ENGINEERING | AND | SCIENCE

October 1960

New Student Houses . . . page 29

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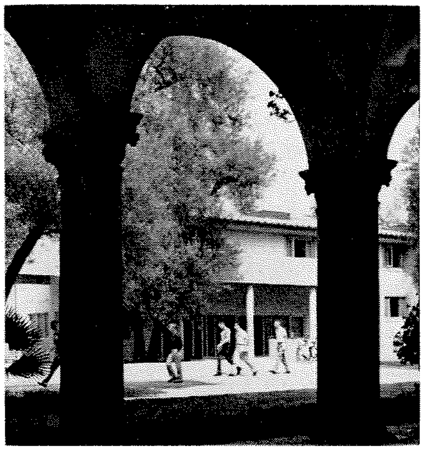
ENGINEERING AND SCIENCE

OCTOBER 1960 VOLUME XXIV NUMBER 1



On Our Cover

a view of the new Student Houses, across the Olive Walk from the old ones. On page 34 of this issue, a report on the dedication of the three new undergraduate Houses – Page, Lloyd, and Ruddock – on October 3. On page 29, a description of the Houses, and some notes on student life in these new quarters.

Norman H. Brooks,

assistant professor of civil engineering, took a five-month leave of absence from Caltech during the last academic year to teach at the Southeast Asia Treaty Organization's Graduate School of Engineering in Bangkok, Thailand, during its first year of operation. Dr. Brooks reports on this experience in his article on page 13.

Eberhardt Rechtin,

chief of the Telecommunications Division of the Jet Propulsion Laboratory, wrote "Who Says There's a Space Race?" for E&S last December. The question has changed now; Dr. Rechtin's article on page 18 – "What Are We Racing For?"

Dieter H. Sussdorf,

who describes some of his recent research in "The Appendix," on page 22, is a research fellow in chemistry at Caltech.

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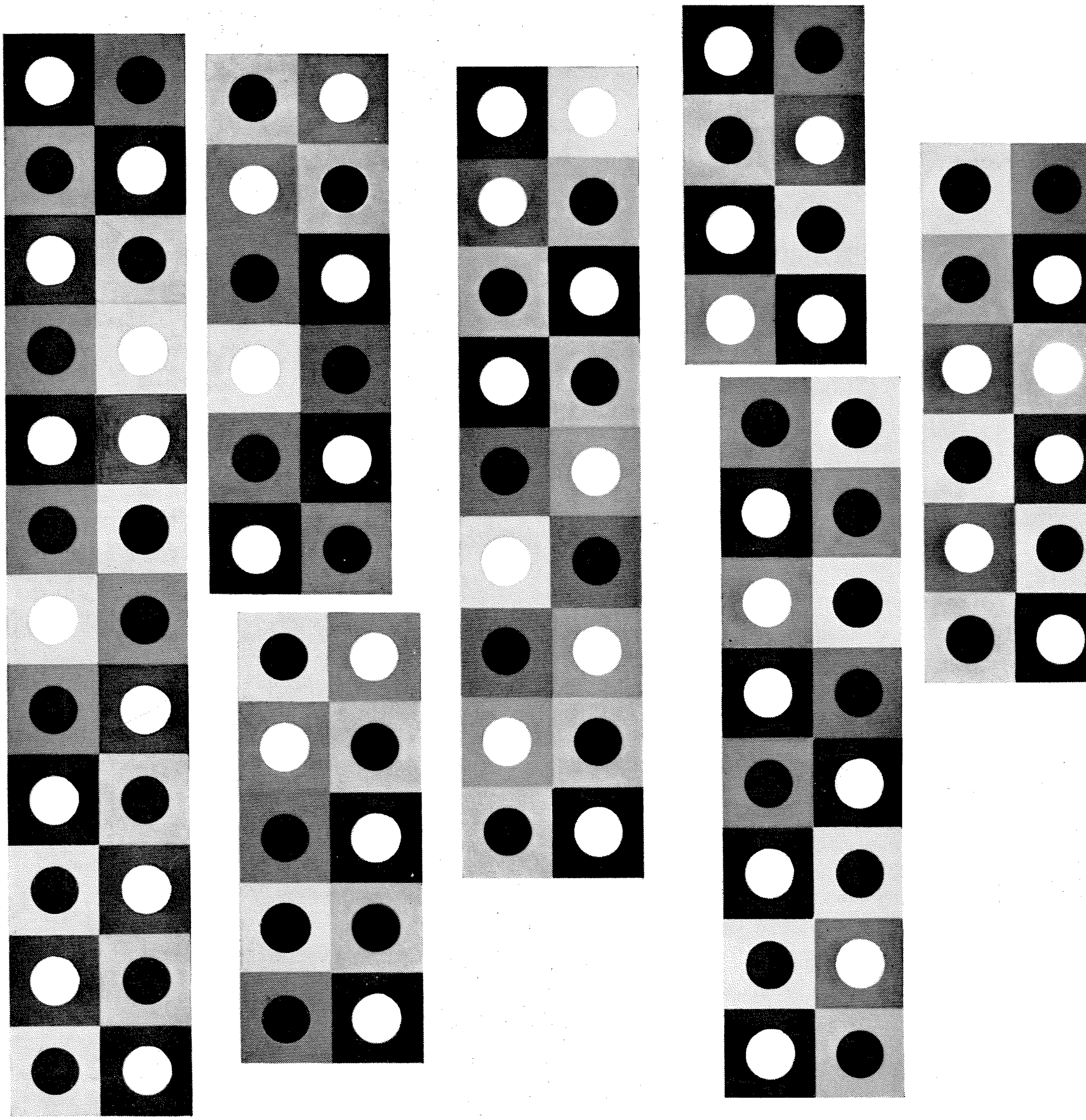
Things we know about tomorrow:



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Books

The Restless Atom

by Alfred Romer

Doubleday Anchor Books .... *$.95*

Reviewed by Paul S. Epstein, professor of theoretical physics, emeritus

The Restless Atom belongs to the Science Study Series published by the Physical Science Study Committee of Educational Services, Inc., whose main purpose is to provide collateral reading for the secondary school physics program now being developed by the committee. However, the level of presentation is aimed not only at the high school student, but also at the college undergraduate and the general public, by offering to them "the most stirring and fundamental topics of physics, from the smallest known particles to the whole universe."

In keeping with this objective, Romer's book is devoted to the discovery of radioactivity and the disentanglement of the laws of spontaneous transmutations of atoms during the 20 years from 1895 to 1915. The author succeeds in fulfilling the aims of the series since his presentation is accurate, but at the same time skillful and sufficiently lively to hold the interest of the reader.

The work described in the book was intimately interwoven with obtaining the definite proofs for the existence of atoms and elucidating their structure. The author even writes in his preface: "This is a book about the experiments by which we have gained one section of our knowledge of atoms and the way in which they behave." But if this was his primary aim it is hard to understand the omission of certain material which would have rounded out the subject of the book without appreciably adding to its bulk.

(1) More might have been said about the discovery of the electron, which was entirely independent of Roentgen's x-ray discovery although almost contemporaneous with it. Romer regards the x-rays as the beginning of modern physics, but the conception of the electrons was at least of equal importance. It is mentioned in the book that J. J. Thomson was the discoverer of the electrons but nothing is said about the circumstances.

(2) Of considerable value would have been some reference to the cloud chamber experiments of C. T. R. Wilson, making visible the tracks of electrons and x-particles. This was the most palpable and dramatic demonstration of the existence of elementary processes.

(3) The author justifiably writes a good deal about the periodic system of elements, but the culmination of its understanding in this period is unaccountably not sufficiently emphasized — namely the realization that it is the nuclear charge of the atom and not its weight that determines the position in the system. The Soddy-Fajans rule that led to it is mentioned, but the text seems to imply that nuclear charges and atomic weights lead to the same result.

A factual inaccuracy occurs on pages 32-33 where a figure and its long caption (entitled "Pierre Curie's Electrometer") purport to describe and illustrate Marie Curie's way of measuring radioactive intensities. In reality the method used by her and previously developed by her husband was materially different. Pierre Curie's electrometer, though a good instrument, was of the standard Kelvin type and was used by the Curies only as a zero device. The essence of the method was to balance the potential difference to be measured against a piezo-electric quartz crystal, which could be done in a rapid and precise way, the electrometer serving as yes-or-no indicator. Pierre Curie, jointly with his brother Jean, had established the Curie laws of piezo-electricity in a famous investigation for which they received a prize from the Academie des Sciences. The piezo-electric quartz instrument for accurately measuring small voltages was a by-product of this work. Its availability was one of the main reasons why Marie Curie undertook the investigation of radioactivity.

Also, in another connection, Romer's writing is less felicitous when it deals with the scientific background of early times remote from his own. On

continued on page 8

page 16 he makes the statement: "In 1896 not many physicists believed in atoms." On page 21 he amplifies it: "In spite of all the chemist knew, the physicist found very little about the atom that he could fix his mind on . . . It seemed necessary to leave it out of physics altogether, and what gets left out can hardly seem real."

The facts are otherwise: The kinetic theory of gases was founded in the late 1850's by Krönig and Clausius. By 1890 it had received a high development at the hands of Maxwell, Kirchhoff and Boltzmann, and could boast of spectacular successes in predicting the temperature independence of viscosity and the value of the ratio of specific heats, and in elucidating the nature of the entropy concept.

The atoms were no longer so elusive to physicists because the order of magnitude of their dimensions and absolute weights had been calculated from the data of viscosity and heat conduction. In the 1890's the standard physics courses in practically all universities contained some account of the kinetic theory. An important educational event was the posthumous publication of Kirchhoff's lectures on theoretical physics which was completed in 1894. After that, most universities provided an advanced treatment of kinetic theory either in connection with thermodynamics or as a special course.

Of the leading figures in physics only Planck had for a time some vaguely stated reservations, not so much against the atoms as against the statistical method; but on the whole the situation was that in the classroom and in the laboratory the physicists of the 1890's spoke of the atoms as of a scientific fact, although in their writings they thought it prudent to refer to them as a theory, or even a hypothesis.

This hedging was necessary because of a small but vocal group of philosophic hairsplitters who loved to bait the physicists by reminding them that they had no conclusive proof for the existence of the atom. Strangely, the center of this group of doubters was the famous chemist, Wilhelm Ostwald. Romer makes it appear that the custodians of atomism were the chemists, and perhaps they were, but Ostwald was an annoying exception. For a few years he was a source of great irritation to the physicists through his championship of this and other lost causes, in company with a few philosophers of the Machian school, until his contentions were disproved by the accumulating knowledge.

It must not be forgotten, however, that the older men – familiar with the early period through having lived and worked in it, or soon after it – did not write about its history. We must be thankful to Alfred Romer, who undertook this labor of love, even if his account contains a few unavoidable minor errors. Therefore, the present reviewer has no hesitation in warmly recommending to Caltech students this useful and interesting book, whose author is incidentally himself an alumnus (PhD '35) of our institution.

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Tobias Dantzig...on mathematicians

"The mathematician may be compared to a designer of garments, who is utterly oblivious of the creatures whom his garments may fit. To be sure, his art originated in the necessity for clothing such creatures, but this was long ago; to this day a shape will occasionally appear which will fit into the garment as if the garment had been made for it. Then there is no end of surprise and of delight!

"There have been quite a few such delightful surprises. The conic sections, invented in an attempt to solve the problem of doubling the altar of an oracle, ended by becoming the orbits followed by the planets in their courses about the sun. The imaginary magnitudes invented by Cardan and Bombelli describe in some strange way the characteristic features of alternating currents. The absolute differential calculus, which originated as a fantasy of Riemann, became the mathematical vehicle for the theory of Relativity. And the matrices which were a complete abstraction in the days of Cayley and Sylvester appear admirably adapted to the exotic situation exhibited by the quantum theory of the atom."

—Number, The Language of Science, 1930

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The Challenge of Technical Assistance

An experiment in what may be the most permanent and valuable aid we can give.

by Norman H. Brooks

For five months last winter I served as a temporary professor at the Southeast Asia Treaty Organization's Graduate School of Engineering in Bangkok, Thailand, during its first year of operation.

Though SEATO is primarily a mutual defense organization, it does encompass several educational and cultural activities, such as the graduate school. Contributions for financing the school have come from all of the SEATO countries in varying amounts, with the United States supplying by far the largest share. The government of Thailand is providing the land and the buildings on the campus of Chulalongkorn University plus several staff members and some services. The United States has been providing the majority of the faculty and much of the laboratory equipment and technical books. The United Kingdom, Australia, New Zealand, and France have all been making additional contributions in equipment, staff, books, and scholarship funds. In fact, considering the varied sources of support, it is an administrative masterpiece that the school was even able to get started.

The graduate school is open to students from any of the Southeast Asian countries — including those which are not members of SEATO, such as India and Burma. In the first year there were fifteen students from Thailand, two from the Philippines and one from East Pakistan — all SEATO countries. Because of the military activities of SEATO, the school has yet to establish its reputation as a nonpartisan, nonmilitary academic institution.

So far, only civil engineering subjects are being offered, because of the great need in Asia for civil engineers to work on the development of natural resources and the building of public works. As a modest beginning, in the first year only a hydraulic engineering program was offered; structural and highway engineering are being offered in the second year. Students can receive the Master's degree after two years of study including preparation of a thesis.

The American contribution comes through the International Cooperation Administration of the State Department. ICA, in turn, has a contract with Colorado State University for actually hiring professors and carrying out the program in Thailand. It was the enthusiasm of the director of this project, Dr. M. L. Albertson of CSU, which induced me to accept this challenge. The entire graduate school in Bangkok is under the capable administrative direction of Dean Thomas H. Evans (Caltech BS'29, MS'30) on leave from his post as Dean of Engineering at Colorado State.

While I was there, the faculty was comprised of five Americans, three Thai, and one New Zealander. All of the other Americans are there on two-year assignments, but because of other commitments I could stay for only one semester. Eventually, the school should develop a permanent nucleus of Asian professors to carry on the year-to-year administration and teaching. Americans and other foreigners on temporary assignments could then assist in advanced subjects and research, in support of the permanent faculty.

Since the University cannot be run with temporary professors from the outside indefinitely, the development of a native staff is essential. Toward this end, several of the best students are being sent abroad for advanced work leading to PhD degrees in the United States, England, and France with the hope that they may become professors. It was disappointing to me not to have a Thai or Asian counterpart, (i.e. a professor in hydraulic engineering), but there was simply no one available last year with suitable qualifications to teach graduate work in this field at the school.

As with many technical assistance projects, the planning for this one was overoptimistic in its objectives. In arranging the curricula and in hiring men to teach the courses there was too much emphasis on specialties and applications. It was assumed that the students were well versed in the fundamentals of such subjects as mathematics and fluid mechanics.

Although these courses were listed on the students' undergraduate transcripts, after teaching began it was found that the students had a very poor grasp of fundamental concepts and operations. For example, they did not know how to use logarithmic graph paper; some were even using long-hand multiplication and division because they were not confident in the use of a slide rule.

Although I was engaged to teach two courses (Flow in Open Channels, and Sedimentation and Erosion Control) my instruction actually had to include a good deal of preparatory material in fluid mechanics and mathematics. But, with the small group of students all enrolled in the same four courses, we were able to keep the curriculum flexible— practically on a week-to-week basis – in order to adjust to the students' strengths and weaknesses.

Analyzing and reasoning

The main weakness of the students was in analyzing or reasoning for themselves. In Thailand, general cultural attitudes are not conducive to developing scholars. To a Thai, respect for one's elders is even more important than seeking the truth. Consequently, in the schools and universities the students are taught implicitly to learn what they are told, and are discouraged from asking questions or being inquisitive. (By contrast, Caltech students seem to be especially challenged to detect errors in their professors' lectures!)

The Thai learn mainly by memory and do not become accustomed to determining what is correct from a logical point of view. The very deep respect of Asian students for their professors is best illustrated when one asks a student whether he understands something explained to him. He will almost surely reply, "Oh, yes sir, yes sir." What this really means is that he is grateful to you for explaining it and respects your ability, and if he doesn't understand, because of his shortcomings, he does not wish to embarrass you by saying so!

A student, given a general problem to do, without any explicit instructions, may feel lost; it is a new experience for him to try to understand and analyze by himself. Since my students felt it extremely important to submit all their homework problems (and thus please the professor) they were prone to excessive collaboration. One or two of the bright students often prescribed the procedure for the slower students, so there were students who submitted nearly perfect homework papers time after time, and yet failed miserably on the quizzes.

Sometimes when I would ask a small explicit question in a quiz, which required an answer of just a few lines, the students would open the valves wide on that subject and give me a facsimile of several lectures from their notes, to be sure to cover the point which I had asked! As a student said to one of my colleagues after a frustrating experience with an American-type quiz, "I really know all this material, but I got mixed up on the quiz because I don't understand it."

English was also a problem for many of them. They had studied it in secondary school and college, but usually with Thai teachers who had not acquired facility in listening, speaking, and using the English idiom. The lectures were all given in English, although I did study the native Thai language for conversational purposes and sometimes used a few Thai phrases in class to emphasize a point (or at least provide comic relief). At first the students were very reluctant to ask questions in class, but later overcame their shyness when they were assured that I wanted questions.

It also became clear that the students were not accustomed to using books or the library. On several occasions when I gave assignments that required looking things up in the library, two or three of the students would make the necessary library exploration and then report back to the other students what they needed to know to finish their work.

Always please the professor

In spite of one's best efforts, the pleasing of the professor still seems to be a stronger habit than the seeking of truth. Once while I was conducting a seminar with five of the best students in the class, the brightest student gave a completely illogical explanation of a certain problem. After he had finished his blackboard derivation, I asked the other students if they all understood the solution, without implying that I myself would reject it. There was a vigorous nodding of heads and looks of satisfaction all around the table, as they eagerly thought they were agreeing with me. I hope they will not soon forget the shock of discovering that they were all wrong.

In spite of their difficulties, however, the students were consistently diligent and cheerful, and many made remarkably good progress during the semester. I have never known such an enthusiastic, congenial, or respectful class. For instance, a few days before I left, at a tea party in my honor, they presented me with a beautiful engraved silver plaque showing the coat-of-arms of the school, my name, and an inscription.

Because of the eagerness of the U.S. and the Colorado State University to develop an outstanding graduate school of engineering, a great deal of money has been spent on laboratory equipment, principally in the field of hydraulics and fluid mechanics. As often happens, much of the equipment was designed and planned before the school was even started, and before a good determination of the needs of the school could be made.

