ENGINEERING | AND | SCIENCE

April 1960

Off Guard . . . page 11

Published at the California Institute of Technology

ENGINEERING AND SCIENCE

APRIL 1960 VOLUME XXIII NUMBER 7

On Our Cover

an off-guard photograph of Carl Anderson, professor of physics, taken in his laboratory, while he was examining a cloud-chamber photograph through a viewer. The picture of Dr. Anderson was taken by Joe Munroe, as part of an assignment to photograph Caltech people and places for *Fortune Magazine*. For a further sampling of some of Mr. Munroe's candid views of Caltech faculty members, see "Off Guard" on pages 11-15.

Robert L. Daugherty,

who gives a progress report on smog control on page 17, is emeritus professor of mechanical and hydraulic engineering at Caltech. Professor Daugherty served as chairman of the advisory committee of the Los Angeles Air Pollution Control District from 1948 to 1953. Since 1954 he has been a member of the Air Pollution Control Hearing Board

Research in Progress

in Caltech's bustling immunochemistry center is described in the article on page 21. This research is part of a nationwide program to find relief for 17,000,000 allergy sufferers.

Photo Credits

Cover, pps. 11-15–Joe Munroe
16–Los Angeles County Air Pollution Control District
21-23–J. W. McClanahan

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

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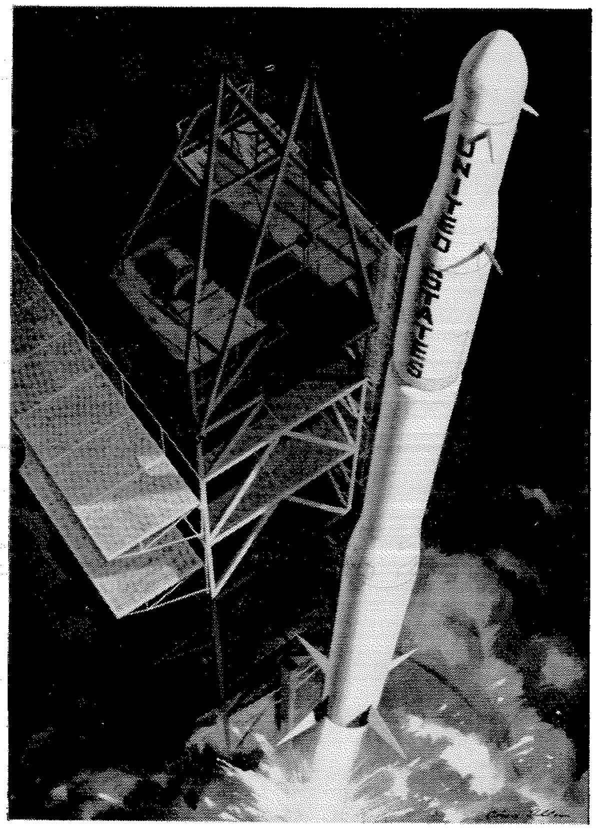
1 of 5 divisions at Vought where young engineers can rocket ahead!



FUTURE SPACE TRAVELER. Scheduled to do much of NASA's research in space is *Scout*. Vought Astronautics has a contract for the development of this 4-stage research rocket and its 7-story launcher.

Of particular interest to young engineers are the opportunities for advancement made possible by Vought Astronautics, a division of Chance Vought Aircraft, Incorporated.

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In all of this work, Vought's greatest asset is its strong backlog of technical and operational experience acquired through 43 years of leadership in high-performance vehicles.

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Books

Introduction to Chemical Engineering Problems

by William H. Corcoran and William N. Lacey

McGraw-Hill *$6.90*

Reviewed by Paul D. V. Manning, professor of chemical engineering

Many Caltech alumni who, as undergraduates, pursued the applied chemistry option will remember the course from which this book takes its title. They were the "guinea pigs" used by the authors. Both authors have participated in presenting this course, and their patient understanding of student psychology has done much to develop enthusiasm for the subject and is no doubt responsible for the underlying method of handling it.

Since chemical engineering fundamentals make use of physical chemistry in the consideration of chemical changes which result in processes, this book might be called "An Introduction to Applied Physical Chemistry." The authors have begun with the premise that the student has been exposed only to general inorganic chemistry.

The book is just what it purports to be – an *introduction* to the subject, and therefore its coverage is limited to several important essentials. For this reason, one who is more sophisticated may be tempted to put it aside as somewhat elementary. This criticism might be apt if applied to the first three chapters, but the authors had no intention of developing a reference book. Nevertheless, the chemical engineer who finished school ten years ago may find it a very worthwhile means of reviewing his grasp of this subject.

Anyone who has had the privilege of studying with the authors will remember their penchant for perfection, exactitude, and attention to detail. The book exhibits this, together with some boldness in method of attack. The result is an accurate, logical presentation. The student is led by means of the concept of internal energy through the solving of exemplary problems relating to chemical processes. The examples selected are such as to stimulate student interest not only because the chemicals involved are familiar, but also because the processes are of the relatively few concerning which very complete data is available in the literature. This makes it unnecessary to fill in with guesses – always a distracting thing to students.

The approach used is patently logical and develops the feeling that the fundamental methods involved can be successfully applied in studying other and more complex examples which the student may later meet. As stated in the preface, the effort is pointed towards learning by "active application of principles."

With characteristic care, the authors first set up two pages of symbols used. These are followed by chapters on units and an 18-page summary on methods of using mathematical procedures in solving engineering problems. Next comes a chapter on engineering measurements which is possibly more elementary than the rest of the treatise.

It is logical that the behavior of gases is then taken up. This is followed by an excellent discussion of material balances as applied to different methods of process operation. There follows the study of energy and the development of the energy balance. These lay the groundwork for a somewhat brief but well executed consideration of equilibria and kinetics of chemical reactions.

Four final chapters provide exceptionally good treatment by application of the preceding principles to processes. Those used include the synthesis of ammonia, production of nitric acid by ammonia oxidation, the manufacture of sulfuric acid, and finally of caustic soda.

Fifty-one problems bring this small volume to a close. The solution of at least some of these will tax the knowledge and resourceful thinking of many of our older chemical engineers.

Errors appear in almost every book and this one is no exception. However, these do not detract from its usefulness and the treatise will be found worthwhile by the chemical engineering profession, even at the somewhat astonishing price of nearly four cents a page.

Letters

SIRS:

In his article on the Caltech YMCA (*E&S*–February, 1960) Lance Taylor attempts a critical analysis of the organization which is "the orginator and guardian of almost all organized culture on the campus." His concluding criticism pinpoints the Y's failings on the fact that "as a liberal religious organization, it imports liberally religious speakers; as a hierarchal organization, it insures that most of its discussion leaders are of one mind; as an educational organization, it concentrates on quick once-over-lightly doses of culture."

In my estimation, Lance Taylor falls into the all-too-common error of identifying the YMCA as THE Caltech organization. His criticisms, though generally sound, are misdirected.

To illustrate this point, let us examine the context in which the Y operates. Caltech is an educational and research institution. The catalog states that cultural studies are included in the curriculum "to enlarge the student's mental horizon beyond the limits of his immediate professional interest and thus better qualify him to realize his opportunities and fulfill his responsibilities as a citizen and a member of his community."

