Introductions—Gerald P. Foster, President, Alumni Association
Remarks by Dr. Lee A. DuBridge, President, California Institute of Technology

THE OBLIGATION OF THE NORMAL CITIZEN TO UNDERSTAND THE WORKINGS OF HIS GOVERNMENT

Dan Kimball, President, Aerojet General Corporation

Southern California is fortunate to have a resident and business executive who has dedicated a number of years of his career to governmental service. Mr. Kimball recently resigned his post as Secretary of Navy to devote all his time to industry. His observation of people's attitudes inside and outside government should prove thought-provoking to every "normal citizen."

William R. Parlett, Cornell '48, Sets Sights on Executive Sales Job

BILL PARLETT has learned that helpful engineering suggestions promote good customer relations.

"Within the next ten years", says William R. Parlett, young Worthington Sales Engineer, "many of the officers of the corporation, district office sales managers and top salesmen will be retired.

"Appreciating the fact that someone must fill these jobs, our management is striving to develop capable leadership among the younger men of the corporation.

"As a prospective Worthington Sales Engineer, I received several months of classroom instruction by works managers, top sales personnel and application engineers at all of the Worthington plants. The background I obtained was a sound basis for further development and learning gained in one of the product sales divisions and then in a district sales office. After obtaining sufficient product knowledge and sales training, I was ready to sell directly to industry. As more important sales assignments are available, I feel I will progress in proportion to my own development and sales performance.

"As a Worthington salesman I contact a class of trade with which it is a pleasure to do business. The company's reputation is a key to a welcome reception by my customers.

"I have found that with Worthington you have job satisfaction, adequate compensation, and unlimited opportunity."

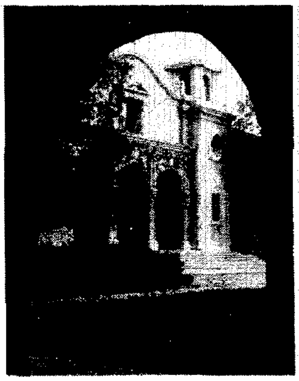
When you're thinking of a good job, think *high*—think *Worthington*.

3.6

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

WORTHINGTON

The Sign of Value Around the World



CALTECH CALENDAR

March, 1954

ALUMNI ACTIVITIES

March 16	Dinner Meeting
April 3	Alumni Seminar Day
June 9	Annual Meeting
June 26	Annual Picnic

ATHLETIC SCHEDULE

Baseball

March 12, 4:15 p.m.
LaVerne at Caltech

March 24, 1:00 p.m.
L.A. State at Crystal Springs

March 26, 3:00 p.m.
Caltech at Cal Poly (SD)

March 29, 3:00 p.m.
Caltech at Whittier

March 31, 4:15 p.m.
L.A. State at Caltech

April 3, 2:15 p.m.
Caltech at Redlands

April 7, 4:15 p.m.
Nazarenes at Caltech

Track

March 12, 4:00 p.m.
Occidental at Caltech

April 2, 4:00 p.m.
Whittier at Caltech

Tennis

March 13, 1:30 p.m.
Redlands at Caltech

April 3, 1:30 p.m.
Long Beach State at Long Beach

Swimming

March 12, 7:30 p.m.
Relays at Redlands

April 2, 4:00 p.m.
Caltech at Campton

April 6, 4:30 p.m.
East L.A.J.C. at Caltech

Golf

March 12, 1:30 p.m.
Glendale J.C. at Brookside

March 22, 1:30 p.m.
U.C.L.A. at Brentwood

April 2, 1:30 p.m.
Long Beach State at Meadowlark

DEMONSTRATION LECTURES

Friday Evenings

7:30 p.m. — 201 Bridge

March 12—"The Manufacture of Penicillin," by Professor W. H. Corcoran

April 2 — "Flood Prevention Through Better Vegetation," by Dr. Henry Hellmers.

April 9 — "Chromatographic Analysis of Natural Products," by Dr. Walter A. Schraeder.

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