The establishment of a new university laboratory is usually a slow process, with pieces of equipment being added from time to time as the staff decides what is wanted. However, for a technical assistance project there always seems to be a much greater rush to get started because the appropriation money comes only a year or two at a time.

Furthermore, in this case there has been an overemphasis on expensive laboratory equipment. Perhaps to visiting politicians equipment with the red, white, and blue American ICA seal looks more tangible than professors – upon whom it is not so easy to stick the seal. As a result, the hydraulics laboratory now being built with equipment specially designed and built in the U.K. and U.S. will be equipped far beyond the present capabilities of the students to make good use of it.

Ultimately the school may be a center of hydraulic research for Southeast Asia, but again the bottleneck will be in the training of the men and not in the availability of the equipment. Since only a few of the American staff know how to use the vast quantities of hydraulic laboratory equipment, it will take time to train the students, research workers, future Asian faculty members, and even the mechanics and technicians. As a matter of fact, the hydraulic laboratory at the SEATO Graduate School of Engineering will be far better equipped for student instruction than the hydraulic laboratory at Caltech.

There is one hazard in giving the Asian students too much elaborate laboratory equipment. Although it is important for them to have laboratory instruction, still nothing should take precedence over the learning of fundamentals. Furthermore, the students may not learn how to improvise, and later in their careers may not be able to get a job done without fancy instruments or black boxes. After all, it might be a good experience for Asian students to have to make something in the laboratory with baling wire instead of using American-made gadgets.

It is an excellent idea to have a center of advanced study in Thailand, because it keeps local problems clearly before the student during the course of his study and research. Traditionally, most Thai students have taken graduate study abroad, but somehow many of these young men fail to relate their advanced technical education to the basic practical problems at home. Illustrating this point, Ronald McLaughlin (Caltech MS'52, PhD '58) sanitary engineer in Bangkok for a two-year hitch for the World Health Organization, observes that several Thai men with Master's degrees in public health from the U.S. subconsciously do not really accept the germ theory of disease.

In Thailand, a country of 198,000 square miles (25 percent larger than California), 80 percent of the 22,000,000 people derive their livelihood directly from agriculture. Because there is less population pressure than in other Asian countries (about 110 persons per square mile compared with about 300 and 600 per square mile in India and Japan respectively), Thailand is able to export about 20 percent of her rice crop. Rice alone accounts for 50 percent of the value of all exports, with other agriculture products amounting to another 30 percent. Thus, the balance of trade and the ability of Thailand to import needed manufactured goods depends heavily on the agricultural output, which, in turn, depends on the availability of water.

Between the annual monsoon periods (May-October) there is a six-month dry season during which no

The Thai government built this fine classroom and office building to house the SEATO Graduate School of Engineering on the campus of Chulalongkorn University.

crops can grow without irrigation water. A typical rice paddy grows one crop during the wet season, with natural or controlled flooding from the rain-swollen rivers. But to deliver significant amounts of irrigation water through the canals in the dry season will require the building of large storage dams to hold back some of the flood waters.

One large project on the Ping River, the Yanhee Dam, currently under construction, not only will provide 8,000,000 acre-feet of water storage for irrigation in the fertile central plain (the "rice bowl") but will also generate 550,000 kilowatts of electricity for power-hungry Thailand which, at present, has only 200,000 kw of installed generating capacity in the whole country.

Development of water resources

It is clear that the benefits to be derived from comprehensive development of the huge rivers in Southeast Asia will be enormous for this region, and some of the technical problems involved will challenge the world's most competent hydraulic engineers. (Indeed, it is gratifying for a hydraulic engineer to work in a country where the prime minister is more concerned with how successful the rice crop will be this year than with hitting the moon!)

During my stay in Thailand I visited several hydraulic projects. A typical irrigation project consists of a low diversion dam (without appreciable storage) for diverting water into a system of earth canals when the natural river flow is adequate. In some projects I noticed gross errors in design, such as spillways discharging into alluvial channels without stilling basins. Because of the urgency of resource developments and the low national income, we should do all we can to help the Thai government avoid making such mistakes. But in one newly-completed project it was an American technical assistance expert who had laid out the faulty spillway, which is in real danger of failing under flood conditions unless rather drastic revisions are now undertaken. Not only can the Thai people not afford to make mistakes; the United States can afford even less to send over any but our very best engineers.

Students at the Graduate School of Engineering on a field trip in Thailand.

In addition to my field trips, I arranged some informal consultations with the Royal Irrigation Department, asking many questions for background information for my teaching and they, in turn, asked me questions. (For example, "How can we stabilize the royal bathing beach in front of the King's summer palace?") In the process I learned something of how an engineering organization works in Thailand. The engineers are all very status-conscious. In fact, the civil servants have definite ranks and often wear uniforms which clearly indicate their rank to one another.

If a committee meeting is called to decide something, it is silently ascertained who has the highest rank, and he is the one who decides. The Director-General of the Irrigation Department may solicit suggestions from his senior engineering staff, but somehow they always like his suggestions best. In such organizations, where the initiative and directives come from above, there is little opportunity for the young engineer to use his imagination and initiative; conversely, he takes little responsibility for his work because all decisions, big and small, are made at higher levels.

The practical approach

The engineers in Bangkok also seem to be reluctant to get out into the field. Because of social custom they shun dirty work even though it may be the way to get on with the job. For example, I inquired about the nature of the bed sediment of the large Chao Phya River which runs south through the heart of Thailand. The engineers in the Irrigation Department said they themselves were very interested to know, but that they did not have the proper type of sampling equipment to get a bed sample, and besides their survey parties were all busy in other places. So, the next time out on a field trip I wore my bathing suit, jumped overboard and scooped up a sample off the bottom in a jar. Not the very best sampling procedure, to be sure, but nonetheless there was a sample.

Thai engineers do not seem to have the ability to shortcut a lot of red tape, apply a little common sense and get the job done in a hurry. In fact, when American technical experts work with the Thai people they are often tempted to take over too much of the initiative because they don't have the patience to wait through innumerable delays and cross-checking. They forget that their role is only to assist, and not to take charge.

Since we can never hope to provide technical assistance on all kinds of projects indefinitely, education is perhaps the most permanent or valuable type of technical aid. Assistance in particular projects is certainly helpful in getting quick results but, in the long run, only by improving the education of the young men of today can there be better leadership and planning in building future engineering works.

In general, I believe it is extremely worthwhile for the United States to share its wealth and know-how with underdeveloped nations. It can promote lasting friendships, and increase the prosperity of the world as a whole, and lead to a more peaceful environment for everyone.

In 1958 about $20,000,000 worth of technical assistance per year was being granted to Thailand in a variety of projects in the areas of public health, education, agriculture, transportation, communications, water development, industry, mining, fisheries, power, and public administration. I do not like to think of technical assistance as simply an activity to contain communism, with the implication that were it not for the communist threat we would not bother to give technical assistance to the Asian countries. Nevertheless, this attitude was clearly stated by the ICA director in Thailand in a briefing session for the ICA staff, and is probably the official attitude of the State Department and Congress.

It is certainly not conducive to establishing permanent friendship, inasmuch as the receiving country is apt to feel that our aid is a tool of diplomacy given for some political advantage, and not through a sincere desire to assist the people of that country for their own sake. In fact, if a country wants to get the most aid dollars from the United States, it should probably manage to act slightly friendly to the U.S. but still behave as though it might espouse Communism next year or the year after!

I felt this attitude particularly when I visited South Viet Nam briefly on my return trip. The State Department, in its eagerness to pour technical assistance money into that country, has not taken sufficient care to see that the projects undertaken are worthwhile or well conceived. This is apt to result in second-rate accomplishments.

Aid from the World Bank

Because of the political implications of unilateral assistance, more effort should be made to channel technical assistance through agencies of the United Nations, including the World Bank. These agencies can ask probing technical questions and make numerous suggestions but, when no longer wanted, they can be asked to leave without political repercussions Like any other lending institution, the World Bank insists on reasonable investigations, planning, and methods of financing. If a government asks for a loan to build a dam (as in the case of Yanhee Dam) the World Bank will not grant the loan until it is convinced that a full engineering study has been made of the feasibility and desirability of the undertaking. In this way the local governments are forced to do their planning, but with outside assistance to indicate what planning is needed.

A good example of the excellent unbiased work of the World Bank is the recent comprehensive economic and social report of a mission it organized at the request of the government of Thailand – "A Public Development Program for Thailand," published by the Johns Hopkins Press in Baltimore, Md., 1959.

Although technical assistance is certainly worthwhile, I believe there are very definite limits to the amount which a small foreign country can absorb. The limitation exists in the administrative setup of the receiving country. Without the threat of undue foreign influence the United States can put in only as much assistance as the foreign government can plan for and accommodate with its available manpower and budget. In 1958, the ICA budget for Thailand was already about 5 percent of the total spending of the Thai government. Some technical assistance projects have been only partially successful because of adverse administrative arrangements.

At the Chulalongkorn University, for example, the efforts of the University of Texas in upgrading the engineering program were lost in default because the Dean of Engineering was not receptive to change. New, young, well-qualified faculty members who could have been inspired to serve the university simply were *not* inspired and did not stay. Much of the elaborate equipment sent to the university is not used because of the poor quality of the faculty in general. Clearly what is needed is a new Dean of Engineering, but this is something which cannot be accomplished through the American technical assistance program.

Technical assistance depends on people

Except for emergency measures like wheat to India, or public health measures in times of epidemic, I believe the emphasis in technical assistance should be on people. We do not necessarily need *more* personnel in foreign countries, but in some instances *better* personnel should be sent.

In my opinion some engineers employed by the State Department in responsible jobs could not hold equally responsible engineering jobs in this country because of inadequate qualifications. Technical assistance experts need not always be older men with years of experience, but can just as well be young men with imagination and adaptability, for many engineering problems cannot be solved by the same techniques used in the U.S. anyway.

In filling technical assistance posts, the State Department should not imply that the jobs are political chores to be done in disagreeable places; instead it should present such jobs as a challenge to our best qualified people to be of service to underdeveloped nations. I believe many outstanding engineers and scientists would accept such a challenge.

Six months ago the question was,

"Who says there's a race for space?"

Today it's,

What Are We Racing For?

by Eberhardt Rechtin

Our country is now engaged in an effort to go into space at a pace which was almost inconceivable only five years ago. We did not embark upon this course easily or without considerable controversy. We are not the only country so engaged. As a point of fact, it was the vigorous activity of the Soviet Union which prompted our own scale of activity and which has given the exploration of space most of the elements of a race.

Superficially, at least, you might give the present status of the race by saying that the Russians are definitely ahead in terms of the size of their payloads, and that the United States is definitely ahead in terms of the quality and quantity of information obtained from superior instrumentation. It is also fair to state that this particular race got off to a badly organized start. The two racers did not start at the same time. There is some question that the two racers are going in the same direction. The scientific merit of this whole demonstration is certainly not obvious. And we seem to have a few Generals on the racetrack as well.

If, six months ago, the question was, "Who says there's a space race?" then today the question might be, "What are we racing for?"

One of the remarkable things about human societies is that by the time a society is sufficiently well organized to plan everything ahead of time with complete knowledge of all its motivations, the society is on the way out. A dynamic society which is moving ahead generally embarks upon new ventures almost brashly, and leaves it to later historians (from Homer to Parkinson) to fill in all the reasons. If our present space race were mankind's first, then the reasons for running it might be difficult to find at this particular time. But this is by no means the first venture of its kind – and the motives for launching it are just about the same as they have always been.

One of the strongest motives is as a demonstration of a successful society. A successful society must have sufficient organization, purpose, skill, energy and assets even to start large projects and certainly to complete them. It is far more difficult to carry out a large and well organized program than it is to carry out a collection of smaller, independent programs. The societies which built the cities of ancient Crete, the Acropolis, the city of Rome, the magnificent churches of Europe, and the wonders of the Far East were certainly not weak and anarchistic.

If the elements of competition are also present, these projects are carried on with salesmanship and prestige in mind. We have had World's Fairs for thousands of years. Cities of medieval Europe built towers; the number and heights of the towers were an indication of the wealth of the city. Later, these cities built magnificent cathedrals. The sales and public relations aspects of such projects were tremendously important then, and are now, in acquiring a share of the world trade market.

For example, the recent Soviet successes in space have unquestionably affected the world market in their favor. The Russians are now selling more bridges and roads and electronic equipment and automobiles and surgical supplies to the world at large than they did before Sputnik I, even though the launching of Sputnik I had no more to do with these specific world market goods than the towers of Europe had to do with local trade. To the worldwide consumers, it seems readily apparent that a society that can launch the first satellite is certainly capable of building a good bridge.

There is often a memorial or a monumental aspect to these ventures as well – the recognition of forces that are stronger than the individual, such as religion, freedom, democracy, the church, the king, and the state. Khrushchev has been endeavoring to exploit this aspect of the situation by claiming that one of the strong underlying forces of the Russian space program is the philosophy of communism. He maintains that one of the reasons for the success of the venture is the 40 years of communist society which preceded the space program.

Channeling excess energy

One of the more surprising, but most compelling, reasons for programs from the building of the Acropolis to the space program is the need for channeling the excess energy of a society in a direction which will hold the society together rather than tear it apart. When Pericles was asked why he was proposing the construction of the temples on the Acropolis, he admitted that one of his strongest reasons was to provide an outlet for the energies of the youth of Athens as a way of minimizing juvenile delinquency! More recently, the late Louis Ridenour maintained that such seemingly wasteful projects as crash military programs and marginal space activities were a necessity in the United States because otherwise our excess productivity would immediately lead to a depression. It is for the same reason that our U.S. Department of Labor is viewing the years of 1965 to 1970 with some concern, because at that time there will be an enormous influx of raw labor caused by the post-World-War-II birthrate surge. Large projects have real value as at least a partial solution to channeling excess energy.

Although it is difficult to measure the exact value of large-scale memorial projects, there is little question of the economic and social benefits which they produce. These are above and beyond such practical benefits as aqueducts, highways, harbors, electronic components, and new military devices.

More than 100 years ago, Michael Faraday was demonstrating his electromagnetic equipment to a British government committee in the hope of obtaining government support. One member of the committee admitted he was fascinated but asked Faraday, "What practical benefits can we expect?"

"I can't answer that question," Faraday replied, "but I can tell you this: 100 years from now you will be taxing it."

These large-scale races or adventures or projects have strikingly similar characteristics, whether they occurred thousands of years B.C. or A.D. Generally speaking, these projects are undertaken in time of peace and are abandoned or interrupted by periods of war. Occasionally, a project is undertaken which is never successfully completed. The projects which fail before they start are generally lost to history. However, projects which have proceeded for quite some time before they were abandoned as unsuccessful, or were interrupted by war, or were destroyed by a succeeding society, are still known to us. The Tower of Babel and the Sacred Circle at Stonehenge, England, are examples. It would be interesting sometime to describe the collapse of the Tower of Babel project in social and union jurisdictional terms rather than in the religious terms of the Bible.

Regardless of the project, there seems to be a running fire of criticism throughout the project and often long after its completion. The criticism generally proposes smaller projects of limited participation and of more immediate need. The criticism by certain groups in Athens over Pericles' construction of the Acropolis sounds surprisingly like the criticism of elements in the United States over the NASA annual budget.

There have always been hundreds of people to maintain that, by spending only one percent of the budget of the large program on their own particular program, the relative benefits would presumably be greater. Curiously enough, there are seldom critics who would propose alternate programs of the same scale as the large program, with the single exception of advocates of national defense whose proposals almost invariably are an order of magnitude greater.

Adding uniqueness to practicality

Although these demonstrations of a successful society are strongly concentrated in the areas of engineering and technology, to be really successful they seem to need certain elements which are certainly beyond those needed for strictly functional or utilitarian purposes. We find palaces with magnificent landscaping. We find churches whose domes are far higher than are needed for air conditioning. Supporting columns are sculptured, ceilings are elaborately decorated, floors are inlaid. And yet, these often expensive departures from the ordinary are the things that are remembered by future generations and are the real distinguishing marks of a large-scale success.

These are the elements that are destroyed first by any radically different society which tries to replace the original society. These are also the elements that are continuously modified and improved by a continuation of the original society. It is this extraordinary element which is necessary to add uniqueness or identity to the program which excites the admiration and respect of the audience. A good modern example is that part of the generally practical space program which tries to place a man on the moon (and return him to the earth) — an effort whose immediate utilitarian value is certainly controversial at best.

In other words, we might answer the question of "What are we racing for?" by stating that we are racing for the same things which dynamic and successful societies have raced for from the beginning of history.

In the light of historical precedents, it is illuminating to attempt to answer some of the modern questions which have been asked about the space program. For example, we might question the size of the NASA budget, or the position of science in the space exploration program, or the value of the Mercury Program, or the presence of Generals on the racetrack.

The NASA budget, or even the total space program budget, including all military applications, is actually relatively small compared to similar projects in the past. The total space program budget is somewhat less than two billion dollars per year — which amounts to less than 0.4 of 1 percent of the energy and productivity of our country as described by our gross national product.

As another comparison, the present NASA budget of one billion dollars per year is less than 2½ percent of our annual defense budget. In comparison, societies in the past have customarily carried out large projects of far greater relative scope than this. Indeed, the space program, instead of being criticized, might well be commended for generating so much interest, enthusiasm, and prestige per dollar spent, in comparison with earlier projects.

Again on a comparative basis, we might predict that the space program can grow considerably if it can attract the same relative support that built the Palace of Knossos, the city of Rome, the cathedrals, and other monuments in the past.

The importance of science

So much for the size of the budget. Now let's consider the importance of science.

Despite the great interest of scientists in the space program, science is not, and cannot be, the driving force for space exploration. The reasons for this are quite fundamental. Advanced science is so abstract, and so little understood even to the scientist himself, that it makes very poor public relations and propaganda to people at large. Therefore, it is not reasonable to expect a ground swell of support for scientific projects just because they are scientific. Scientific exploration, by its very nature, is seldom successful more than 50 percent of the time and is often successful less than 10 to 15 percent of the time. Consequently, any scientific proposal is immediately subjected to alternate scientific proposals whose presumed success ratio might be higher. For this reason, scientific studies in space are often roundly criticized by scientists working in other fields, who maintain that, by spending even a small fraction of the money spent in the space program, they could obtain far greater results.