These are noble aims, but unfortunately they often fail to achieve fruition in the case of the individual student. The one-third attrition rate is not the sole evidence of this, but merely represents one solution to the great dilemma that inevitably faces Joe D. Tekman, typical undergraduate, at some point in his Caltech career: "To be or not to be? And if so, why?"

These questions are perhaps common to all college students, but the problem is accentuated at Tech because of the overwhelming pressure to "conform and meet the norm" in science and engineering. The curriculum (which as yet imposes severe restrictions on the individual's freedom of choice) is a major source of this pressure, since it carries the implication for many people that to excel in the technical disciplines is commendable and desirable, but that to merely "get through" in the humanities is quite all right.

The second source of pressure is more insidious and subtle, for the majority of the instructors (dedicated scientists and engineers as they may be) tend to mix philosophy with fact in a manner often detrimental to the student's development as a social being.

We are therefore prompted to search on our campus for evidences of concern with the maturation of the student as a human being and a citizen of the world. And there are a number of such evidences. Though the YMCA is perhaps the only *organization* devoted to this area, there is a Public Affairs Room, capably administered by Mrs. Doris Logan; an InterNations Association; and various non-Y student groups such as the Drama Club, Debate, Model U.N., and others. To be sure, the conspicuous lack of formal participation in the area of "cultural education" on the part of the Institute is an important point to consider, but is a subject beyond the scope of this letter.

The point I am trying to stress is that, in the final analysis, the ultimate responsibility for gaining a broad perspective and concern lies with the individual himself. Others can assist in this process, but although it is undoubtedly difficult to develop in a vacuum, the vacuum often exists in the mind and not in the environment. Mr. Taylor, in criticizing the occasionally slanted program of the Y, is in reality criticizing himself and other members of the student body for failing to perceive this fault.

The YMCA, after all, is a *student* organization, and – as such – reflects student opinion and desires. I would be one of the first to agree with Norman Cousins that, in this day and age, it is imperative for every individual to be aware of world realities and to *act* on conviction. There is no better instrument than the Y for achieving this aim on the campus, but the incentive and drive must come from the student community.

– Tom Jovin '60

United Air Lines pilots review flight plan calculated by Bendix G-15 Computer at UAL's Operating Base, Denver, Colorado.

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Antoine Lavoisier...on algebra as a language

"Languages are not only intended, as is commonly supposed, to express ideas and images by signs, but also are real analytical systems by which we advance from the known to the unknown, and to a certain extent in the manner of mathematicians: let us try to expound this idea.

"Algebra is the analytical method *par excellence:* it has been contrived to facilitate the operations of the understanding, to make reasoning more concise, and to contract into a few lines what would have needed many pages of discussion; in short, to lead by a more convenient, rapid, and unerring method, to the solution of the most complicated questions. But a moment's reflection readily shows us that algebra is a real language: like all languages it has its representative signs, its methods, its grammar, if I may use this expression. Thus an analytical method is a language and a language is an analytical method; and these two expressions are, in some sense, synonymous."

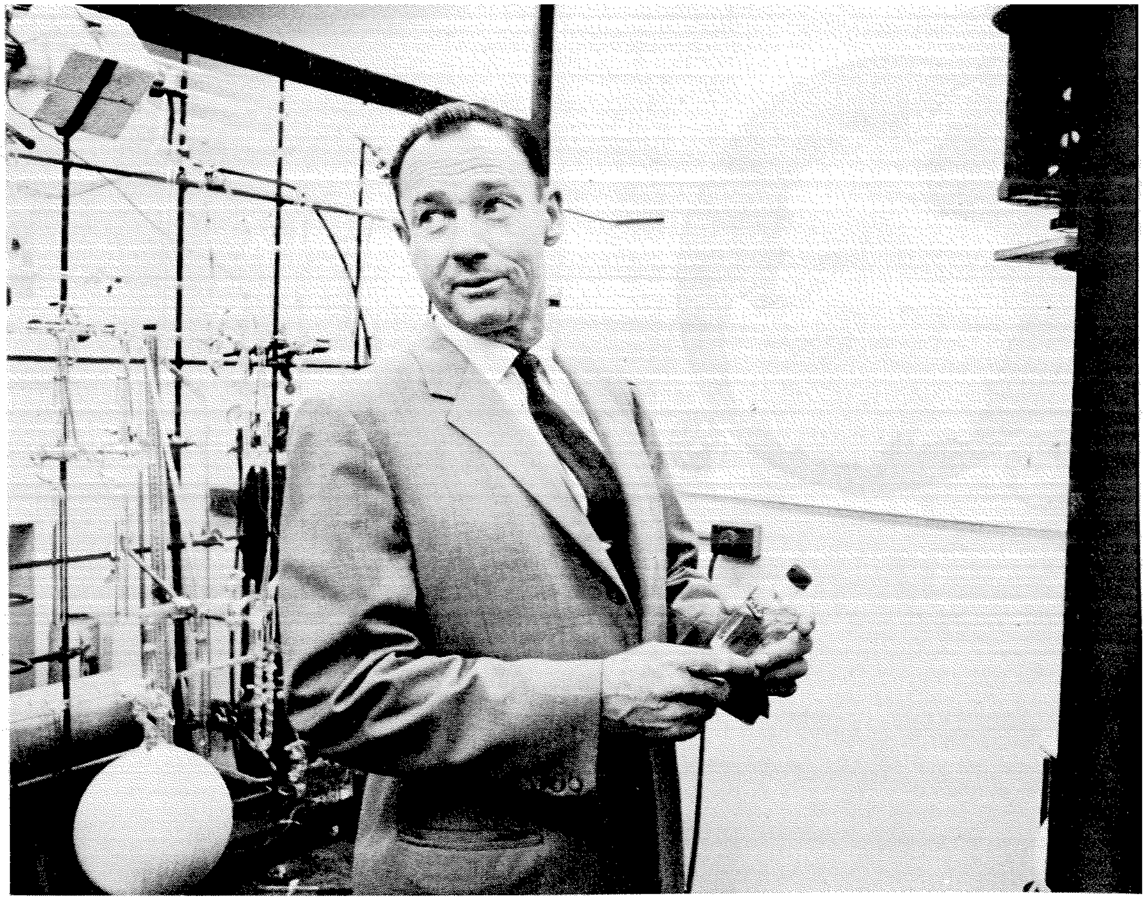
— Méthode de nomenclature chimique, 1787.