This criticism, as we have seen, is classical. The more general criticism, however — which might be paraphrased by the question, "Was it worth 150 million dollars to find out that the earth was not quite round?" or, "Was it worth 20 million dollars to discover the Van Allen belt?" — can certainly not be so easily dismissed. The answer to such questions is most simply given by declaring that the purpose of such programs is *not* scientific but rather political, economic, social, and psychological.

If we *must* assign costs, we should therefore start by assigning costs to these requirements of the program first. In so doing we find that the net cost of performing a scientific experiment is actually quite small. It is no more correct to bill the scientific experimenters in the space program for space technology than it is to bill the oceanographer for the cost of advancing ocean technology by finding the best hydrodynamic shape for a submarine. Indeed, the use of scientific merit as a major criterion in evaluating space programs yields such patently peculiar answers that the criterion itself *must* be incorrect.

Quite obviously, there must be less expensive ways of discovering the Van Allen belt and discovering that the earth is pear-shaped than the way which was actually used. Since these experiments were done by satellites, and since there is every prospect that further experiments will be carried out, the answer must lie in the fact that there are considerably more returns to the space program than just the scientific results.

Technological development comes first

Also, it is true of science that no great discoveries are made until the technology is ready for them. The underlying principles of physics have presumably always been the same, and yet the discovery of the motions of the solar system had to await the development of the telescope, and the formulation of the laws of electromagnetism had to await the development of simple electrical components. At the present time, the amount of science which can be accomplished in space must await the launching of larger and larger payloads, better and better communications, guidance, control, and so forth. By any comparison which we would wish to make, the expense of developing technology far outshadows the cost of the novel scientific experiment.

One further feature of science precludes its being used as the driving force for the space program. The value of scientific results is very seldom known at the time of discovery and, unfortunately, there is no theorem which states that all scientific discoveries will be valuable. It is difficult to gain immediate support when the value of scientific results is determined ten to a hundred years later.

It is characteristic of efforts such as the space program that they represent technological achievements of considerable magnitude. Virtually by definition, therefore, the efforts and cost are largely devoted to technological advancement.

To the technologist there will always be high value in reaching the moon or the planets or the stars, even if there were too little weight allowance to permit any scientific measurements to be made the first time.

Using science as a criterion is an excellent way of producing a wrong answer to the question of the value of the Mercury Program. It is evident to most people, including most of the people in the Mercury Program, that the purely scientific value of that program is zero.

As a matter of fact, one quick way of distinguishing between a space scientist and a space technologist is to ask the individual in question what he thinks of the Mercury Program. The scientist will invariably say that it is a terrible program. The technologist will almost always state that this program is advancing technology as rapidly as it possibly can and that, as such, it is a valuable and worthwhile program.

Generals on the racetrack

We now come to the question of Generals on the racetrack. Again, on a comparative basis, we can see that in the past there have been programs with Generals present and those with Generals absent. The presence or absence of the Generals per se seems to be less correlated with success or failure than with the prevailing conditions at the time. If the nation is strongly concerned with national defense and security, it will have mobilized a fair amount of its national effort along those lines for some time. The military arts, including military science and engineering, will be strongly developed and will attract some of the finest brains in the country. Under these circumstances, we find that the military technologist is not only present, he is extremely valuable.

From past history, the Generals on the racetrack are dangerous only when they attempt to convert a peaceful activity into an instrument of war and are foolish only when they try to justify advancing technology solely on the basis of military requirements.

As you may have gathered, I believe that the space program is inherently a good idea and that, after the difficult start, both the civilian and the military programs are proceeding in a generally worthwhile direction. Whether we are proceeding at a great enough pace is another question altogether. The answer to this question lies in a comparison with the Soviet Union. In this kind of a race, it does not pay to be a poor second — and never has paid. It is not always necessary to be markedly out in front, but it helps.

It would be foolish of us to maintain that the Soviet Union is not presently the pace setter. We would seriously underestimate the Soviet Union if we were to assume that the United States could put a man in space first, for example. We are probably three to five years behind the Russians in those aspects of space technology which depend upon large chemical propulsion units. These aspects, unfortunately, control the size of the launching booster.

On the other hand, the prediction of the future may be surprisingly bright for the United States. The United States has often been compared unfavorably to other countries in terms of our generation of science; but it has never been unfavorably compared with any other nation in its astonishing ability in technology. Inasmuch as the space race is a demonstration of technology, the United States has available to it basic assets which no other country, including the Soviet Union, can claim.

Whether or not these assets will be applied efficiently to the space program is again a separate question. One measure of the assets which are applied to the space program is the size of the budget. If the United States were to apply the same relative effort in the space program that the Soviets apply in theirs, the United States would unquestionably surpass the Soviet Union in less than ten years, even giving the Russians a lead-time of five years. We are not, at the present, putting forth this effort, although we are putting forth enough effort that the gap will close slowly.

One encouraging aspect of most races is that the initial pace setter does not necessarily win the race. Instead, the successful winner is often the racer who has mastered the art of being second when it is not so important, and then being first at the final payoff. This is a *real* art. It involves crowding the pace setter in such a way that the pace setter will begin to make mistakes and will begin to feel the pressure.

Crowding the pace setter

For example, the recent U.S. technological successes in the space race seem to be crowding the Russians in a way which hurts. There is slowly mounting evidence that the Russian space shots are now no longer invariably successful. There certainly have been missed opportunities, long periods without successful launchings, and occasionally evidences of incomplete engineering. The Russian pictures of the back side of the moon were surprisingly poor considering the payload weight available. The engineering deficiency seems to have been in the communication link, an area in which the U.S. has done particularly well. Recently their propagandists had to virtually republish an older achievement of sending animals up to 120 miles.

Needless to say, the advantages of being second are only temporary.

Six months ago there was some question as to whether or not we were in a space race. We now know that we *are* in a space race and that it is likely to be a fairly long one. We are not racing purely for science. We are racing to demonstrate that we are a successful and dynamic society. We are racing for the prestige necessary in a purely economic world market situation. We are racing as one method of channeling our excess energy and productivity, and for such side benefits as may result. We are racing to demonstrate that democracy is every bit as good as, if not far superior to, communism; and at times we are racing out of the sheer joy and exuberance that has long been characteristic of a proud and capable people engaged in a pursuit of happiness.

by Dieter H. Sussdorf

The Appendix — New Facts About a Lowly Organ

Most people consider the appendix an obsolete, utterly useless organ. It can, however, be an interesting research subject for the immunologist. And — in certain animals, at least — it may even serve some physiological purpose.

Our research on the appendix did not begin with an experiment solely devoted to this organ. It began with an evaluation of the importance of various organs in antibody formation — a process which insures the defense of the body against the attacks of many microorganisms. Antibodies are proteins which are made by certain cells in certain organs in response to the introduction of foreign substances called antigens into the body. Antibodies have the capacity to combine with the antigens which stimulated their manufacture. Since invading microorganisms are made up of, and produce, substances foreign to the animal they attack, the antigen-antibody combination may result in the destruction of the bacterial cell, and in rendering harmless such bacterial products as toxins.

Where in the body are antibodies made? It has been known for many years that organs involved in this process are rich in lymphatic tissue — a tissue capable of producing a species of white blood cells, the lymphocytes. Organs of major interest in this group have been the lymph nodes and the spleen. Another organ that has been implicated is the liver. Although it contains only a relatively small amount of lymphatic tissue, it is very active in the synthesis of certain blood proteins.

One way to study the importance of these organs in antibody production is to remove them surgically from an experimental animal, either singly or in various combinations. After surgery, the animals are injected with a foreign protein. The amount of antibody formed in response to this injection is followed over a period of time. If a surgically removed organ is significantly involved in the manufacture of antibodies, the antibody response should be depressed.

A second method of study is based on the use of X rays. Because lymphatic tissue is more susceptible to the destructive effects of this radiation than are most other tissues, an animal's antibody response can

Obsolete? Useless? Not to the immunologist, who has found the appendix to be a particularly interesting research subject.

be greatly delayed and depressed by exposing its body to X rays. If, howver, an organ involved in antibody formation is protected with a lead shield during irradiation, antibody levels should be higher than in unprotected animals.

Experiment I

The first of this series of experiments was begun by the author and Dr. Laurence R. Draper at the University of Chicago, under the sponsorship of the U.S. Atomic Energy Commission. The work was then continued at the Argonne National Laboratory and completed at Caltech in the laboratory of Dr. Dan Campbell, professor of immunochemistry.

Our work on the appendix began when we became interested in organs supposedly involved in antibody synthesis. However, an additional interest existed. Since the end of World War II there has been an intense research effort concerned with the effects of atomic radiations on the mammalian body, and with the protection of radiation-exposed animals against these effects. The immunologist's interest in radiation research derives from the fact that one cause of radiation death is the breakdown of the body's defense system against infection, and the resulting invasion of the body by bacteria – especially those residing in the intestinal tract.

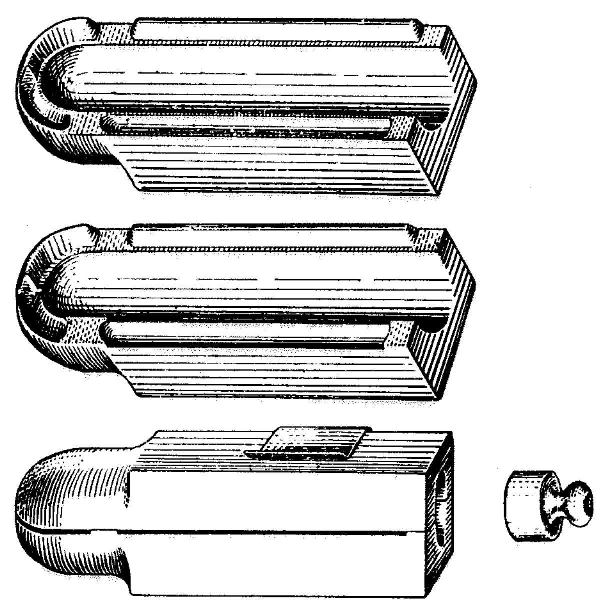
By designing an experiment which involved the shielding of antibody-forming organs of an experimental animal during x irradiation, we hoped to obtain information on both problems: that of the importance of the organ studied as an antibody former, and that of the protection of the immune system against radiation effects.

For our study, we decided on the rabbit as the experimental animal, and we selected the spleen, the appendix, and the liver as the organs to be investigated.

In the rabbit, the spleen is a dark red organ, about 1½ inches long and ¼ inch thick, located near the stomach. It consists of two major tissue components which are present in about equal amounts: the "white pulp" which is strictly lymphatic tissue, and the blood-storing "red pulp." The appendix (more accurately, the *vermiform* appendix) is the end portion of a blind intestinal pouch located at the juncture of the small and large intestines. The rabbit appendix is about 3 inches long and 1/3 inch thick, and its wall is very rich in lymphatic tissue similar to that found in the tonsils. The rabbit appendix is approximately the same size as the human appendix – which means that the appendix in an adult rabbit is relatively about 30 times larger than in an adult man. This enormous difference in relative size does not justify a direct application of our experimental findings to man.

In order to protect the organs of interest to us during irradiation, special lead shields had to be designed and manufactured. They had to meet three major requirements; (1) they should cover the organ only and no other part of the body, (2) they should provide an opening for the blood vessels attached to the organ, and (3) they should be free of any X ray leaks. The lead shield used to protect the spleen or appendix is shown below. The shield consisted of two halves which, when joined, were held together by a steel clamp. The spleen or appendix rested in the hollow center of the shield, while the blood vessels passed freely through a baffle on its side. The open end of the shield, which allowed for the passage of the intestine in the case of appendix shielding, was closed with a lead plug when the spleen was protected.

Because of the anatomy of the liver and the shield requirements we had set forth, we were unable to



The lead shield used to protect the spleen or appendix of the rabbit during x-irradiation.

design a shield which could accommodate the whole liver. The final version of this shield was, in principle, similar to that for the spleen and appendix, except that it was much larger and contained only about ¾ of the liver.

The rabbits were divided into five series. Each one of three series was x irradiated with one of the three organs shielded. The fourth series was totally irradiated (no shield was applied during irradiation) and the fifth series remained unirradiated. The shielding of an organ involved giving the animal an anesthetic, making an incision, applying the shield to the organ, and placing the anesthetized animal under the X ray beam. After irradiation, the shield was removed and the incision closed. The X ray dose was 500 roentgens, a dose which causes a marked delay and depression of antibody formation in the unprotected rabbit. If the animal survives, the antibody-producing mechanism requires about four weeks to recover.

On the day following irradiation, our rabbits were injected intravenously with an antigen, red blood cells of the sheep. The antibodies formed against these cells have the capacity to lyse them, i.e., to cause the release of hemoglobin from the cell interior. Therefore, in order to measure the concentration of antibody in a sample of blood taken from one of the injected rabbits, we determine how much serum is required to lyse a known number of sheep red cells. The smaller the amount of serum required, the greater is the antibody content of the blood sample.

A surprising observation

We made a surprising observation upon examination of our experimental data. Shielding the spleen or liver during irradiation resulted in an antibody response about halfway between that of the totally irradiated and the unirradiated rabbits (indicating about 50 percent protection). However, the response was practically normal in the appendix-shielded animals (indicating almost complete protection).

This finding was unexpected because the spleen has always been considered a major site of antibody production when the antigen is introduced via the intravenous route, while no contribution of the appendix could be demonstrated. These conclusions are based on experiments in which the spleen or appendix was removed surgically before the injection of antigen. If the spleen is absent, antibody production is greatly delayed and depressed. If the appendix is removed, antibody formation remains unaffected. Thus, an apparent paradox had to be resolved: although the appendix does not seem to participate in the antibody response, shielding the organ during irradiation results in almost complete protection of the response. If we assume that the spleen is the most important antibody contributor and that the recovery of the antibody-producing mechanism in an x irradiated rabbit is related to the recovery of this organ, the following question arises: Could, in some way, the shielded appendix accelerate the recovery of the spleen from radiation damage?

Experiment II

The question of the effect of the appendix on the recovery of the spleen immediately suggested a second experiment. We would have to study the changes in that tissue component of the spleen which is most likely associated with antibody production. We learned earlier that this component is the white pulp. If we assume that, within certain limits, the amount of white pulp in the spleen is related to the organ's antibody-producing capacity, we could follow the changes in this capacity by measuring the amount of white pulp at intervals after irradiation.

Experimentally, this approach required first the preparation of an appendix-shielded and a totally irradiated series of rabbits as outlined in Experiment I. Then, at intervals after irradiation covering a period of up to 67 days, the spleens were removed from groups of 3 to 4 animals in each series. The organs were cut into sections, mounted on glass slides and stained. With the aid of a projector, an enlarged image of the spleen was projected on paper, on which the outline of the spleen and of the areas representing the white pulp were traced. From the proportional sizes of these areas, the amount of white pulp could then be calculated.

The recovery curves we obtained for the splenic white pulp confirmed our earlier supposition: the antibody-producing tissue in the spleen regenerated much faster in the appendix-shielded than in the unprotected animal. Until about the fourth day after irradiation, the white pulp virtually disappeared in both series of rabbits. From then on, differences between the recovery rates became apparent. While we did not find normal amounts of white pulp in the totally irradiated animals until 23 days after irradiation, normal amounts were already present on the 8th day in the appendix-protected rabbits. Apparently, the shielded appendix caused the spleen to develop, in very short time, enough antibody-forming tissue to insure a virtually normal antibody response.

What was the nature of the effect of the appendix on the spleen? After having examined the spleens of the appendix-shielded rabbits microscopically, we began to believe that the lymphoid cells appearing in the spleen after the 4th day could not all have arisen locally, since very little cell division occurred in the organ at that time. The cells apparently came from somewhere else – perhaps from the appendix.

Experiment III

With our third experiment, we intended to examine the possibility that lymphoid cells from the shielded appendix repopulated the spleen, causing its accelerated recovery. To demonstrate this cell migration, it seemed essential to mark the cells of the appendix in some manner and to look for these cells in the spleen. Fortunately, a recent development in radiobiology provided the tools for this experiment.

By attaching a radioactive atom (tritium) to a substance (thymidine) which is used by the cell nucleus as a building block, a radioactive cell label can be made. Labeling of cells occurs within a few hours after the injection of the tritium-labeled thymidine, when all the cells engaged in the synthesis of nuclear material pick up the labeled compound and deposit it in the nucleus.

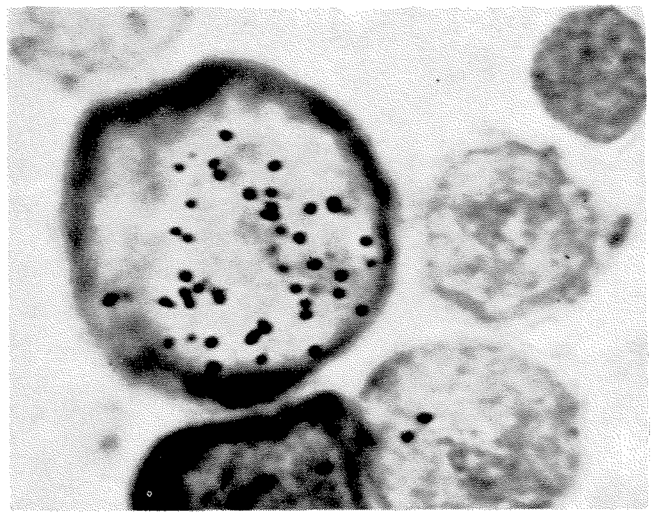
Detecting radioactive cells

We can detect these radioactive cells by preparing stained slides as we did for the spleen and covering the slides with photographic film. After about 6 weeks, the emulsion immediately above each labeled nucleus will have been exposed by the radioactive emission from the tritium. If the film is then developed (actually both the slide and the attached film are processed), and the slide examined under the microscope, tiny black dots can be seen overlying the nucleus of a labeled cell (right). This radioactive label represents a perfect marker since it remains with the cell until it dies. If the cell divides, each of its daughter cells receives ½ of the label. In this way, the label is diluted progressively until it becomes undetectable.

One major feature made this technique especially useful to us: the tritium-labeled thymidine is incorporated only by cells preparing for cell division. Since X rays inhibit the division of surviving cells, and since only the shielded appendix should contain an appreciable number of intact cells, most of the label, we hoped, would be taken up by the appendix.

This hope was borne out by our third experiment. Within a few hours after the injection of the labeled compound into a group of x irradiated, appendix-shielded rabbits, over 20 percent of the lymphoid cells of the appendix were labeled, while practically no such cells were found in the spleen. To make sure that among the lymphoid organs only the appendix contained a significant number of tagged cells, we also examined a lymph node. But here, too, no labeled cells were present.

Then our main expectation was realized. On the day following the first examination, labeled cells appeared in the spleen. A temporary decrease of the percentage of these cells occurred in the appendix at the same time. To us, these observations furnished a very good support for the repopulation hypothesis. The intact lymphoid cells in the appendix apparently left this organ shortly after irradiation, and implanted in those organs where lymphatic tissue was destroyed by the X rays. Once implanted, the cells began to proliferate, bridging over the time gap between X ray exposure and the return of the exposed but surviving cells to normal.



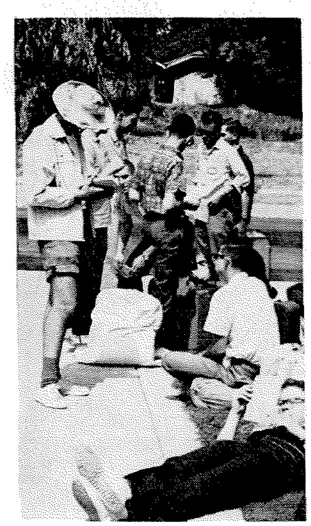
A lymphoid cell of the appendix carrying a radioactive marker (represented by the black dots).

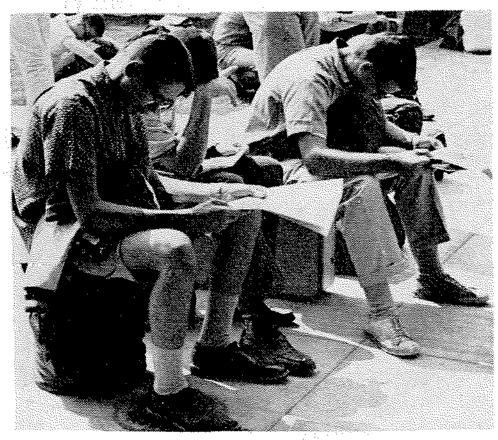
The observation that shielding the spleen gave only 50 percent protection still had to be explained. There is some evidence that lymphocytes proliferate better in an environment rich in cellular breakdown products. This type of environment existed in the spleen exposed to x irradiation and was encountered there by the large number of cells coming from the shielded appendix. Some cell destruction occurs even in a shielded spleen, but the ratio between the amount of breakdown products and the number of surviving cells may not be as favorable.

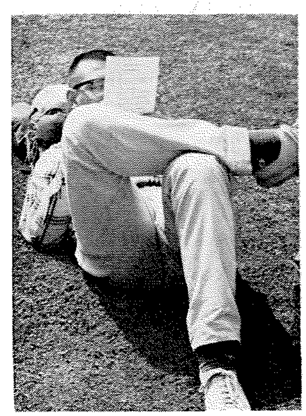
Summing up

The appendix in man is, relative to body size, about 30 times smaller than in the rabbit. Consequently, this organ is probably immunologically insignificant in the human, but may fulfill a defense purpose in the rabbit. We failed to demonstrate any contribution of the appendix in the unirradiated rabbit to the antibody response – probably because the organ did not receive enough of the intravenously injected antigen. Nevertheless, as we have seen, the lymphoid cells of this organ are capable of transforming into antibody-producing cells if they meet the proper conditions. We may generalize that, irrespective of their place of origin, lymphocytes can migrate to and implant in any part of the body, and develop there into antibody-forming cells if they encounter antigenic substances.

The shielding experiments permit a speculation on a quite different subject – that of cancer therapy. Certain forms of cancer call for therapy involving high doses of radiation administered to the whole body. One of the problems associated with this treatment is the subsequent breakdown of the body's defense system against infection. According to our experimental results, it might be possible to minimize this complication by shielding small areas rich in lymphatic tissue during the radiation treatment.







'64 MOVES IN
Freshmen collect name tags and sleeping bags and settle down to wait for the bus to take them to Freshman Camp.

The Class of '64

Caltech's class of '64 came with sleeping bag in hand, went off to camp, returned to campus, and started classes in one of the least exciting debuts in Caltech history. That old familiar saw, "Freshmen Are Better Than Ever," doesn't seem to have the old appeal – partly because it may not be true, and partly because there was no rotation this year to provide the upperclassmen with the incentive to meet and greet the freshmen.

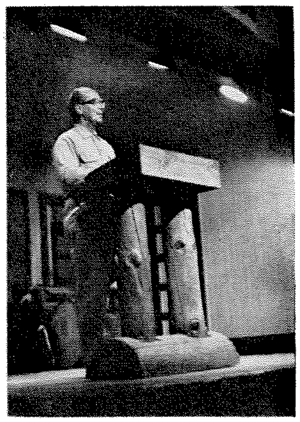
This is unfortunate, for the new freshmen are a very worthwhile group, and an excellent monument to the increasingly spectacular job being done by the Admissions Committee.

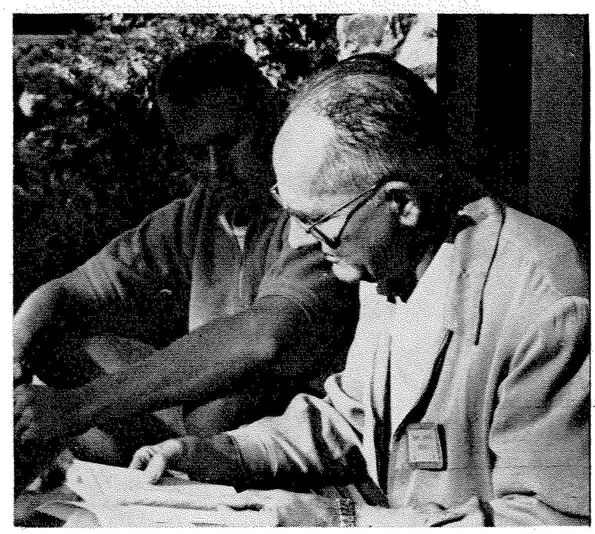
As has been the trend in the last few years, the freshmen come from all around the globe. Only 78 of the 202 who registered are from California – about half of those from the Los Angeles area. The class has a strong foreign flavor, with students from England, Japan, Mexico, Switzerland, and Turkey.

Aside from this similarity, Caltech's newest class is different from its predecessors. Even on a Caltech scale it is not very athletic, contrary to advance notices. While there are a few experienced athletes in the class, including an All-Conference basketball player from California's Desert League, the over-all athletic ability of the group as displayed at camp was not particularly notable. And no other class has ever been beaten *quite* so decisively by the faculty in a softball game.

Likewise, this class represents a break with the recent trend at Caltech to admit increasingly brilliant freshmen every year. The final averages of the new class's College Entrance Examination Board test scores have not yet been computed, but Dean of Freshmen Foster Strong believes that when the results are tabulated the Class of '64's scores will be about the same as those of last year's freshmen. Assistant Dean of Admissions Peter Miller thinks the scores may be even lower. Undoubtedly the class is still by far the most intelligent freshman class in the world, but this year the freshmen don't seem to be as sharp as their immediate predecessors, or to possess as high a degree of quick-wittedness as has been common in the past.

But this admittedly small difference in brilliance, which could prove to be no more than a difference in





FRESHMAN CAMP
Freshmen meet the President and the faculty informally – Dean of Freshmen Foster Strong (left) President DuBridge (top), and Dean of the Faculty George W. Beadle (above).

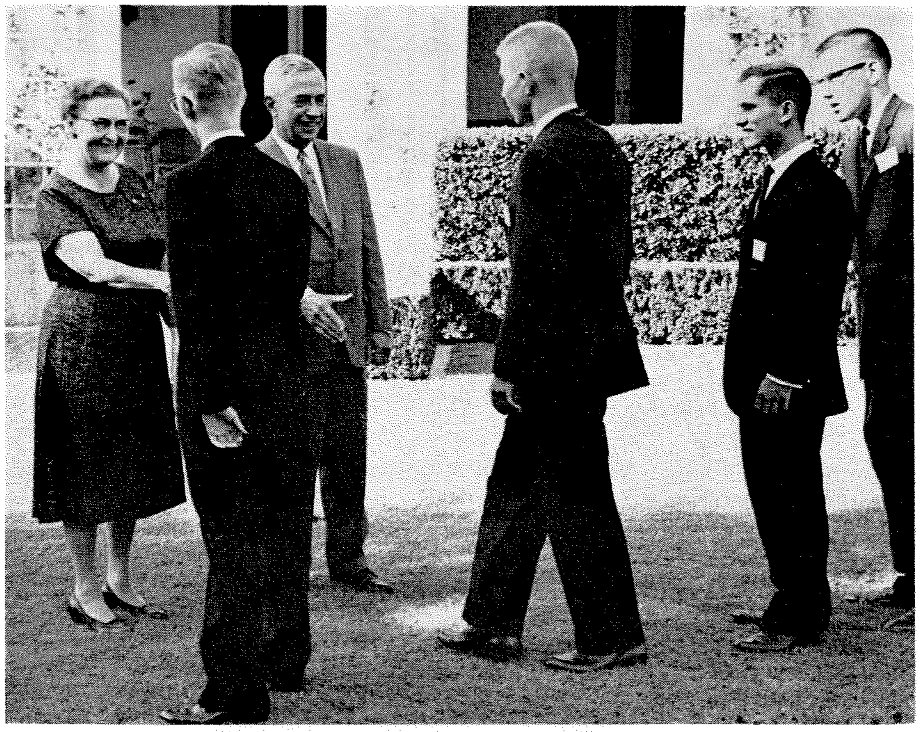
interest and application, is not the distinguishing feature of the class. This year's class is full of gregarious people who enjoy company and have a genuineness all too rare on a college campus – especially this one. In the sense that the freshmen find it very easy to get along with other people, this is one of the most socially adept classes Caltech has had. They seem to know the difference between being friendly and being obnoxious, between enthusiasm and naive effervescence. The class is full of the strong, silent type – the freshman who is always there when you want him, but never there when you don't.

The reason behind this rather important change from precedent is a change in the admissions procedure. Dr. Miller tells us that, while College Board scores and recommendations used to be about the only criteria for entrance, the Admissions Committee decided last spring to place a greater emphasis on class standings, high school grades, and extra-curricular activities. The Class of '64 has many members whose College Board scores were not remarkable, but who displayed an active and serious interest in studies and activities in high school.

This approach to evaluating prospective freshmen recognizes two glaring weaknesses in admitting students solely on the basis of their College Board scores. First, the people whom Caltech seriously considers for admission have uniformly high scores – high enough so that the difference between the best and the worst is within the statistical error of the test.

Second, a person who does well on a College Board test does not necessarily have the emotional and intellectual maturity to successfully meet the challenge of a top-notch college. Regardless of his intelligence, a student who continually rebels against the academic atmosphere of a high school is a prime candidate to do the same things in college. On the other hand, a student who has taken his high school grades seriously, and who has taken an active part in high school activities, is most likely to do the same in college.

This switch in admissions procedure has tended to weed out those people who, in spite of a great intel-



FRESHMAN TEA
The Class of '64 makes its formal debut at tea on the President's lawn.

ligence, do not have the responsibility and maturity to get along in a highly competitive atmosphere. The new freshmen are better equipped to cope effectively with the problems of Caltech life from the beginning of their stay.

The class has managed to survive a rugged introduction to Caltech. First, the lack of rotation has meant a letdown on the part of the upperclassmen from their usual procedure of meeting as many freshmen as possible. At student camp, the upperclassmen were generally very helpful when asked by the freshmen for advice and comments, but were prone to pay little attention to the freshmen unless forced to.

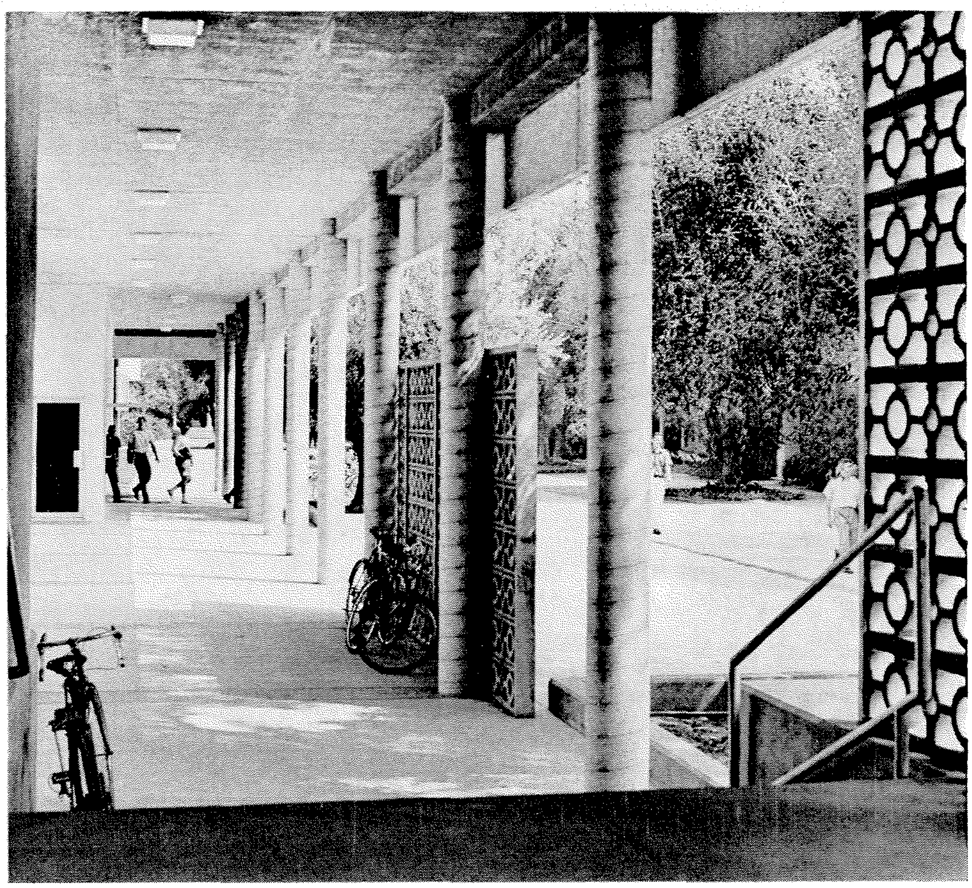
The second major change was in the tone of camp itself, which this year managed to scare the freshmen more than usual. The freshmen were told by speakers that there was a good chance they would not enjoy their undergraduate years for, although being a scientist is fun, *learning* to be one is not. They were reminded several times that many among them would not make the grade, and that many more would become so discouraged they would leave. This point is true enough, and should not be overlooked at camp, but the degree to which it was reiterated even unnerved the councilors. This all helped to produce a more somber and serious camp than usual.

The friendliness of the faculty during the informal recreation periods at camp did much to overcome the shock treatment of the speeches. One freshman said that there must have been a contest between faculty members to see who could be the neatest guy. Even though one speaker warned the freshmen that Caltech professors were not as accessible as the upperclassmen might tell them (a truly unprecedented statement for a student camp speech) this thought was quickly dispelled by the friendliness of the faculty, who did the best camp job they have ever done.

The freshmen saw the good and the bad, and acted accordingly. They have, since camp, been quiet but friendly (the best approach to snap the upperclassmen out of their lethargy). They seem to have settled down to work, and have successfully put fun and studies in proper perspective. They are interested in Caltech, and they are interested in their fellow students. They only wonder why their fellow students seem not to be interested in them.

– Roger Noll '62

THE NEW STUDENT HOUSES



Caltech's three new Student Houses opened this month (page 34), early results of the current Development Program and a long-belated culmination of campus planning done some 40 years ago. They've been a long time a'coming.

As far back as 1922, the present House system was envisaged in a report by Robert A. Millikan. He advocated small Houses with alleys and Resident Associates, modeled after the Oxford system. The Board of Trustees agreed with him, and also added that the advantages of small living groups justified their additional cost.

Practically everybody from the Trustees on down was interested in filling the costs, and would-be Tom Paines filled Institute pamphlet after Institute pamphlet with reminders that only 60 students were living on campus (in the recently abandoned Old Dorm), and that a lot more should be. This big search for House donors ran on through the 20's.

It finally reached pay dirt in mid-1928, when Mr. and Mrs. Joseph B. Dabney announced they would put up $200,000 to pay for one House. Dr. and Mrs. L. D. Ricketts, Mr. and Mrs. R. R. Blacker, and 20 donors who financed Arthur H. Fleming House soon followed suit, and the (now) old Houses were dedicated in September 1931. Four other Houses, planned for across the Olive Walk, were left to a benevolent future.

While the benevolent future obligingly provided a depression, a war, an inflation, and another war in quick succession, the new Houses remained tantalizing dreams. Every so often, somebody like the Master of Student Houses or a Dean suggested that the old Houses were really getting awfully crowded, and that an architect ought to be brought in, but nothing ever seemed to come of it. The cost of living was too high, let alone the cost of giving.

It looked as though the cost of giving were going to be too high for the next 100 years, until the Development Program came along in the spring of 1958, and provided a sure-fire method of getting three new Houses as well as a parcel of other buildings. All the Development people had to do was go out and get three money-heavy donors to give $800,000 apiece (as much, incidentally, as all the old Houses put together had cost). Or so everybody thought.