ENGINEERING AND SCIENCE
April 1960, Volume XXIII, No. 7

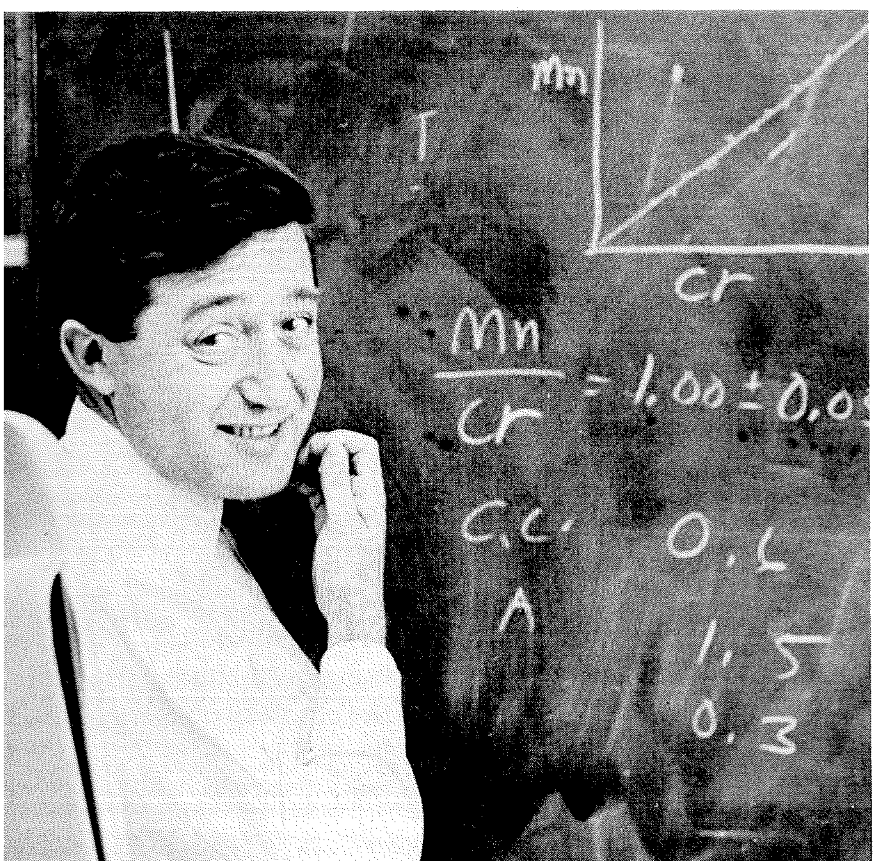
OFF GUARD

Some Unposed Faculty Portraits

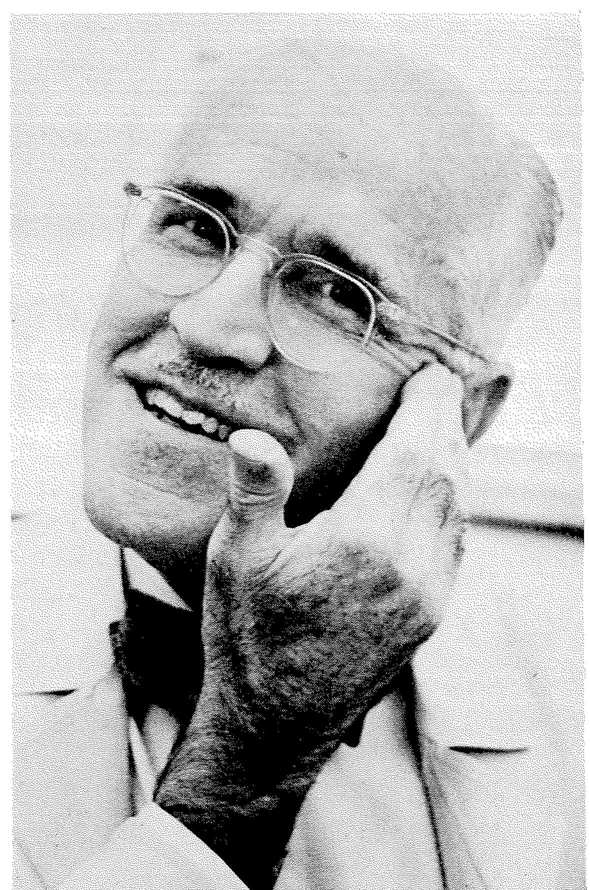
Readers of *Engineering and Science* are familiar with the continuing series of faculty portraits we have been running in these pages since 1956. These impressive camera studies by Tom and Muriel Harvey are forming a permanent pictorial record of some of the prominent members of the Caltech faculty in these years. On the following pages are some informal footnotes to this formal record — a lively series of unposed faculty portraits by Photographer Joe Munroe. When *Fortune Magazine* was preparing its feature article on the Institute last year ("Magnetic Caltech" — September 1959), Joe Munroe spent several weeks roaming the campus, recording the daily life of the Institute. From his extensive collection of Caltech photographs (and through the courtesy of *Fortune*) we have chosen some of the most candid of his faculty portraits.



Robert P. Sharp, chairman of the division of geological sciences



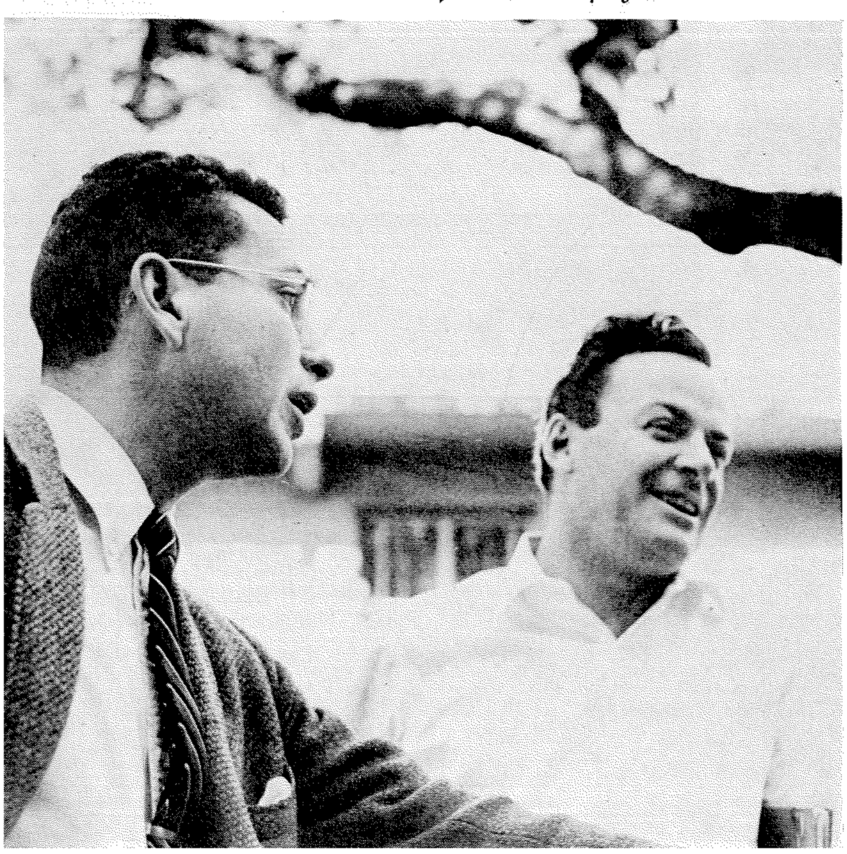
Harrison Brown, professor of geochemistry



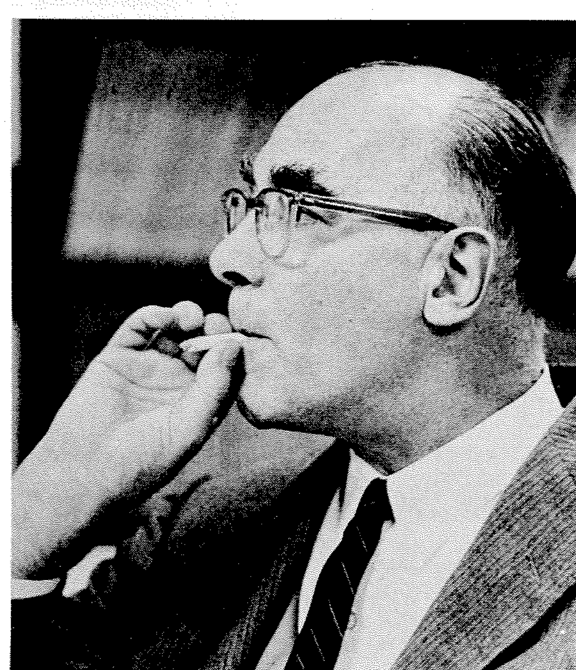
Ernest H. Swift, chairman of the division of chemistry and chemical engineering

Robert F. Bacher, chairman of the division of physics, mathematics and astronomy.