Everybody thought incorrectly. One House did come from a single donor, but the other two were pieced together from parents' donations, friends' donations, alumni donations, Pasadena citizens' donations, trustees' donations, practically any scraps of money that the Development people could lay their hands on. The one-donation House was named in honor of Ralph B. and Lulu Lloyd since it was paid for by the Lloyd Foundation. The other two were named

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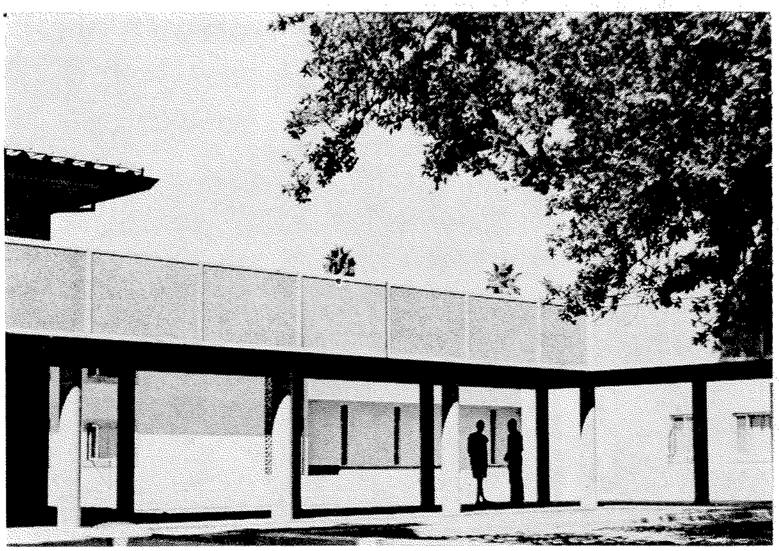
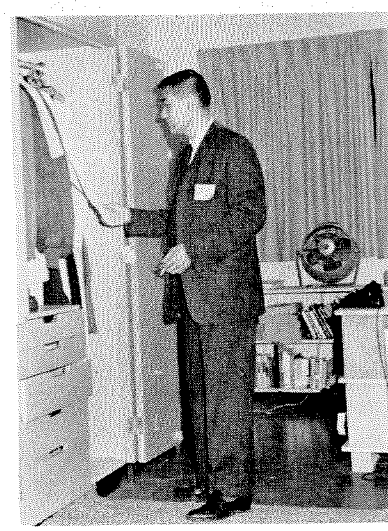
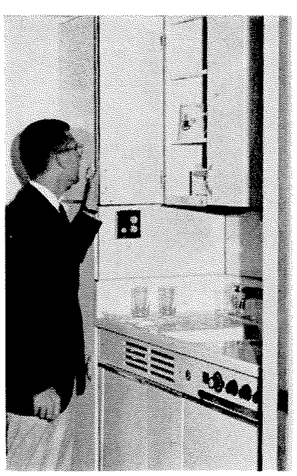






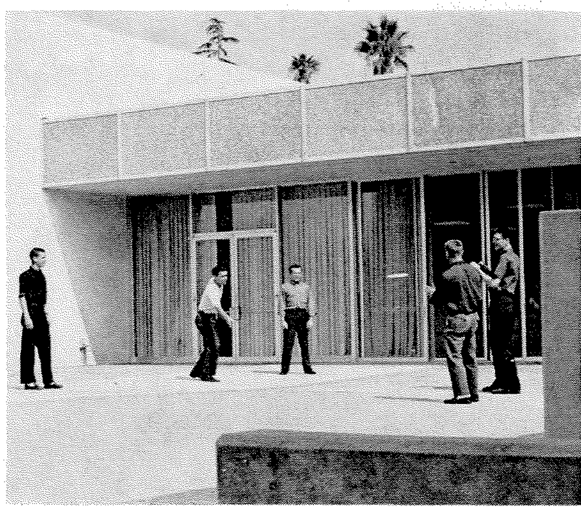
Life in the new Houses will undoubtedly carry on most of the old traditions from across the Olive Walk.

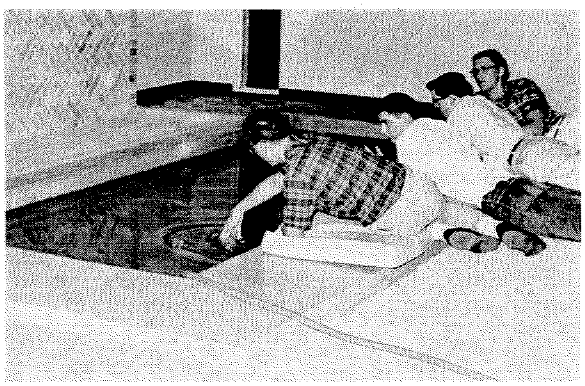
for James R. Page and Albert B. Ruddock, former and current chairmen respectively, of the Board of Trustees.

The new Houses were designed by Smith, Powell and Morgridge, who tried to retain the style of the old Houses and pay 1960 prices at the same time. Considering the difficulties involved, Messrs Smith, Powell and Morgridge didn't do too badly. Because of esthetic and building complications known only to architects, the new Houses don't wrap around their courtyards the way the old ones do, and the alley divisions are indicated by bends in the corridors and by swinging doors rather than by foot-thick reinforced concrete walls. They also don't have the charming air of the old Houses, which comes from incidentals like sculptured concrete gargoyles on the pillars and ennobling Latin mottos carved imperishably over the doors.

On the other hand, the new House rooms are bigger, the lighting is decent, and the Swedish modern furniture, for all its bleakness, looks nice in the lounges.

The lounges, in fact, are the most interesting parts of the new Houses – especially the fireplaces. Page has a foot-and-a-half-deep "conversation pit" in front of its fireplace (which was immediately converted into a goldfish pond). Lloyd's hearth looks like the sacrificial altar in a multi-megabuck Hollywood epic,





Everyone is taking great pains to insure that the new Houses don't degenerate into "just nothin' but dorms."

and Ruddock's mantel has brightly polished stonework which looks as if it's going to fall off any minute in a thundering, spectator-smashing avalanche. Actually, this is unlikely, as every new viewer realizes after about fifteen minutes. The new Houses are built of reinforced concrete, and even the fireplaces could probably stand up under anything short of a direct hit or a magnitude seven earthquake on the San Andreas.

Life in the new Houses will undoubtedly carry on most of the old and hallowed traditions from across the Olive Walk. People – students, faculty, everybody – are taking great pains to insure that Page, Lloyd and Ruddock don't degenerate into "just nothin' but dorms."

Most of the members are working hard for their new Houses by becoming busy with the usual concerns – meeting frosh, hectoring frosh, holding parties, holding bull sessions, even studying. The only usual thing they aren't doing is griping about House dues. Everybody is shockingly willing to pay extra money – at least for first term.

Caltechmanship – the fine art of passing while ingeniously wasting 23½ hours a day – is also taking its hold on the new Houses. The goldfish in Page's Pit were the first stunt, but they were soon followed by enforced elevator rides in the dumb-waiters, a few minor waterfights in the courtyards, and good old reliable frisbie-flipping. Pretty soon now, somebody will figure out how to send 70 watts of air-raid sirens into somebody else's medicine cabinet, and things will be completely normal.

The other prominent features of the old Houses – devices for the regulation, containment and suppression of Caltechmanship – are also getting established. New Resident Associates have been appointed and are doing their jobs with quiet competence; student Executive and Upper Class Committees are holding long meetings and sometimes solving House problems at the same time.

The Houses themselves – officers, members, and everybody connected with them – seem to be solving their problems as well. Just as soon as somebody figures out how to hang soap dishes in the showers (the architects forgot to) things should be great.

– by Lance Taylor '62

Distinguished guests at dedication and ground-breaking ceremonies— Norman Chandler, president of the Times Mirror Company; Mrs. Mark J. Dees; James R. Page, honorary chairman of Caltech's board of trustees; and Albert B. Ruddock, chairman of the board of trustees.

The Month at Caltech

Campus Construction

A multiple ceremony took place on the Caltech campus on October 3 when the Chandler Dining Hall and three new student houses were dedicated, and ground was broken for four graduate houses.

The dining hall is named for Harry Chandler, publisher of the Los Angeles *Times*, and president of the Times Mirror Company, who was a Caltech trustee from 1920 until his death in 1944. The hall is a gift of the Chandler family, The Times Mirror Company and the F. X. Pfaffinger Foundation of the Times.

The new undergraduate houses which are providing homes for about 250 students are named for Albert B. Ruddock, chairman of the Caltech board of trustees; James R. Page, a former board chairman and now honorary chairman; and the third house is named in memory of Lulu H. Lloyd and Ralph Lloyd, who was a trustee from 1939 to 1952, and died in 1953.

The graduate house group will consist of four reinforced concrete buildings of contemporary style, located on a new section of the campus north of San Pasqual Street on the east side of Holliston Avenue. The houses are named for their donors: Carl F. Braun; David Marks; William M. Keck, Jr.; Earle M. Jorgenson and Samuel B. Mosher.

Science and Government

General Maxwell Taylor, former U.S. Army Chief of Staff, comes to the Caltech campus this month as the first seminar speaker in the Carnegie program of science and government. He speaks on "A Blueprint of National Security."

These seminars, to be held weekly throughout the academic year, are made possible by a grant of $330,000 from the Carnegie Corporation of New York, designed to develop the social sciences in Caltech's division of humanities. The lectures for 1960-61 will center around the problems of armament control with respect to national policy and international relations.

The second lecture in the series, on October 19, will feature Jules Moch, the permanent French member of the United Nations Committee on Disarmament. He will speak on "Why Disarmament is Necessary, and How to Control It."

Among other lecturers in the program will be Sir Charles P. Snow, author and scientist; Professor H. A. Kissinger of Harvard; Professor Warner Schilling of Columbia; Professor C. E. Osgood of Illinois; and Professor I. I. Rabi of Columbia.

Harry J. Bauer

Harry J. Bauer, president of the Automobile Club of Southern California, and a trustee of Caltech, died on September 11 of cerebral thrombosis.

Mr. Bauer was past president and board chairman of the Southern California Edison Company and had been associated with the company for more than 50 years. A graduate of Pasadena High School, he later received a degree in law from SC and formed the law firm of Bauer, Wright, and MacDonald in 1921.

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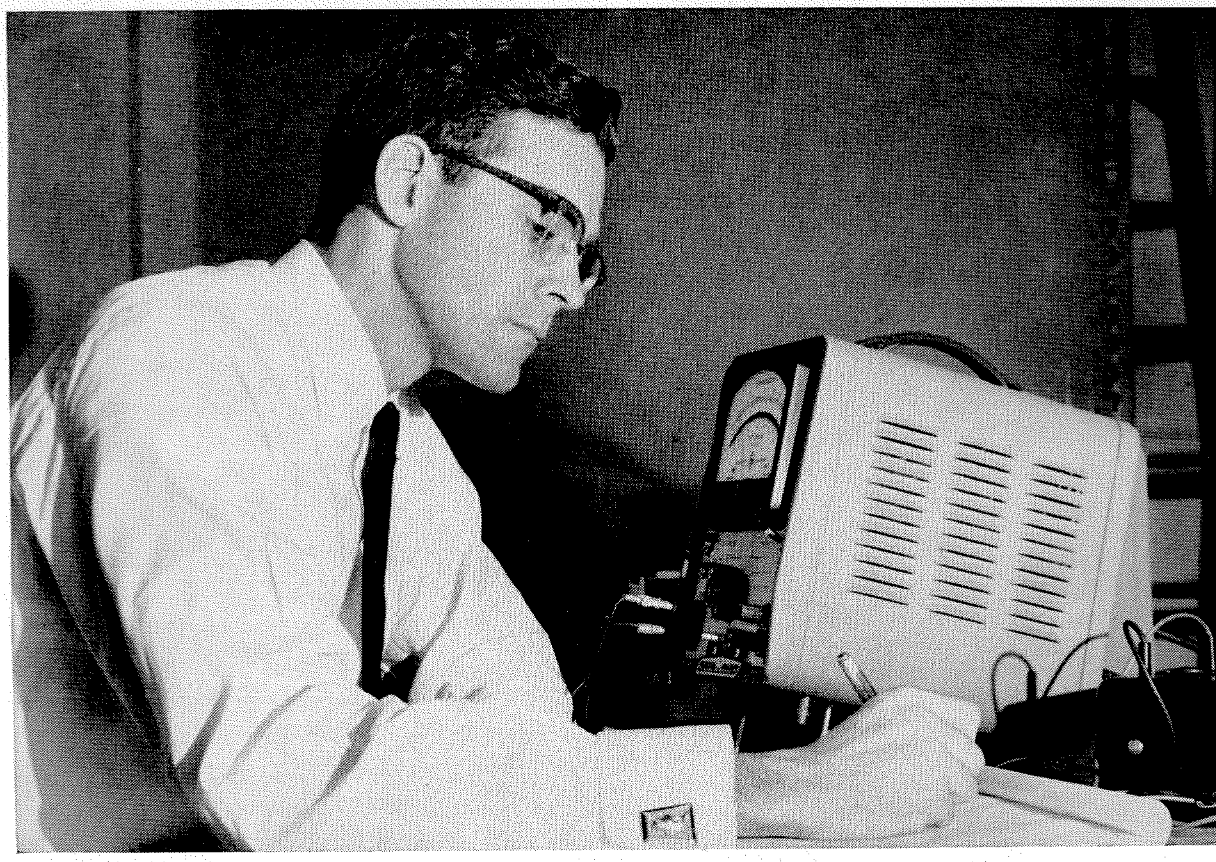
A Campus-to-Career Case History



Field assignments, plus theoretical lab work (above), keep Larry Carmody's engineering career stimulating.

If your future is engineering, put yourself in Larry Carmody's shoes

Lawrence M. Carmody formed some firm convictions about his future engineering career while a senior at Illinois Institute of Technology.

"I wanted to do significant work," he says, "and have a variety of assignments that would broaden me and keep my job interesting. I wanted to make good use of my schooling and express my own ideas. And, like anyone with ambition, I wanted all the responsibility I could handle and some genuine opportunities to keep moving ahead."

Larry got his B.S.E.E. degree in June, 1955, and went with Illinois Bell Telephone Company in Chicago. He first worked in the Radio and Special Services Group of the Transmission Engineering Division. There, in addition to receiving more advanced training, he:

- designed mobile radio systems
- did path studies of radio circuit routes
- worked on a special air-to-ground communications project for an airline
- did field work for a new, transistorized walkie-talkie system developed by Bell Laboratories.

Today, Larry is planning and designing statewide long-distance facilities involving microwave, carrier, and cable systems—projecting circuit needs as far ahead as 20 years. His recommendations often represent hundreds of thousands of dollars in equipment and facilities.

"Telephone company engineering is 'tops' in my book," says Larry.

Like to be in Larry's shoes? Many young college men are pursuing careers just as rewarding with the Bell Telephone Companies. Why not find out about opportunities for you? Have a talk with the Bell interviewer when he visits your campus—and read the Bell Telephone booklet on file in your Placement Office.

BELL TELEPHONE COMPANIES

Mr. Bauer had the longest period of service on Caltech's board of trustees – from 1929 to 1960. He made many contributions to the Institute. In 1930 he financed a student committee of three undergraduates for a tour of eastern colleges, and as far as Oxford, Cambridge, Heidelberg and The Sorbonne, so that the Caltech student body could determine whether it should have college dormitories or fraternity houses. He then contributed $25,000 toward the completion of Fleming House. Another of his gifts to the Institute consisted of about 300 volumes in the field of Renaissance science, including several first and early editions of Copernicus, Galileo, and Kepler.

Mr. Bauer also served as chairman of Caltech's Budget Committee, as a member of the Finance Committee, and as a member of the Palomar Committee.

Honors and Awards

George Beadle, chairman of the biology division and acting dean of the Caltech faculty, has been named honorary advisor to the American Institute of Biological Scientists.

Ray D. Owen, professor of biology, has been appointed vice president of the Genetics Society of America.

John D. Roberts, professor of organic chemistry, has been elected to the board of directors of the newly-formed science book publishing house of W. A. Benjamin, Inc., in New York.

Theodore von Karman, chairman of the Advisory Group on Aeronautical Research and Development of NATO, and professor emeritus of aeronautics at Caltech, has received the Lamme Medal for distinguished contributions to engineering education and research – one of the nation's highest awards in engineering education.

Faculty Changes

New members of the Institute's staff of instruction and research for 1960-61 include:

Paul R. Baker, instructor in history, from Harvard where he received his PhD in June.

Manuel Bass, assistant professor of geology, from the Carnegie Institution at Washington, D.C. where he has been a research fellow for two years. He received his BS in 1949 and his MS in 1951 from Caltech, and his PhD in 1956 from Princeton.

Robert I. Conhaim, instructor in history, from UCLA where he received his PhD in June.

Egon T. Degens, assistant professor of geology, from the University of Wurzburg in Germany where he was a scientific associate. He received his PhD from Bonn University in Germany in 1955.

Chuan C. Feng, visiting associate in engineering, from the University of Missouri where he is associate professor of civil engineering. He received his BS from the National Chiao-tung University in China in 1945, and his MS in 1955 and his PhD in 1959 from the University of Missouri.

Dieter Gaier, senior research fellow in mathematics, from the University of Giessen in Germany where he was professor of mathematics. He received his PhD from the University of Rochester, New York, in 1951.

Stewart E. Hazlet, visiting associate in chemistry, from the University of Washington in Seattle, where he is dean of the graduate school and professor of organic chemistry. He received his PhD from Iowa State University in 1935.

Charles E. Helsley, assistant professor of geology, from Princeton University where he received his PhD in June. He received his BS from Caltech in 1956 and his MS in 1957.

Alvin F. Hildebrandt, senior research fellow in chemistry, from the Jet Propulsion Laboratory where he is research specialist. He received his BS in 1949 from the University of Houston, and his PhD in 1956 from Texas A&M.

Alan J. Hodge, professor of biology, from MIT where he was a research associate in biology. He received his BSc from the University of Western Australia in 1946, and his PhD from MIT in 1952.