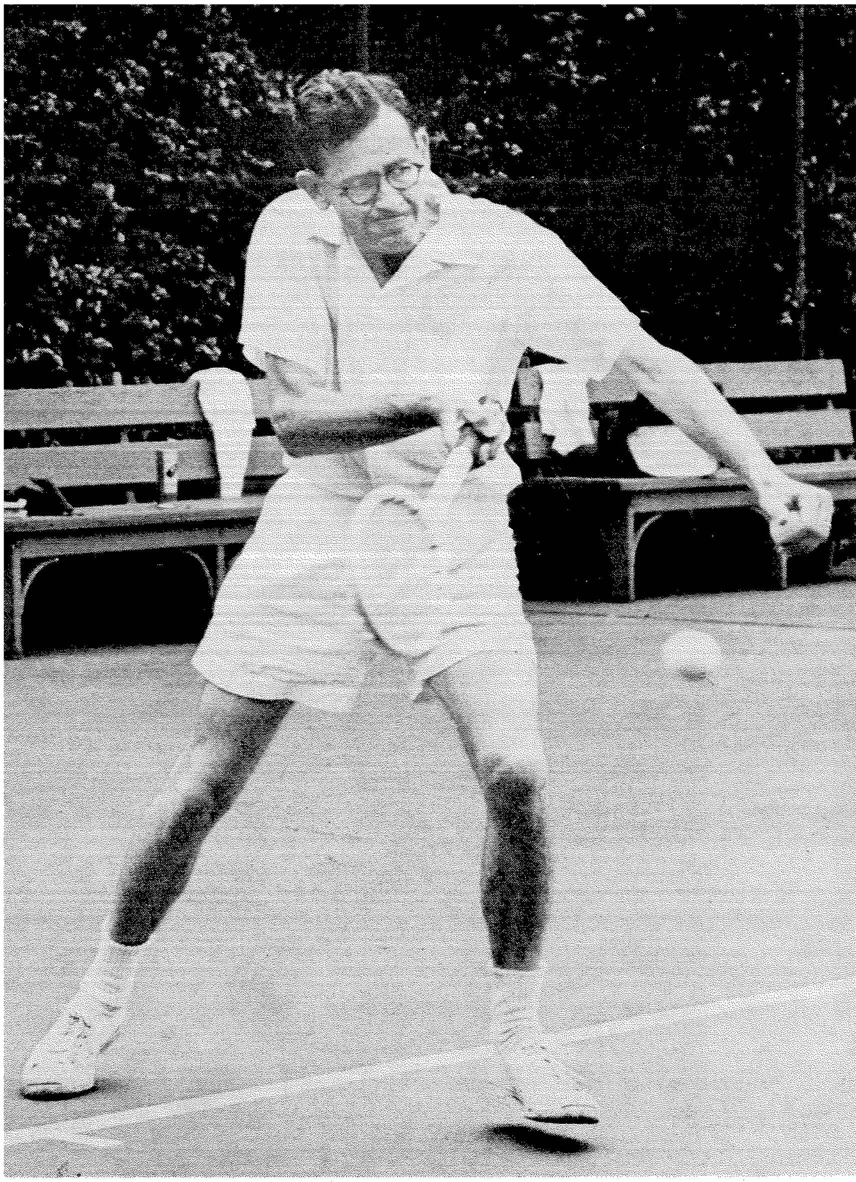
Olga T. Todd, research associate in mathematics



Murray Gell-Mann, professor of theoretical physics; and Richard P. Feynman, Richard Chase Tolman professor of theoretical physics



Carl D. Anderson, professor of physics



John D. Roberts, professor of organic chemistry

Hallett Smith, chairman of the division of humanities

Clark B. Millikan, director of the Guggenheim Aeronautical Laboratory

Frederick C. Lindvall, chairman of the division of civil, electrical, and mechanical engineering and aeronautics

President Lee A. DuBridge

Linus Pauling, professor of chemistry

John G. Bolton, professor of radio astronomy

Meteorological conditions make the air pollution problem particularly acute in the Los Angeles area.

The Control of Air Pollution

A progress report on smog control in Los Angeles County

by Robert L. Daugherty

Air pollution is becoming a worldwide problem, but it is particularly acute in the Los Angeles area because of the meteorological conditions that cause a temperature inversion more than 50 percent of the time. A layer of air aloft may have a temperature 20 degrees or more higher than the air at ground level and so it acts as a "ceiling" to prevent convection currents from dissipating contaminants into space. When this ceiling is several thousand feet above the ground there is no particular trouble, but when it drops down to 1,000 feet, or 500 feet, or even lower, the contaminants arising from the activities of something over 6,000,000 people are confined in too small a space.

Other places have legislation to cope with air pollution, but no place has a code for control that is as comprehensive and as strict as that of Los Angeles County. The word "smog" is coined from "smoke" and "fog" and is applicable to conditions in areas where coal is burned, but it is not an appropriate term here. Air pollution is the result of chemical reactions between many contaminants, and the products may be very different from the original constituents. Sunlight is an important factor in producing photochemical reactions. As an illustration, nitrogen dioxide (NO_2) is decomposed into NO and O and the free atom of oxygen then combines with O_2 in the air to produce ozone (O_3).

Air contaminants consist of: (1) invisible gases, (2) minute liquid droplets suspended in the air which produce haze and decrease visibility (3) particulate matter such as dusts and carbon particles which also decrease visibility. These air contaminants come from many different sources, but practically all of them may be put into one of 3 groups. In order of importance these are:

(1) Motor vehicle exhaust gases.

(2) Emissions from industry of all types, including steam power plants; heating plants for schools, hospitals, hotels, office buildings and others where residuum oil fuel is burned; oil refineries; storage and marketing of petroleum products; steel mills; iron foundries; chemical plants; and many others.

(3) And, formerly, emissions from open fires and single-chamber incinerators ranging from the silo-type in lumber yards, through the chute-fed type in apartment houses in which garbage and all other combustible refuse was burned, to the small backyard type in which theoretically only clean dry paper was burned — but in reality garbage, fresh grass cuttings, old rubber hose, greasy papers, oily rags, and other objectionable matter was consumed.

A reason for this grouping into three sources is the difference in the control problem for each.

(1) For the motor vehicle exhaust gases there is, up to the present time, no feasible commercial device for control for general use, but there may be in the near future. Until there is a practicable method of control there can be no enforcement of any law. The nuisance of smoking Diesel trucks and smoky emissions from worn "jalopies" is not included here because there is a law covering such emissions, which can be and is enforced by enforcement officers in patrol cars of the Air Pollution Control District. The main concern here is with the much greater quantity of invisible gases emitted from cars with engines in good condition.

(2) For industry there is a variety of control equipment — electrostatic precipitators, bag houses, water scrubbers, cyclone or centrifugal separators, gas-fired after-burners, catalytic chambers, sulfur recovery plants, and vapor recovery systems at gasoline loading-racks. And there are laws which are applied to industry which necessitate the employment of some means of control.