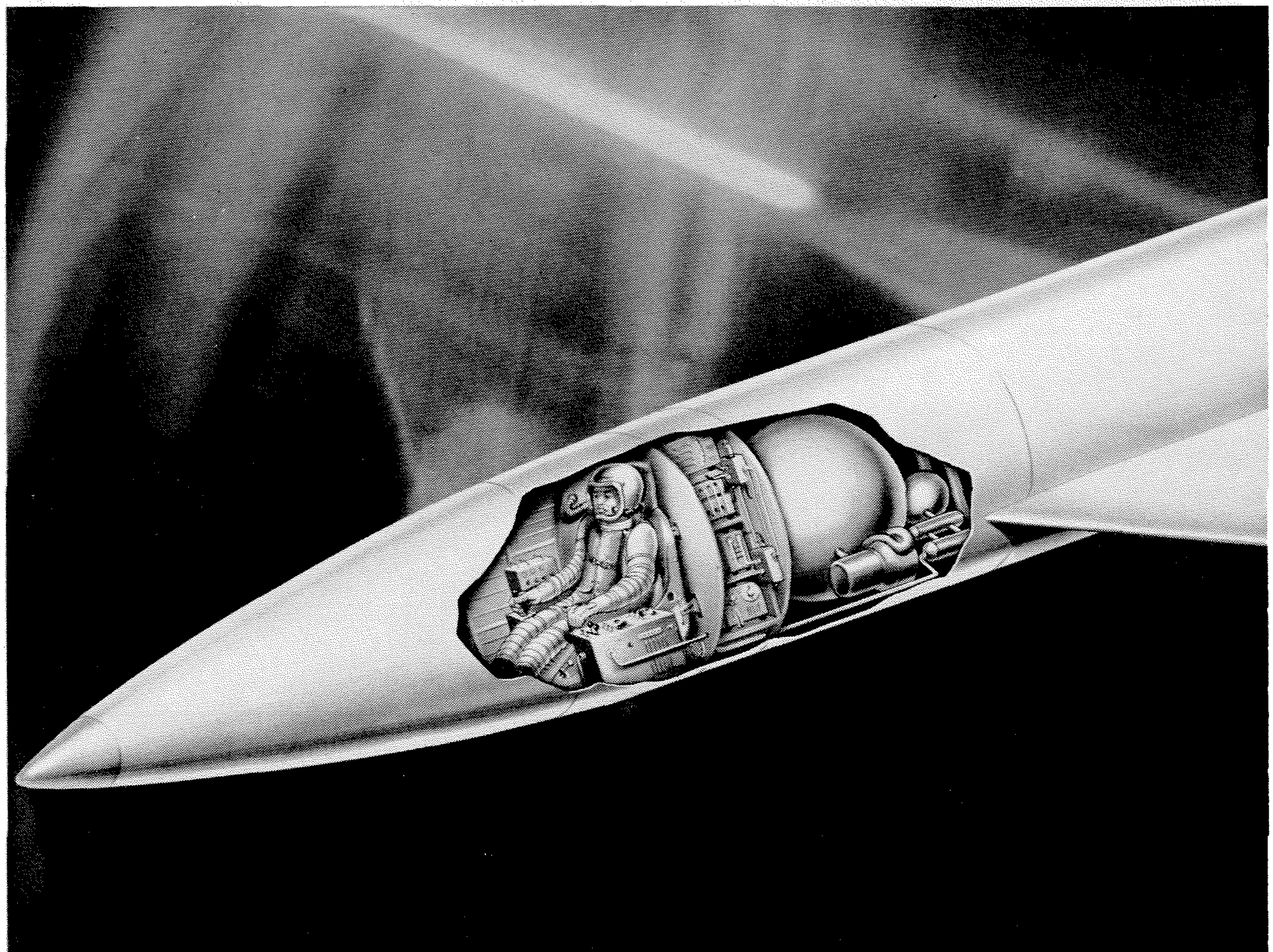
Jean Humblet, research associate in physics, from the University of Liège in Belgium where he is a staff member of the Astrophysical Institute.

Charles E. Jacob, lecturer in engineering, who is in private practice as a consultant in Northridge, Calif. From 1953 to 1955 he was professor of geology at Brigham Young University in Utah.

Theodore A. Jacobs, senior research fellow in jet propulsion, received his PhD from Caltech in June. He is a graduate of Emory University in Georgia, and received his MS from USC in 1954.

Lowell B. Koppel, instructor in chemical engineering, from Northwestern University in Illinois where he received his PhD in June. He received his BS from Northwestern in 1957, and his MS from the University of Michigan n 1958.

Robert V. Meghreblian, associate professor of applied mechanics, from JPL where he still serves as chief of the physical sciences division. He received his MS in 1950 and his PhD in 1953 from Caltech.



Elliot Pinson, instructor in electrical engineering, and now a candidate for a PhD at Caltech, received his BS from Princeton in 1956, and his MS from MIT in 1957.

William P. Schaefer, instructor in chemistry, from UCLA where he received his PhD in June. He received his BS from Stanford in 1952, and his MS in 1954 from UCLA.

John Howe Scott, visiting associate in chemistry, from Macalester College in Minnesota where he is associate professor of chemistry. He received his AB from Clark University in Massachusetts in 1930, and his MS from Iowa State University in 1931.

Leonard Searle, senior research fellow in astronomy, from the David Dunlap Observatory in Toronto. He received his PhD from Princeton in 1956.

Paul A. Walker, visiting associate in biology, from the Randolph-Macon Woman's College in Virginia where he is professor of biology and chairman of the department. He received his AB from Bowdoin College in Maine in 1931, his AM from Harvard in 1932, and his PhD from Harvard in 1936.

M. L. Weidenbeck, research associate in physics, from the University of Michigan where he is professor of physics. He received his BS in 1941 from Canisius College in Buffalo, and his MS in 1942 and PhD in 1945 from the University of Notre Dame.

Helmut Weilandt, visiting professor of mathematics, from the University of Tubingen in Germany where he has been professor of mathematics since 1951. He received his PhD from the University of Berlin in 1935.

Peter Yankwich, visiting associate in chemistry, from the University of Illinois where he is professor of chemistry. He is at Caltech on a National Science Foundation senior postdoctoral fellowship.

Adriaan C. Zaanen, visiting professor of mathematics from Leiden State University in Holland where he has been professor of mathematics since 1956 where he received his PhD in 1938.

Frederik Zachariasen, assistant professor of physics, from Stanford University where he has been assistant professor of physics since 1958. He received his BS from the University of Chicago in 1951 and his PhD from Caltech in 1956.

On Leave of Absence

Robert F. Christy, professor of theoretical physics, to the Institute for Advanced Studies in Princeton, N.J.

Hans Ellersieck, associate professor of history, to Europe and the Soviet Union on a Ford Foundation Grant.

Albert E. Engel, professor of geology, for a second year as professor of geology at the Scripps Institute of Oceanography at La Jolla.

W. Barclay Kamb, associate professor of geology, to Switzerland on a Guggenheim Memorial Fellowship for studies on alpine glaciers.

Departures:

Richard H. Jahns, professor of geology, has left Caltech to become chairman of the department of earth sciences at The Pennsylvania State University. He has been on the Caltech staff since 1946.

Dr. Johns received his BS in geology at Caltech in 1935, his MS from Northwestern University in 1937, and his PhD from Caltech in 1943. Shortly after graduation in 1935 he joined the staff of the U. S. Geological Survey. He returned to Caltech as assistant professor of geology in 1946, became an associate professor in 1947, and was made a full professor in 1949. He was elected to the board of directors of the Caltech Alumni Association in 1955.

Promotions:

To Professor:

J. Kent Clark — English
Charles E. Crede — Mechanical Engineering
James C. Davies — Political Science
David C. Elliot — History
Alfred Stern — Languages and Philosophy
M. L. Williams, Jr. — Aeronautics

To Associate Professor:

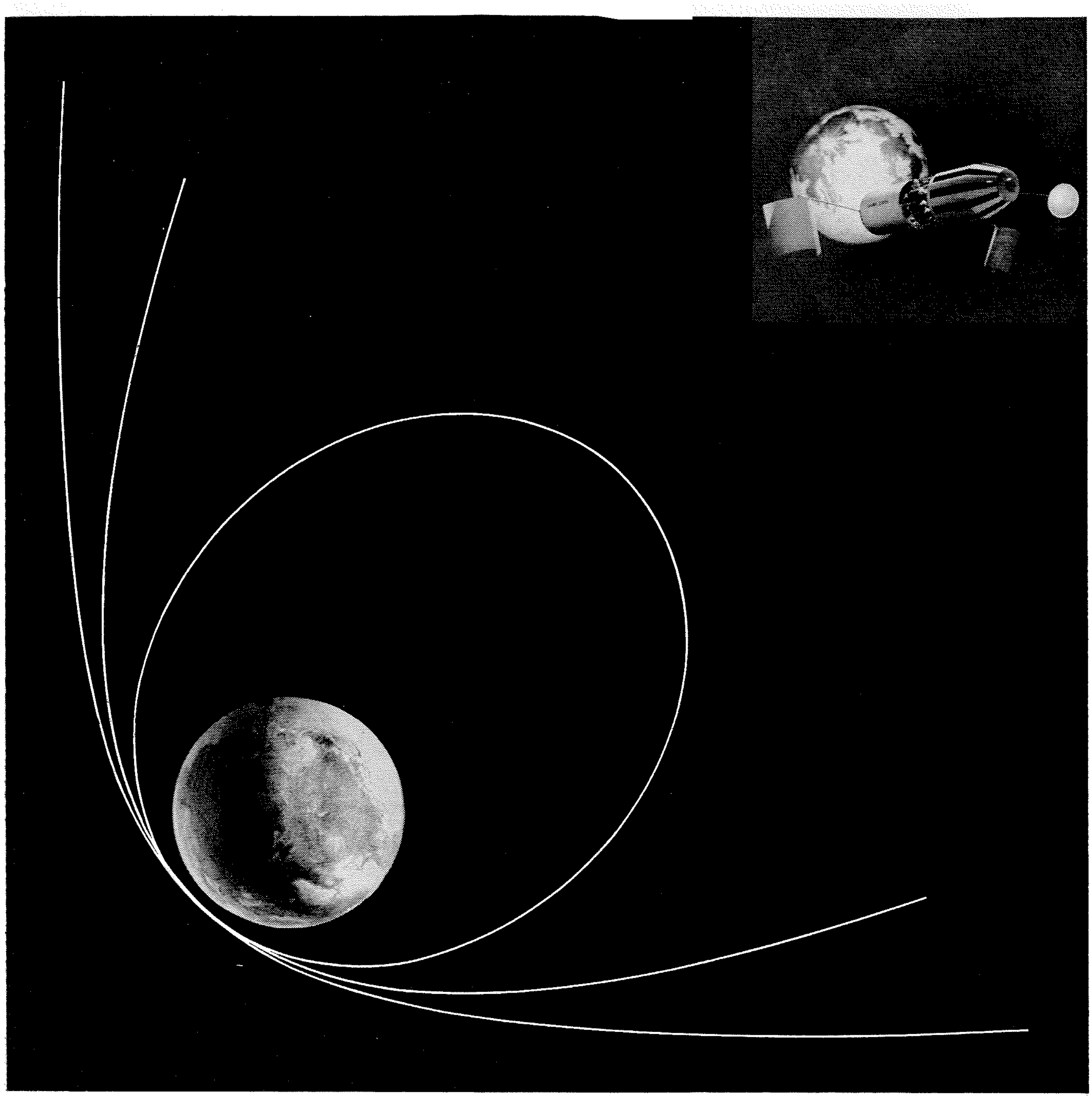
A. L. Albee — Geology
Nicholas George — Electrical Engineering
Peter W. Fay — History
W. Barclay Kamb — Geology
W. A. J. Luxemburg — Mathematics
George P. Mayhew — English
C. H. Wilcox — Mathematics
E. E. Zukoski — Jet Propulsion

To Senior Research Fellow:

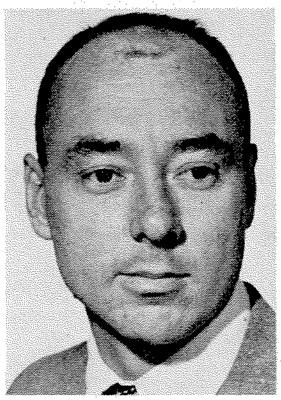
Anthony Demetriades — Aeronautics
J. H. Mullins — Physics

To Assistant Professor:

R. E. Block — Mathematics
R. S. Edgar — Biology
R. A. Huttenback — History
R. W. Kavanagh — Physics
Carver Mead — Electrical Engineering
R. G. Rinker — Chemical Engineering
D. R. Smith — English
H. A. Weidenmuller — Physics



Alumni News



William C. Pilkington, his wife Rosella, and their three children were killed in the crash of their private airplane near Blair, Illinois, on August 6. The party was enroute from Los Angeles to New York and Boston on a combined business and pleasure trip. A violent storm tore the plane apart in midair.

Bill Pilkington was born in Fall River, Massachusetts, in 1930. He received his BS in electrical engineering from Caltech in 1952 and his MS in 1953. He and Rosella Becker were married in June 1953, then left for Oslo, Norway, where they spent a year on a Fulbright scholarship.

On their return Bill went to work at Caltech's Jet Propulsion Laboratory, where he remained until his death. He played a considerable part in the development of electronic circuitry for Explorer I, the first American satellite. At the time of his death, he was Research Group Supervisor of the New Circuit Elements Group.

After their return from Norway, the Pilkingtons had three children – Kari, Glen, and Dale – who were 5, 3, and 1½ respectively at the time of their deaths.

As a memorial to the Pilkingtons, their friends have established a Foreign Students Tour Fund in their names at Caltech. This fund, to be administered by the Dean of Graduate Studies, will award $100 to a foreign student for travel expenses, so that he can see more of America while he is here. This is felt to reflect the Pilkingtons' own interests in people of foreign countries, and to be in the spirit of the Fulbright award which they themselves enjoyed.

If enough donations are received, a perpetual fund will be established; if not, awards will be made annually until the fund is exhausted.

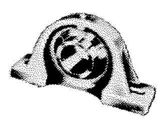
Those friends who wish to donate may send their checks to the Institute, to the attention of George Green, Vice President for Business Affairs. The check should be made out to the Institute, but with a note that it is for the Pilkington Memorial Fund.

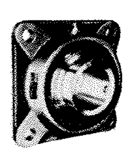
– Peter V. Mason, BS '51, MS '52

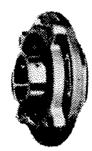
CALTECH DEVELOPMENT PROGRAM – Final Summary of Alumni Gifts – June 30, 1960

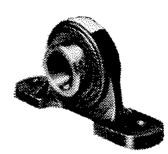
With the conclusion of the alumni phase of Caltech's Development Program we proudly publish the final summary of alumni gifts by Division.

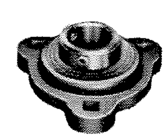
Division	$ Totals	$ Goals	% of Goal	# Alumni	# Donors	% Part.	Ave. Gift–$
BERKELEY	$ 40,728	$ 44,551	91	268	148	55	$275
BEVERLY HILLS	110,783	102,500	108	391	228	58	485
GLENDALE	31,127	49,110	63	278	131	47	239
INGLEWOOD	47,840	69,258	69	392	185	47	258
LONG BEACH	52,126	45,777	114	231	179	77	291
PASADENA	202,410	160,021	126	795	443	56	458
SACRAMENTO	8,732	9,401	93	72	51	71	171
SAN BERNARDINO	13,490	19,533	69	118	62	53	218
SAN DIEGO	16,087	28,582	56	172	68	40	236
SAN FRANCISCO	33,580	62,513	54	396	202	51	166
SANTA ANA	26,825	32,661	82	206	112	54	239
SANTA BARBARA	15,523	13,395	116	88	52	59	299
SOUTH PASADENA	58,424	101,733	57	585	243	42	240
VAN NUYS	38,038	49,733	76	277	116	42	328
ALBUQUERQUE	8,887	10,180	87	59	39	66	228
BOSTON	22,498	21,830	103	132	94	71	239
CHICAGO & MIDWEST	23,420	23,216	101	263	103	39	228
CINCINNATI	14,849	14,000	106	88	60	68	248
CLEVELAND	9,975	9,690	103	48	33	69	302
DALLAS	1,578	3,900	40	30	9	30	176
DENVER	7,548	12,106	62	91	40	44	189
DETROIT	13,891	9,326	149	75	44	59	316
FORT WORTH	6,090	6,000	102	38	22	58	276
HOUSTON	27,851	19,000	144	103	80	78	348
NEW HAVEN	3,782	8,026	47	55	33	60	115
NEW YORK	55,063	53,086	104	427	222	52	248
PHILADELPHIA	9,890	8,483	117	83	51	61	194
PHOENIX	6,190	5,880	105	44	44	100	141
PITTSBURGH	7,219	7,780	93	57	45	79	160
PORTLAND	3,257	4,668	70	34	19	56	171
SEATTLE	12,391	14,697	84	85	73	86	170
TULSA	3,363	7,255	46	45	29	64	116
WASHINGTON, D.C.	12,931	41,572	31	229	112	49	116
DIVISION TOTALS	$ 943,886	$1,000,000+	95%	6,255	3,372	54%	$280
UNREACHABLES	63,108	———	—	1,348	240	18	263
GRAND TOTALS	$1,008,994	$1,000,000+	101%	7,603	3,612	47%	$279

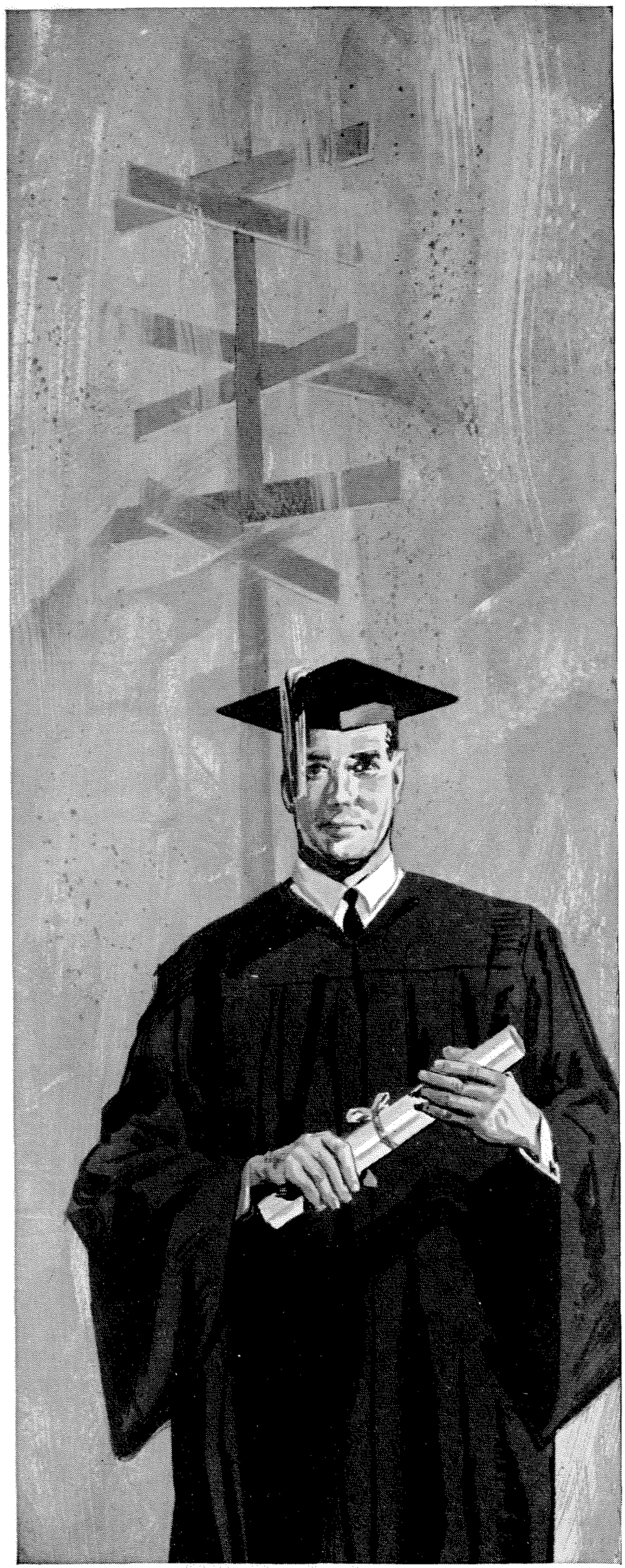












For the man who likes to make his own career decisions

The Allis-Chalmers Graduate Training Course is based on freedom of opportunity. You will have up to two years of practical training to find the right spot for yourself. At the same time, you enjoy a steady income. You can accept a permanent position at any time — whenever you can show you are ready.