(3) The control for open fires and single-chamber incinerators was to prohibit their use. Open fires were forbidden in 1956. The use of 17,000 commercial incinerators was prohibited after July 1, 1957, and the 1,600,000 "backyard" incinerators for family use were banned after October 1, 1957. Multiple-chamber incinerators, which can be so designed as to comply with the rules and regulations, are permitted, but these are too large and too costly for family use.

Before there was any prohibition of such burning, it was estimated that about 2,000 tons of rubbish per day were burned in open fires and about 9,000 tons per day in single-chamber incinerators. To burn any substance completely it is necessary that four fundamental conditions be fulfilled:

1. There must be a proper amount of air supplied, usually from 10 to 50 percent more than the theoretical amount.
2. There must be a thorough mixing of air and combustible gases in the proper zone so that each particle of combustible matter may be in contact with the necessary oxygen at the proper time and place.
3. There must be a sufficiently high temperature for the reaction to take place. This temperature is about 2000°F to 3000°F.
4. There must be sufficient time for the chemical reaction to be completed before the temperature drops to too low a value for combustion to continue. This may be of the order of something below 1800°F.

THE AIR POLLUTION CONTROL DISTRICT

Los Angeles County's code for the control of air pollution is one of the most comprehensive — and one of the strictest — in existence. Violations of the air pollution control laws are criminal offenses. They are tried in regular courts, which may (and do) impose fines and even jail sentences.

The Air Pollution Control District of Los Angeles County is made up of three branches:

1. The Board of County Supervisors is the Legislative Branch.
2. The Air Pollution Control Officer — with a staff of engineers, inspectors, and enforcement officers — is the Executive Branch.
3. The Hearing Board is the Judicial Branch.

By State law the Hearing Board must consist of two attorneys and one chemical or mechanical engineer. It has a court room in the Hall of Records. It has three functions. It is a court of appeal for anyone denied a permit by the Control Officer. It can revoke permits when requested to do so by the Control Officer. But the greatest part of its duties consists in deciding cases of variances. A variance permits a plant to operate in violation and may be granted for a short time only if the petitioner can convince the Board that it is proceeding to remedy the situation and is diligent in so doing.

Robert L. Daugherty, Caltech professor of mechanical engineering emeritus, has been a member of the Air Pollution Control Hearing Board for the past six years, and was recently reappointed for a third three-year term.

With 6,000,000 people here now, and more arriving every day — what chance have we got of returning to a pure atmosphere?

These four conditions can be fulfilled in the furnace of a steam boiler. They cannot be fulfilled in a single-chamber incinerator or in the cylinder of an automobile engine. In the incinerator the combustion conditions are very bad, especially when wet rubbish or other unsuitable material is burned. Even with the best of care in operation the single-chamber incinerator will periodically emit smoke with an opacity in excess of that permitted by the Health and Safety Code of the State of California, and it will also emit ash in excess of that permitted. Some of the ash emitted may be easily seen, but much of it may be so fine as to be practically invisible to the naked eye, and it would add to the dust in the air and decrease visibility.

Emissions from single-chamber incinerators vary greatly in amount and in character, depending upon the material burned and the conditions of operation. The Air Pollution Control District estimated that prior to their banning these incinerators emitted 130 tons per day of organic gases and 222 tons per day of inorganic gases – or a total of 352 tons of contaminant gases, and from 45,000 to 225,000 pounds of particulate matter per day. The organic gases are hydrocarbons (CH compounds), phenols such as carbolic acid (C_6H_5OH), aldehydes such as formaldehyde ($HCHO$), and ketones such as acetone ($CH_3-CO-CH_3$). The inorganic gases are carbon monoxide (CO), sulfur dioxide (SO_2), sulfur trioxide (SO_3), oxides of nitrogen as (NO_2 and NO), and ammonia (NH_3) All of these are contaminants. Non-contaminants, which form the bulk of the emissions, are carbon dioxide (CO_2), nitrogen (N_2), and water vapor (H_2O).

The contribution of incinerators

No informed person ever contended that incinerators were the principal source of "smog," or that their abolishment would eliminate it. But their contribution, though minor in amount, consisted of very objectionable material, and they were responsible for odors, for which there is no numerical scale. It is my opinion that they were the chief source of just plain smoke.

This is borne out by a movie film taken one clear Sunday morning by a camera set up overlooking all of Pasadena, in which one frame was exposed every few minutes, so that in a few minutes one can see on the screen what took place over several hours. Shortly after daybreak it is possible to see all of Pasadena and even the Montebello Hills in the distance. Then one incinerator is lit and a plume of white smoke rises from it. Then smoke can be seen from a second incinerator, and a third, and many others. Soon all these plumes of smoke merge and blanket the entire city from view. The film is entitled *The City That Disappeared.*

The cost of control equipment

Industry has spent in excess of $79,000,000 for control equipment, practically none of which pays any dividends to stockholders. It is not at all uncommon for the control equipment to cost from 10 to 20 percent of the cost of the entire plant. For instance, a plant costing $40,000 required $10,000 more for control equipment, and another plant costing $1,300,000 needed $320,000 for control equipment. Industry has been very cooperative. In a number of instances, when the Air Pollution Control Hearing Board of Los Angeles, which controls smog violations, has been told of plans to spend several hundred thousand dollars for control, and the question is asked, "Is your company willing to spend this amount?", the answer has been, "Absolutely yes! Our board of directors has told us we must solve this problem regardless of how much it costs."

This amount is only the capital cost. The cost of operation is unknown, but covers such items as the electric power, water, gas, replacement of parts, repairs, and maintenance.

Some problems in industry are readily solved, but others involve much time and expense with many trials. An electrostatic precipitator, for example, may be entirely satisfactory in one plant and not in another similar plant.

Of the many types of industry only two, oil refineries and steam power plants, will be discussed here. The oil refineries have spent $42,000,000 for control equipment and, as a result, their emission of hydrocarbons has been reduced from 800 tons per day to 103 tons per day, and sulfur dioxide has been reduced from 900 tons per day to 115 tons per day.

Sulfur dioxide in the atmosphere

Steam power plants and other installations must use residuum oil fuel at times because there is not enough natural gas to meet all of our needs all of the time. All fuel oil in this area contains sulfur in an amount ranging from a minimum of about 1.2 percent up to 3 or 4 percent, the average being around 1.6 percent. Thus, for every 100 pounds of oil burned there will be emitted an average of 3.2 pounds of sulfur dioxide. The total amount of sulfur dioxide emitted to our atmosphere is now as much as 400 tons per day at times, and will tend to increase in the future. Hence a recent rule prohibits the use of fuel oil which contains more than 0.5 percent sulfur during the "smoggy" season from May 1 to September 30.

There is no known method of removing sulfur from fuel oil except at a prohibitive price and the product will then be a refined oil of some type. And there is no feasible way of removing the sulfur from flue gas, so far as is now known. For example, at a certain power plant the volume of flue gas at stack temperature of 745°F is 775,000 cubic feet per minute, and the percent of sulfur dioxide in it is only about 0.07 percent. To treat such a large volume of gas for such a small amount of sulfur dioxide is impractical.

The Air Pollution Control District reports these emissions from industry (in tons per day) as of July 1, 1959.