You help plan your own program, working with experienced engineers, many of them graduates of the program. Your choice of fields is as broad as industry itself—for Allis-Chalmers supplies equipment serving numerous growth industries.

A unique aspect of the course is its flexibility. You may start out with a specific field in mind, then discover that your interests and talents lie in another direction. You have the freedom to change your plans at any time while on the course.

Types of jobs: Research • Design • Development • Manufacturing • Application • Sales • Service.

Industries: Agriculture • Cement • Chemical • Construction • Electric Power • Nuclear Power • Paper • Petroleum • Steel.

Equipment: Steam Turbines • Hydraulic Turbines • Switchgear • Transformers • Electronics • Reactors • Kilns • Crushers • Tractors • Earth Movers • Motors • Control • Pumps • Engines: Diesel, Gas.

Freedom of Opportunity opens the doors to challenging and interesting careers. Among them is our Nuclear Power Division, with an engineering staff in Washington, D. C., a new research and development center in Greendale, Wis., and an important research effort at Princeton University involving power from the hydrogen atom. For details on the opportunities available, write to Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

A-1192

ALLIS-CHALMERS

Personals

1918

Donavan B. Nutt died of cerebral thrombosis on June 6, 1959 in El Segundo, Calif. He had retired in 1956 after 38 years at the El Segundo plant of the Standard Oil Company, in the Light Oil Division.

1920

Mark Sawyer, protection engineer at the Pacific Telephone and Telegraph Company in Los Angeles, and also secretary for the Class of 1920, writes that the class held a get-together before the Alumni Meeting on June 8 at the Rodger Young Auditorium. Those attending were *Virgil Best, Paul Crosby, Vic Hounsell, T. C. Hounsell, Harvey House,* (MS '26); *Frank Mosher, Mark Sawyer, Carson Smith, George Suman, Roscoe Woodbury, Horace Andrews* and *George Whitworth.*

1924

Hollis W. Moyse died of a heart attack at his home on July 22. He was 57. For 28 years he had been working for the Du Pont Company and, at the time of his death, was technical representative to the film industry in California. He leaves his widow; two sons, George and Hollis Jr., both of San Diego; and a daughter, Virginia, in San Antonio.

Cecil N. Parker, planning engineer for the California Electric Power Company, died of a cerebral hemorrhage on June 19. He had worked for the CEPC since he graduated from Caltech. He leaves his widow, a daughter and two grandchildren.

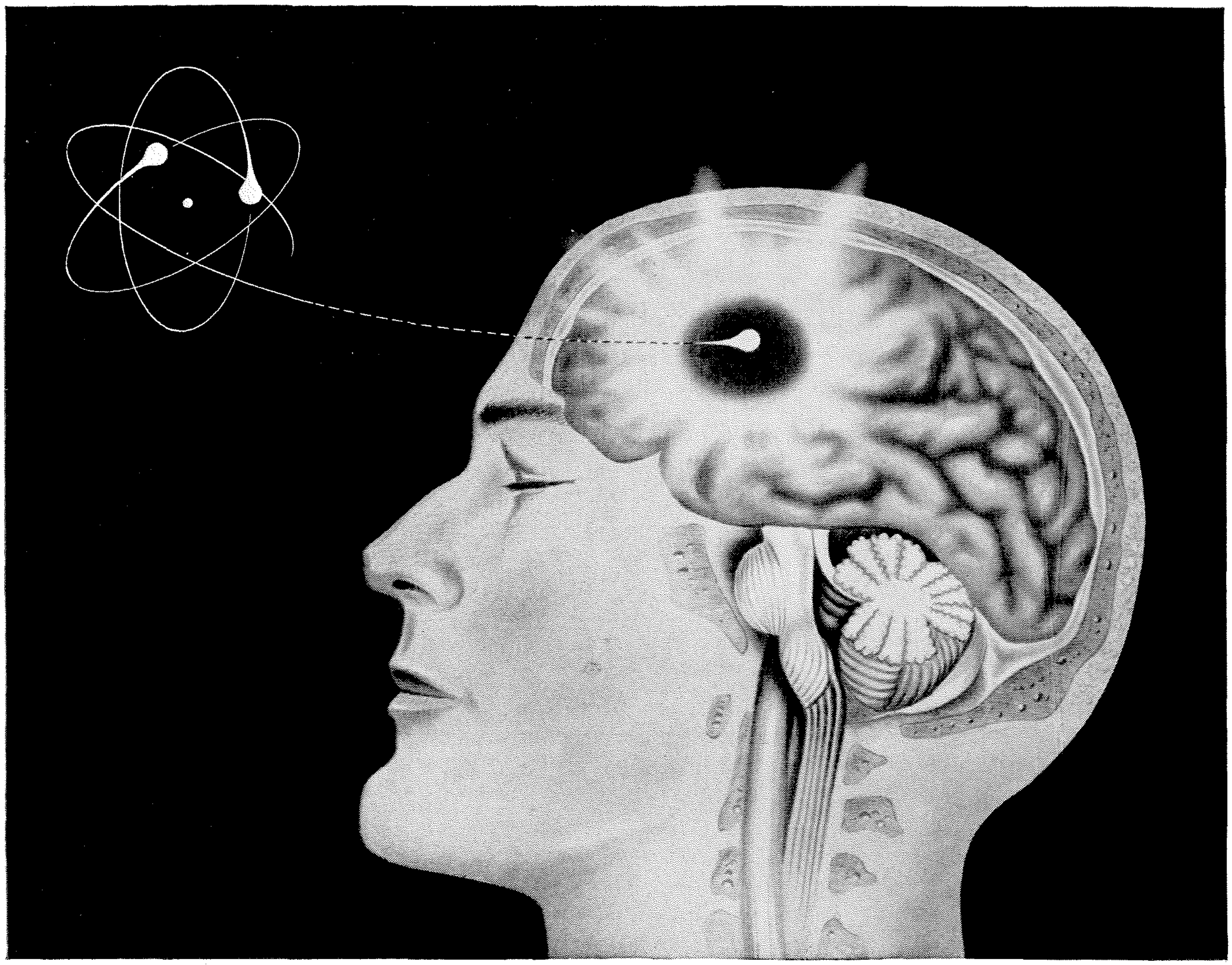
1928

K. H. Robinson, MS '29, head of the technical information department of the U.S. Naval Ordnance Test Station at China Lake, writes that "our first grandson, Michael, was born on April 24 in Berkeley—just in time to attend his father's graduation from the University of California (Charles W. Robinson). Our son Alan is a sophomore at the University of California, majoring in Oceanography."

1930

Ernest C. Hillman, Jr., structural engineer, and also secretary of the Class of 1930, sends along news of various members who were unable to attend the reunion at the Annual Alumni Meeting on June 8. Of himself he writes: "Following graduation I was with the Southern California Gas Company for three years, and with an architectural firm for seven years. In 1940, I opened my own structural engineering firm. In 1945 Mr. Lawrence Nowell became a partner in

continued on page 48



the firm now known as Hillman & Nowell.

"Evelyn and I have been married for 28 years and our daughter just presented us with our first granddaughter in May. Our son, Donald, graduated from USC last June with a business administration degree."

Of his classmates Ernest reports:

Ira Bechtold, private consultant in chemical engineering in Los Angeles, is married, has four daughters and four grandchildren.

Howard E. Baker joined the Underwriters' Laboratories, Inc., in Los Angeles a week after his graduation. With the exception of a three-year absence during the depression he has been with them ever since. He's now associate standards engineer in the New York office.

R. Stanley Lord, Pacific Coast branch area chief of the water resources division of the Geological Survey in Menlo Park, writes that he has put in 30 years with the Survey. The Lords have two sons, Myron and Roy. Myron has just graduated from the University of Pennsylvania Medical School. Roy is studying commercial art at San Jose State College.

Jack D. Pritchett writes that he's still an electrical engineer with the Army Corps of Engineers after 20 years. His home base is Hawaii, but he also sees a lot of Japan, Korea and Okinawa.

Robert I. Stirton, PhD '34, has been with Standard Oil of California for 13 years, first as manager of product development for their subsidiary, Oronite Chemical Company, and now as general manager of the commercial development department of the California Chemical Company in San Francisco. The Stirtons have a 12-year-old son, Rory, who is now in his second year in junior high school.

Theodore Stipp writes that he has been employed by the Department of Water and Power of the City of Los Angeles since 1937. He is an electrical engineering associate in the underground design section.

Clyde E. Giebler, MS '32, is now assistant commercial manager of the Atlantic Plant of U.S. Electrical Motors, Inc., in Milford, Conn. He has been with the company since 1933. His hobbies include sailing on Long Island Sound and bowling. The Gieblers have a daughter in Pomona College, and a married son.

Truman Kuhn, dean of the faculty at the Colorado School of Mines in Golden, writes that he's been there since 1942. He gave up teaching in 1943 to become the first dean of the graduate school, and in 1956 was appointed dean of the faculty. The Kuhn's twin sons are 20 years old – one is at Colorado School of Mines, and the other is at Colorado State College.

David W. Scharf, MS '32, writes from Pescara, Italy, that he has been party chief of a seismic crew for Western Ricerche Geofisiche, the Italian affiliate of the Western Geophysical Company of America. Dave is married and has two children – a boy, 4, and a girl, 3.

Col. Frank N. Moyers, MS '31 ME, MS '40 AE, writes that "most of my time since graduation has been spent in the U.S. Air Force, largely in the field of research and development. My active flying career was abruptly terminated about a year ago by a cardiac difficulty. Although I seem to be fully recovered, the doc says 'no more flying.' In about a year, I shall probably retire – to Florida where our love for boating can be satisfied. We have one child – a daughter, 17."

1936

Albert G. Bodine, owner and manager of the Bodine Soundrive Company

continued on page 52

ALUMNI ASSOCIATION OFFICERS

PRESIDENT
Ralph W. Jones, '38

VICE-PRESIDENT
Holley B. Dickinson, 36

SECRETARY
Donald S. Clark, '29

TREASURER
John R. Fee, '51

BOARD OF DIRECTORS
Robert J. Barry, '38
Franklin G. Crawford, '30
Frederick W. Drury, Jr., '50
John D. Gee, '53
William L. Holladay, '24
Howard B. Lewis, Jr., '48
Claude B. Nolte, '37

ALUMNI CHAPTER OFFICERS

NEW YORK CHAPTER

President Harry J. Moore, '48
I.B.M. Corporation, 590 Madison Avenue

Vice-President James C. Townsend, '54
404 East 65th St.

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56 Center St., Bernardsville, N.J.

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Vitro Corporation of Ameria, 261 Madison Avenue

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Armed Forces Special Weapons Project

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Applied Physics Laboratory, Johns Hopkins University
Silver Springs, Maryland

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Shell Development Co., Emeryville

Vice-President Lee A. Henderson, '54
Weld Rite Company, Oakand

Secretary-Treasurer Edwin P. Schlinger, '52
Scott-Buttner Co., Inc., Mountain View

Meetings: Fraternity Club, 345 Bush St., San Francisco
Informal luncheons every Thursday

CHICAGO CHAPTER

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

Vice-President Philip E. Smith, '39
Eastman Kodak Company, 1712 Prairie Avenue

Secretary-Treasurer Thorne J. Butler, '51
Medical Center, Northwestern University

SACRAMENTO CHAPTER

President James W. Dunham, '29
Division of Small Craft Harbors, State of California,
Dept. of Natural Resources

Vice-President Eugene W. Bolster, '45
Aerojet-General Corporation

Secretary-Treasurer G. Donald Meixner, Jr., '46
State of California, Dept. of Natural Water Resources

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

SAN DIEGO CHAPTER

Chairman Maurice B. Ross, '24
3040 Udal Street

Secretary Frank J. Dore, '45
Convair

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

in Los Angeles, has been appointed to the board of governors of Chapman College in Orange, Calif. The Bodines have two children – Linda and Albert J.

1938

George B. Holmes, MS '50, is now director of administration in the manufacturing and engineering division of the Burroughs Corporation in Detroit. He was formerly controller of the ElectroData Division of Burroughs in Pasadena.

1946

Keith Doig is now chief mechanical engineer in the Shell Oil Company's Houston Area production department. He has been at Shell since 1946.

Frank Lanni, PhD, has been promoted from associate professor to professor of bacteriology at Emory University in Atlanta. His wife, Dr. Yvonne Lanni, has been promoted from instructor to assistant professor of bacteriology and immunology.

1947

Fernand de Percin, MS, is now a polar research specialist at the U.S. Army's Research office in Washington, D.C.

Jonas Brachfeld is now chief of internal medicine at the Levittown General Hospital in Levittown, N.J., and also maintains a private practice there.

William Giacomazzi, manager of the Modern Ice and Cold Storage Company in San Francisco, hosted a swimming pool party for the San Francisco Chapter of the Alumni Association on August 28. New officers were elected at the party.

1949

Hugh Carter, president of the Hugh Carter Engineering Company in Long Beach, writes that a group of post-war Dabney men, and their wives and children, had a beach picnic at Newport Dunes in July. Some of those who attended were: *Thomas Hamilton* '52, *Charles Moody*, '48; *Albert Hook*, '49; *Wilbur Barmore*, '52; *Danny Markoff*, '50; *Roy Gould*, '49, PhD '56; *Bruce Hedrick* '51; *James McQuiston* '51; *Cecil Drinkward*, '50; *James Blom*, '50; *Richard D. Welsh*, '53 and *Hugh Carter*.

1950

Craig Marks, MS '51, PhD '55, writes that "I'm still working at the Technical Center of General Motors in Detroit. *Peter Kyropoulos*, MS '38, PhD '48, is just across the lake in the Styling Department."

1951

Harold F. Martin is now senior engineer and assistant to the director of development engineering in the IBM World Trade Corporation. Although stationed in Paris, Harold travels all over Europe. The Martins have a son, Charles.

Rodney T. Phipps, MS, died on November 5, 1959, of a heart attack. He was a geophysicist at the Union Oil Company office in Calgary, Alberta. He leaves his wife and two sons – Roderick, 9, and Graham, 8.

1952

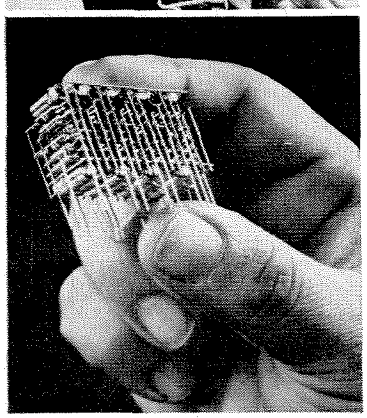
Lt. Col. William H. Wyatt, MS, former commander of the North American Defense Weather Forecast Center at Colorado Springs, is now a professional expert in the Directorate of Chemical Sciences at the Air Force Office of Scientific Research in Washington, D.C. He has been in the Air Force for 18 years. The Wyatts have four children – Evelyn, 17; Buddy, 12; Donna, 10; and Jeffry, 4.

Steingrimur Hermannsson, MS, writes from Iceland that he is "general manager of the National Research Council of Iceland. This is a government insti-

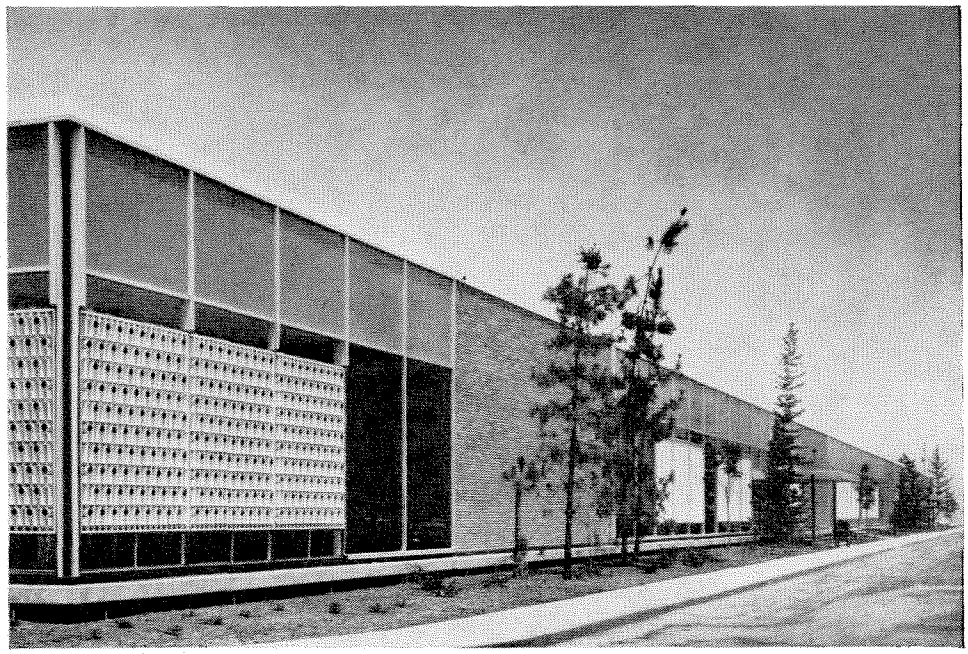
continued on page 56

ADVANCED FACILITY TO IMPLEMENT ADVANCED CONCEPTS IN COMPUTER SYSTEMS

Merritt MacKnight, Manager, Systems Development Department, demonstrates the sophisticated design of a Litton digital computer assembly for the new Grumman A2F.



Welded wire techniques substantially increase component packing densities.



This 180,000-square-foot building is the first unit of a facilities complex which eventually will comprise 825,000 square feet in the Los Angeles suburb of Woodland Hills, California. This facility of the Electronic Equipments Division of Litton Industries is designed for maximum convenience, comfort, and efficiency.