Contaminant	*Total Possible Emission*	*Actual Emission*
Hydrocarbons and other organic gases	1,705	580
Oxides of sulfur	1,325	330
Aerosols (smoke, dust, fumes, mists)	455	65
Carbon monoxide	1,680	890
Oxides of nitrogen	350	280
	5,515	2,145

In 1940 there were 6,000 industrial plants in Los Angeles County. In 1957 there were 18,000. In 1940 the population was 2,800,000. In 1959 it was 5,830,000. In the face of these increases the APCD has done well to keep the air pollution from becoming worse.

The gains that have been made by the elimination of single-chamber incinerators and by the control in industry have been nearly offset by the increase in automobiles and gasoline consumption. In Los Angeles County as of July 1, 1959, we have the following:

Population	5,830,000
Automobiles	2,634,000
Gasoline buses & trucks	286,000
Diesel powered vehicles	9,000
Gasoline, gallons per day	5,820,000
Diesel fuel, gallons per day	100,000

The population has been increasing at an average rate of about 200,000 a year and the gasoline consumption has been increasing at the rate of about 200,000 gallons a day per year. It was recently reported that as of January 1, 1960, the population of the county was slightly in excess of 6,000,000. There is approximately 1 automobile for every 2 persons, and the average consumption of gasoline is 2 gallons per car per day or 1 gallon per day per person. Hence the gallons of gasoline per day is equal to the population. The volume of exhaust gas each day would cover one square mile to a depth of 250 feet.

The air theoretically required to burn 1 lb. of gasoline is about 15 lb. It is necessary to have a high velocity of flame propagation in order that the flame may travel from the spark plug to the most remote part of the combustion chamber while the piston is on or near dead center. The flame velocity will be a maximum when there is a deficiency of air of from 10 to 40 percent. Another consideration is that maximum power will be attained when all of the oxygen in the cylinder is used up, and this requires an air/fuel ratio of around 12:1. Thus, both these factors lead to the same conclusion, which is that for good power at or near full throttle, the mixture must be on the rich side.

Incomplete combustion products

For other reasons, the mixture at or near idling must be even richer. For cruising at steady speed on part throttle the carburetor may provide a mixture with a ratio near to 15:1 or even up to 16:1 in some cases. But even this is not lean enough to ensure complete combustion. To have complete combustion, the mixture would be so lean that the engine would lack power, it would overheat, and combustion would be so slow that exhaust valves would be burned, and there might even be flame coming out of the tail pipe. Hence it is inevitable that there will be incomplete combustion products in the exhaust. This is not the fault of the fuel, the carburetor, or the engine. It is inherent in the combustion process.

The percentage of unburned or partially burned fuel is very high during deceleration, but the amount of fuel used during that operation is relatively small. The rate of fuel use is greatest at full throttle and so any incomplete combustion, even though small in percentage, will provide a substantial amount of incomplete combustion products in the exhaust. So, to estimate the amount of unburned fuel in the exhaust during a normal car operation it is necessary to know, not only what percentages of incomplete products are found in each cycle of operation, but also the total gasoline use in such cycles. In other words one must know the driving cycle of the car. And to estimate the total amount of air contaminants during the day from all cars, it is necessary to determine an average driving pattern for all cars as to the duration of time in idling, decelerating, accelerating, cruising, and full throttle steady speed.

As a result of such studies of driving patterns, the Air Pollution Control District has given the following estimates of automobile exhaust gases as of July 1, 1959, from gasoline powered vehicles only.

	Tons/day	*% of Fuel*	*% of Exhaust Gas*
Hydrocarbons, aldehydes, ketones and other organic gases	947	5.26	0.368
Oxides of nitrogen	430	2.39	0.167
Oxides of sulfur	48	0.268	0.019
Carbon monoxide (CO)	4,200	23.33	1.63
	5,625	31.248	2.184

In addition to the above, some very recent measurements have revealed that the "blowby" (or leakage) past the piston rings and emerging from the crankcase ventilator may be from 10 to 50 percent or more of the hydrocarbons in the exhaust. These emissions are mostly unburned gasoline with only a trace of exhaust gas. Thus the total hydrocarbons from motor vehicle operation may be from 1,000 to 1,500 tons per day. (Compare this with the 103 tons per day from the refineries).

Carbon monoxide—no hazard

Carbon monoxide is deadly in closed spaces, but it is not considered a hazard outdoors because its concentration there is too low. It is colorless, odorless, and tasteless, and is not a contribution to "smog" as we know it.

Oxides of nitrogen are formed by a union of the oxygen and nitrogen in the air when it is at high temperature in a furnace, in an engine cylinder, or in an electric arc. This is a contaminant which has not received much attention up to now.

It has recently been proposed that the crankcase emissions from blowby be returned to the intake manifold to prevent their emission into the air. It has also been found that recycling a small fraction of the exhaust gas into the cylinder will decrease the amount of oxides of nitrogen in the exhaust gases, but more study of this seems to be needed to determine its practicability.

A complete solution of the motor vehicle problem will require an afterburner of some type to complete the combustion of the gases after they have left the cylinder. The afterburner problem is a difficult one. The exhaust gases are hot, but the temperature is not high enough for spontaneous combustion and the addition of the necessary air will further reduce the temperature. Thus it is necessary to initiate combustion by a direct flame or by a catalyst. The problem is also difficult because the percent of combustible gases in the mixture is low. It is necessary to maintain a high temperature to ensure combustion, and this is hard on the material of the afterburner. The catalytic device has many merits, chief of which is that oxidation takes place at a lower temperature than with the direct flame type. But the catalyst has a short life, as it is "poisoned" by the tetraethyl lead used in all grades of gasoline.

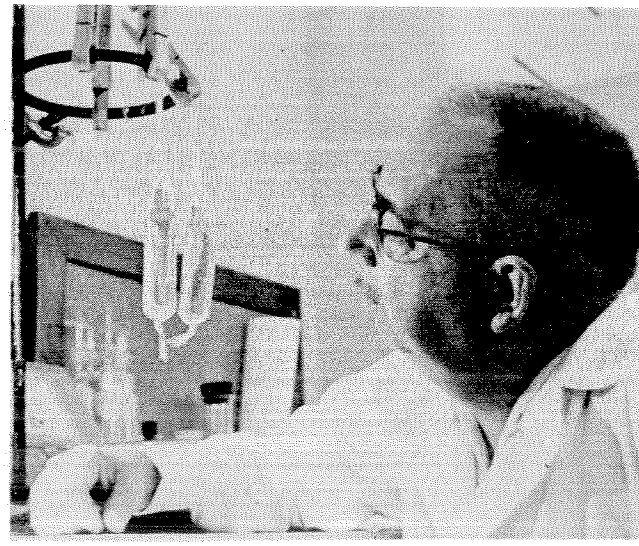
A number of afterburners have been used on test cars and have given promising results. But a commercially successful one must not be too expensive; it must have a long life without any maintenance; replacement of parts should be easy and inexpensive; and an official inspection should not be required too frequently.

So far as the fuel is concerned, it is well known that a petroleum product is "cracked"—that is, its molecular composition is altered by being subjected to high pressure and high temperature simultaneously. But that is the condition in the cylinder of the internal combustion engine. In other words the engine is a good cracking device. It has been determined that hydrocarbons in the exhaust may be very different from those in the gasoline. Thus the U.S. Bureau of Mines found that when pure butane, a paraffin (C_4H_{10}), was used as fuel, the olefins (C_nH_{2n}) in the exhaust were 42.1 percent.

It has been determined by Dr. A. J. Haagen-Smit, professor of bio-organic chemistry at Caltech, that the olefins are more reactive than the paraffins, and there would be some advantage in reducing the percentage of the olefins in the exhaust. With the gasolines used in this area, there seems to be a relation between the proportion of olefins in gasoline and those in the exhaust, and hence there is to be a restriction in the percent of olefins permitted in the gasoline sold in the county.

A look ahead

The abolition of single-chamber incinerators and the use of various control means by industry has resulted in a material reduction of air contaminants from those sources. However, this has been nearly offset by the continual increase in the number of automobiles, with a resulting steady increase in gasoline consumption, until now the motor vehicle is responsible for about 70 percent of the air pollution. There is hope, though, that in the near future satisfactory control devices for automobiles will be available and, in that event, there should be a material reduction in the "smog" nuisance. But with over 6,000,000 people here now, and more coming every day, we cannot expect to return to the atmosphere of 50 years ago. We can, however, look forward to better conditions than we now have.



Dan Campbell, head of Caltech's immunochemistry center, studies protein concentration in a current allergy experiment.

Caltech's Immunochemistry Center

It joins in a program designed to find relief for allergy sufferers

Scientists in Caltech's bustling immunochemistry laboratory are piecing together information from a variety of sources about medical problems that range all the way from house dust allergies to radiation damage.

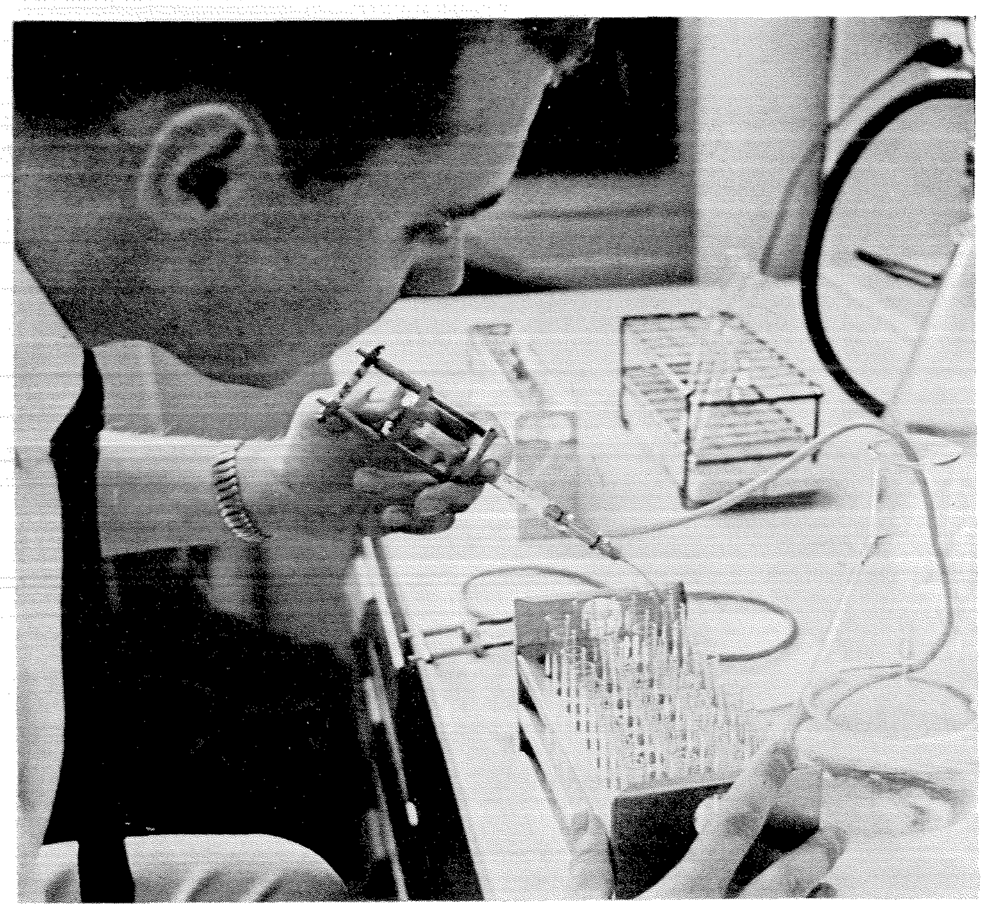
The research is part of a nationwide program by allergists, immunochemists, and the U.S. Public Health Service to find some kind of relief for the 17,000,000 allergy sufferers in America. The Caltech laboratory is one of the principal immunochemical centers in the nation. The laboratory is not only engaged in research; it is also an advanced training center for graduate students, postgraduate and postmedical students in the comparatively new field of immunochemistry.

Immunochemistry is the study of antigen-antibody reactions. These reactions occur when the body produces specific proteins (antibodies) which may combat the harmful effects of foreign substances (antigens) that invade the body. The antigen-antibody reactions can also produce diseases. Practically any protein can act as an antigen, and antigen-antibody reactions can produce side effects ranging from asthmatic sneezes up through fatal body-wide shock.

Dan Campbell, head of the Caltech research group, has been at the Institute since 1942; and his was probably the first professorship ever given in immunochemistry. His current research interests: studies of the mechanisms of antibody formation and antigen-antibody reactions; isolation of allergy-causing antigens (allergens) in house dust and pollens; and studying the effects of high altitude on immune responses and allergies.

Hypersensitive guinea pigs are used in Dr. Campbell's research into altitude effects on various allergies. With E. M. Heimlich of the Pediatrics Department at UCLA (who was at Caltech last year as a research fellow), Dr. Campbell took asthmatic guinea pigs up to a 14,000-foot altitude at White Mountain, California. At this high altitude, their antibody production jumped drastically for two or three weeks. At the same time, the guinea pigs' asthma improved. Research into the "how" and "why" of the increased antibody production is still going on.

Sources of many of the antibodies produced in men and beasts may be the liver, spleen, and lymph nodes. One of the Caltech immunochemists investigating these organs is Dieter H. Sussdorf, a research fellow recently arrived from Argonne National Laboratory near Chicago. While at Argonne, Dr. Sussdorf found that rabbits produced far fewer antibodies after having been exposed to radiation. He encased the appendixes (which are extra large in rabbits) of a few animals in lead, and exposed these rabbits to radiation. Unlike the non-shielded animals, these rabbits produced normal amounts of antibodies. The antibodies came from the radiation-damaged spleen. Dr. Sussdorf's conclusion was that the lymph cells from the undamaged appendix had migrated to the spleen and there produced antibodies — something they never



Dieter H. Sussdorf, Caltech research fellow, determines the amount of antibodies in rabbit serum (left) by adding antigen to various dilutions of serum. The antigen will precipitate the antibody in the tubes. Below, the precipitated antibodies are then separated from the solution by centrifugation and the precipitate is analyzed for its antibody content.