The primary areas of work here are the research, development and production of advanced real-time digital computer systems miniaturized for airborne applications; and high speed general purpose digital computers which incorporate the latest advances in the state of the art.

In our Guidance Systems Laboratory, pure inertial, astro-inertial, and inertial-doppler guidance systems are brought from newborn concepts to operating equipments.

If personal reasons dictate that you seek a new association at any time during the year, contact Mr. Sheldon Hirsch, Head, Research & Engineering Staff, Ventura Freeway at Canoga Avenue, Woodland Hills, California.

LITTON SYSTEMS, INC.
Electronic Equipments Division
Woodland Hills, Canoga Park, Beverly Hills, California • Waltham, Massachusetts

Computer & Control Systems • Tactical Data Processing Systems • Inertial Guidance & Navigation • Advanced Communication Techniques

AUTOMATIC TRANSLATION
INDEXING
ABSTRACTING

To formulate rules for automatic language translation is a subtle and complex task. Yet, significant progress is being made. During the past several years large amounts of Russian text have been translated and analyzed at Ramo-Wooldridge's Intellectronics Laboratories using several types of existing general purpose electronic computers.

Many hundreds of syntactic and semantic rules are used to remove ambiguities otherwise present in word-for-word translation. The considerable improvements that have been effected during the progress of this work indicate that it may be possible within the next year or so to produce, for the first time, machine translation of sufficient accuracy and at sufficiently low cost to justify practical application. Electronic computers are also invaluable for other language research activities at Ramo-Wooldridge.

Techniques for automatic indexing, automatic abstracting, and other aspects of communicating scientific information are also being investigated. Research and development at the Intellectronics Laboratories will eventually lead to electronic machines capable of carrying on self-directed programs of research and analysis and "learning" by their own experiences.

The accelerating pace at which these "communication of knowledge" problems are growing in importance has created challenging career opportunities in new fields of scientific endeavor.

For a copy of our career brochure, "An Introduction to Ramo-Wooldridge," write to Technical Staff Development.

RAMO-WOOLDRIDGE
a division of ***Thompson Ramo Wooldridge Inc.***
8433 FALLBROOK AVENUE, CANOGA PARK, CALIFORNIA

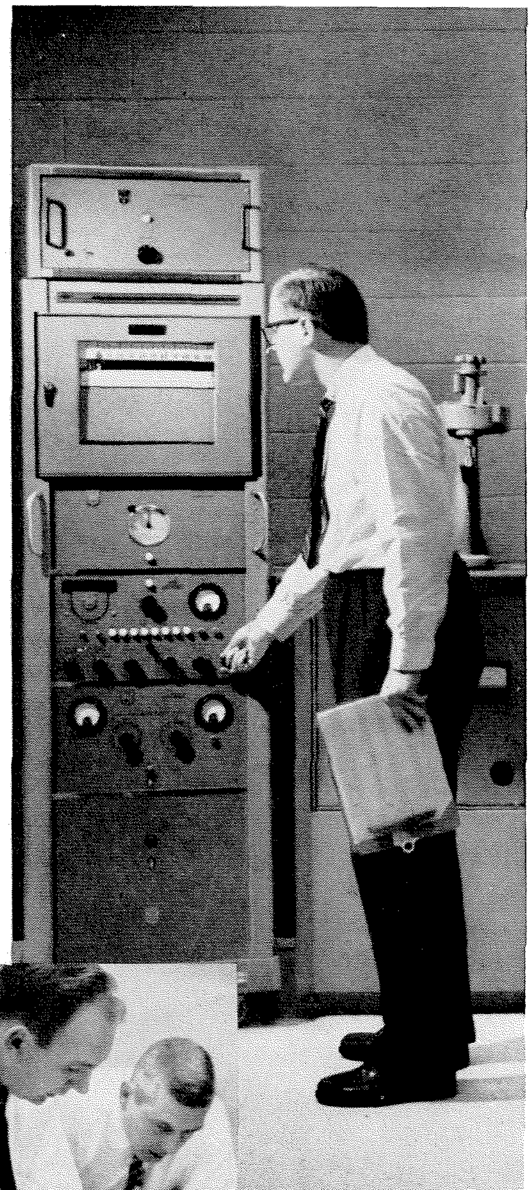
Facts about chemical industry growth that can be important to your future career

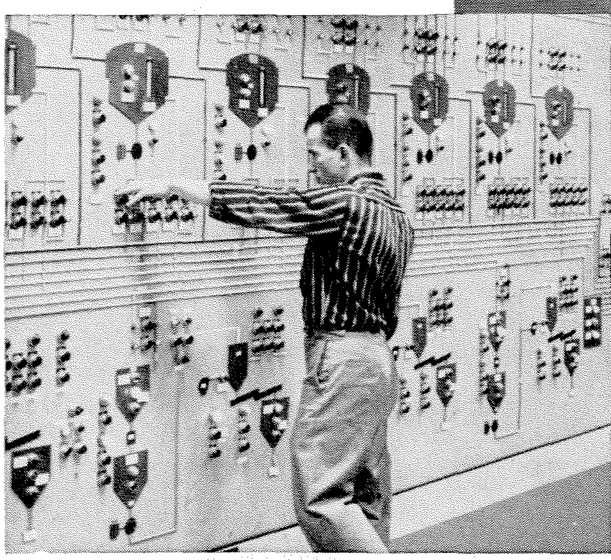
Did you know that the chemical industry has grown at a rate of about 10% per year since 1929, as compared with only 3% for the economy as a whole? It's a fact! And there's every reason to believe that this favorable growth rate will continue.

For the graduating chemist or chemical engineer, this spells opportunity. Opportunity to grow with a growing industry.

Allied Chemical, for example, now produces more than 3,000 diversified chemicals at over 100 plants throughout the country. Many of these products are basic—used in volume by almost every industry. Allied is at the heart of the nation's economy and looks forward to continued growth and stability.

Ask our interviewer about career opportunities at Allied when he next visits your campus. Your placement office can give you the date and supply you with a copy of "Your Future in Allied Chemical." Allied Chemical Corporation, Department 106-R1, 61 Broadway, New York 6, New York.





DIVISIONS:

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COAL CHEMICALS • SEMET-SOLVAY
SOLVAY PROCESS

Allied Chemical

BASIC TO AMERICA'S PROGRESS

tution for the coordination and strengthening of research in the country."

1954

John K. Wall, chief of the aerodynamics section at the Douglas Aircraft Company, Inc., in Charlotte, N.C., was married on July 2 to Joyce Brickman at the Westwood Community Methodist Church in Los Angeles.

1956

Richard H. Pratt is now engineer at De Leuw Cather and Company in San Francisco. He was married on August 27 to Laura Combs in Tulsa, Oklahoma.

1957

Michel Constanty, MS, has now finished his military service in France and is an engineer at the digital computer and punched card machines at Compagnie des Machines Bull in Paris. He was married in 1957 and now has three children – Helene, and twins Philippe and Brigitte.

Lowell M. Schwartz, MS, is now on the staff of the process research division of the Esso Research and Engineering Company in Linden, N.J.

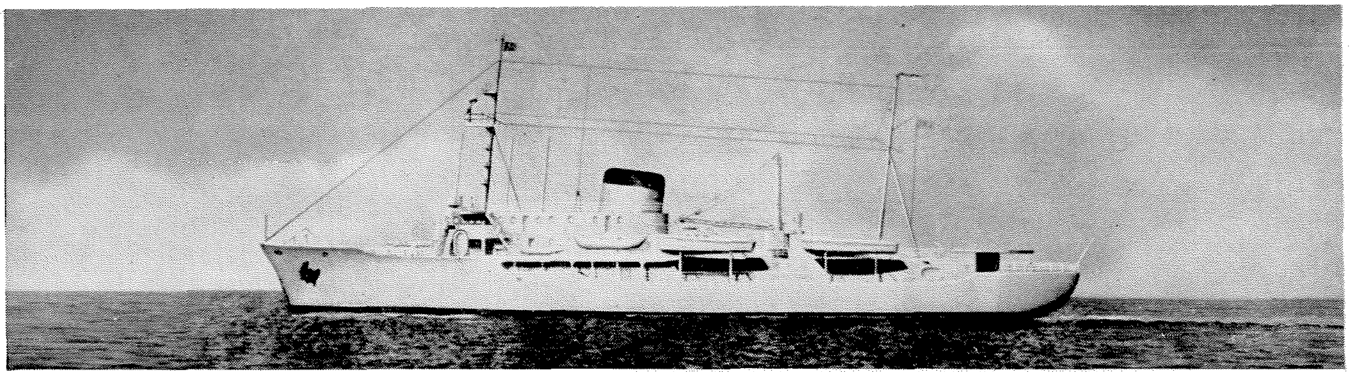
Marcel Landrieau, MS, writes that "after spending 2½ years in the French Army, I started working for Monsanto-Boussois in Pas-de-Calais, the French affiliate of Monsanto Chemicals Company, as a development engineer. We have a one-year-old son, Pierre-Henri.

"While we were still living in Paris, *Lowell Schwarz*, MS, and his wife, visited us. Lowell spent one year in Norway on a research scholarship. I spent six weeks in the U.S. in June. During my ten days in Cincinnati, I met *Andre LeRoy*, MS, who was still in the army."

Arthur W. Crowell died following an automobile accident in Corona del Mar on September 14. He was 29. He had just started working for the Nortronics Company in Anaheim. He was formerly a senior engineer at Automation Instruments, Inc., in Pasadena. Surviving him are his mother, three sisters, and four brothers.

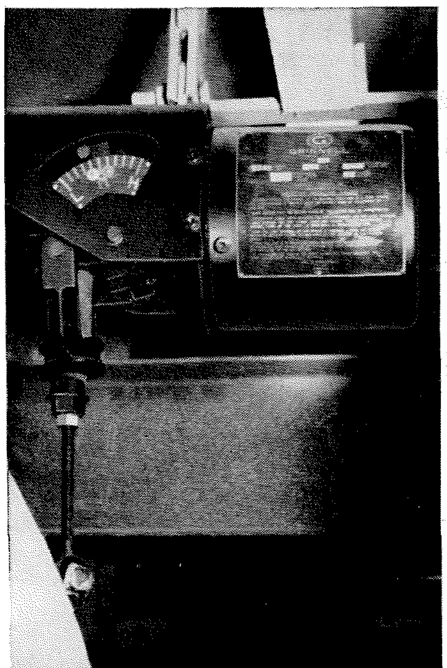
1958

William G. Wagner, *Frank A. Albini* MS '59, and *Robert H. Bond*, MS '59, have been awarded doctoral fellowships by the Hughes Aircraft Company which will allow them to work toward their PhD's at Caltech while holding related part-time jobs with the company.

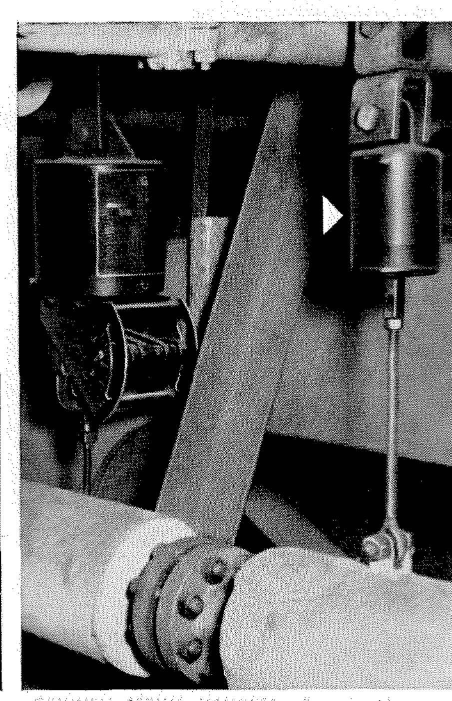


The "Surveyor" was built by National Steel and Shipbuilding Corp. for the U. S. Coast and Geodetic Survey.

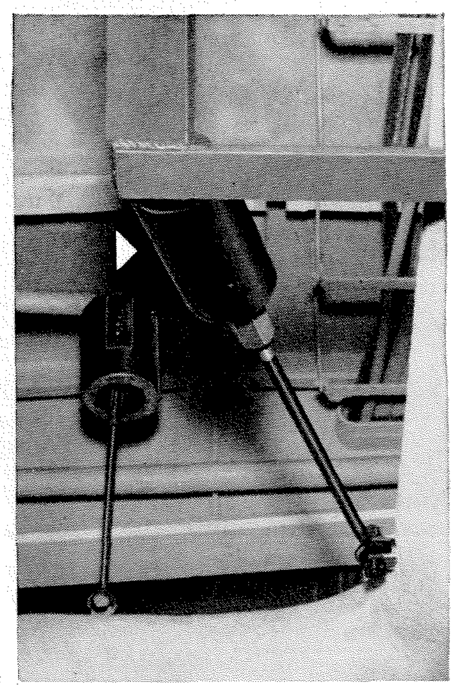
Aboard the new 5½ million dollar "Surveyor"... Grinnell Pipe Hangers and Supports



GRINNELL CONSTANT-SUPPORTS — Maintain full safety factor in high temperature, high pressure systems. For loads from 26 lbs. to 57,500 lbs., with travels up to 16 inches.



GRINNELL SPRING HANGERS — Provide minimum variation in supporting force — variation of only 10½% of rated capacity per ½ inch deflection for standard models. 21 sizes — 50 lbs. to 28,200 lbs.



GRINNELL VIBRATION CONTROL AND SWAY BRACES — Dampen vibration, oppose pipe sway and absorb shock. 3 sizes give full deflection forces from 200 to 1800 pounds.

The "Surveyor" has been called "the finest surveying vessel in the world." This ship . . . a two masted, single screw, steel vessel with a length of 292 feet, beam of 46 feet, and a light displacement of 2070 tons . . . is powered by a single 3500 SHP steam turbine. The cruising radius is 10,500 miles with 30% fuel reserve.

Safety for the high pressure, high temperature piping system aboard the new "Surveyor" was entrusted to Grinnell. Spring hangers and sway braces, designed and detailed by Grinnell, provide flexible support for piping throughout the entire range of movement caused by thermal expansion and sway.

Grinnell offers the services of trained field representatives and design services for consulting engineer firms. For your future hanger requirements, get in touch with Grinnell Co., Providence 1, R. I.

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AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

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CALTECH CALENDAR

ALUMNI EVENTS

October	Fall Dinner Meeting
Nov. 20	Interhouse Dance
January	Winter Dinner Meeting
March 4	Annual Dinner Dance
May 6	Annual Seminar
June 7	Annual Meeting

ATHLETIC SCHEDULE

Water Polo

October 11
Orange Coast at Orange Coast

October 14
College of Pacific at Caltech

October 18
San Fernando St. at Caltech

October 21
Claremont-H. Mudd at Claremont

October 25
Pomona at Pomona

October 28
UCLA at Caltech

Football

October 14
Pomona at Rose Bowl

October 22
Cal Western at Caltech

October 29
Whittier at Whittier

November 5
La Verne at La Verne

ALUMNI ASSOCIATION
CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

BALANCE SHEET – As of June 30, 1960

ASSETS

Cash in Bank			$ 918.00
Investments:			
Share in C.I.T. Consolidated Portfolio		$62,218.65	
Deposits in Savings and Loan Associations		16,899.87	79,118.52
Investment Income Receivable from C.I.T.			3,449.80
Postage Deposit			47.41
Furniture and Fixtures, at nominal value			1.00
Total Assets			$83,534.73

LIABILITIES, RESERVES AND SURPLUS

Accounts Payable			$ 290.59
Deferred Income:			
Membership Dues for 1960-61 paid in advance		$ 9,350.22	
Investment Income for 1960-61 from C.I.T. Consolidated Portfolio (earned during 1959-60)		3,449.80	12,800.02
Life Membership Reserve			55,500.00
Reserve for Directory:			
Balance, July 1, 1959	$2,760.13		
1959-60 Appropriation	2,000.00	$ 4,760.13	
1959-60 Directory Expense		4,566.53	193.60
Surplus:			
Balance, July 1, 1959		$ 9,642.19	
Share of Profit on Disposal of Investments of C.I.T. Consolidated Portfolio:			
1958-59	$3,081.92		
1959-60	1,100.36	4,182.28	
Excess of Income over Expenses for 1959-60		926.05	14,750.52
Total Liabilities, Reserves and Surplus			$83,534.73

STATEMENT OF INCOME AND EXPENSES
For the Year Ended June 30, 1960

INCOME

Dues of Annual Members		$15,837.65
Investment Income:		
Share from C.I.T. Consolidated Portfolio	$ 3,098.03	
Interest on Deposits in Savings and Loan Associations	860.44	3,958.47
Program and Social Functions		4,603.50
Annual Seminar		4,850.40
Miscellaneous		46.05
Total Income		$29,296.07

EXPENSES

Subscriptions to Engineering and Science Magazine:		
Annual Members	$11,086.25	
Life Members	2,873.50	$13,959.75
Program and Social Functions		4,937.68
Annual Seminar		4,640.43
Administration:		
Directors' Expenses	$ 270.44	
Postage	1,103.26	
Printing	240.23	
Supplies	334.53	
Miscellaneous	542.52	2,490.98
Directory Appropriation		2,000.00
Membership Committee		327.25
Fund Solicitation Committee		13.93
Total Expenses		$28,370.02
Excess of Income over Expenses		$ 926.05

AUDITOR'S REPORT

Board of Directors, Alumni Association, California Institute of Technology
Pasadena, California

I have examined the Balance Sheet of the Alumni Association, California Institute of Technology as of June 30, 1960, and the related Statement of Income and Expenses for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as I considered necessary in the circumstances.

In my opinion, the accompanying Balance Sheet and Statement of Income and Expenses present fairly the financial position of the Alumni Association, California Institute of Technology at June 30, 1960, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

CALVIN A. AMES, Certified Public Accountant
1602 West Thelborn St., West Covina, Calif.

One of a series

Interview with
General Electric's Byron A. Case
Manager—Employee Compensation Service

Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

Q Mr. Case, what starting salary does your company pay graduate engineers?

A Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

Q How do you go about evaluating my ability and potential value to your company?

A We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions; work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

Q When could I expect my first salary increase from General Electric and how much would it be?

A Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

Q How much can I expect to be making after five years with General Electric?

A As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have five years' experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

Q What kinds of benefit programs does your company offer, Mr. Case?

A Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50 percent* of the employee's investment, subject to a prescribed holding period.

If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-14, General Electric Co., Schenectady 5, New York.

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