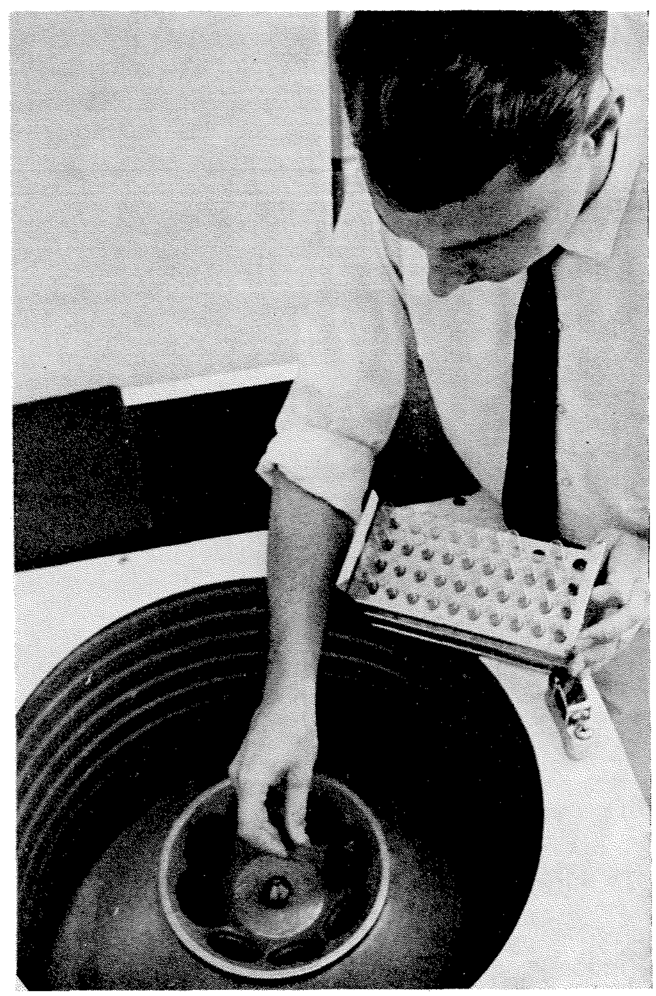
did in the appendix. Dr. Sussdorf is now following up his previous research by attempting to fractionate the spleen (and its lymph cells) into antibody-producing and non-antibody-producing parts.

Researchers all over the nation are trying to isolate and standardize the substances called allergens which cause symptoms like sneezing, asthma, and rashes. Dr. Campbell is chairman of a committee set up by the National Institutes of Health to standardize these allergens.

One of the chief difficulties faced by the committee, when testing and treating persons for allergies, is that the substances used for these purposes are prepared in different laboratories under different conditions, and are not similar enough to produce precise clinical results. For example, a person is tested for sensitivity to ragweed (more than 5,000,000 Americans have this sensitivity) by being injected with ragweed pollen in a saline solution. If he is sensitive to ragweed, a welt will appear. He is then given a series of these same injections until he develops an immunity to ragweed.

The particular pollen used on this patient probably contains several allergens. He may be allergic to one or more of these. Researchers must isolate the exact fraction of every type of ragweed that seems to be causing the trouble until, eventually, standards for each allergen will be established.

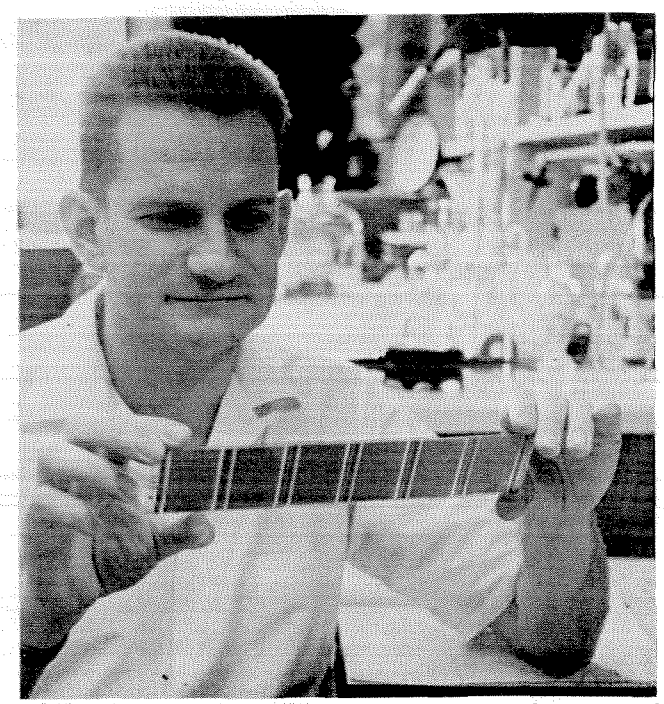
Dr. Campbell and research fellow Wilton E. Vannier, who received his PhD at Caltech in 1958, are



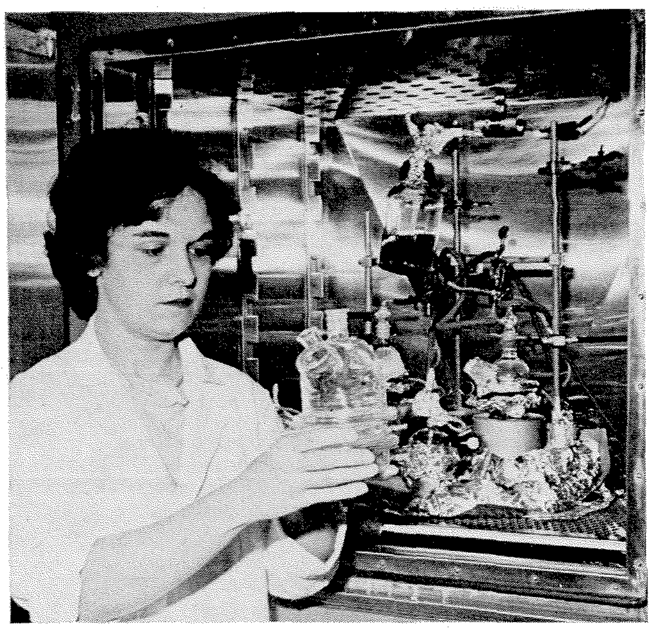
working on the isolation of active house dust allergen fractions. These materials have been found to consist of a mixture of acidic polysaccharides (a complex sugar compound) combined with polypeptides. The importance of house dust in allergy studies has grown since a demonstration in 1922 revealed that this combination of substances contained materials that would produce intense skin reactions in specifically sensitive individuals. About one-third of all allergic individuals give a positive skin reaction to house dust extracts.

Senior research fellow Justine Garvey has been using radioactive tracers to find out what happens to antigens when they enter the body. Instead of being eliminated completely, they often go to certain locations in the body – especially the liver. There are often several thousand molecules of a particular antigen to one liver cell and thousands of these antigen molecules have remained in the liver for as long as 500 days or more. After this time, antigens in the liver are not found in conjunction with any antibodies in the blood.

The immunologists think the reason for this is that when antigens enter body cells they get entangled with ribonucleic acid (RNA), which has a great deal to do with the formation of proteins. The antigen-RNA combination leads to antibody synthesis, and the antibodies react in the cells with the antigens and with RNA. As this occurs, antibody production drops. For some reason, the antigens in the liver are not destroyed during this process. Dr. Garvey is trying to find out why – with the help of an amazing arrangement of glass tubing dubbed a "Marsman." This instrument was developed by research fellow Herman Ainis, who is currently using it to culture and produce antibodies in vitro.



Wilton E. Vannier, staff member of the Laboratory of Immunology at the National Institute of Allergy and Infectious Diseases in Bethesda, Md., studies ultracentrifuge photographs of antibodies which exist in rabbit serum, to determine their molecular weights.



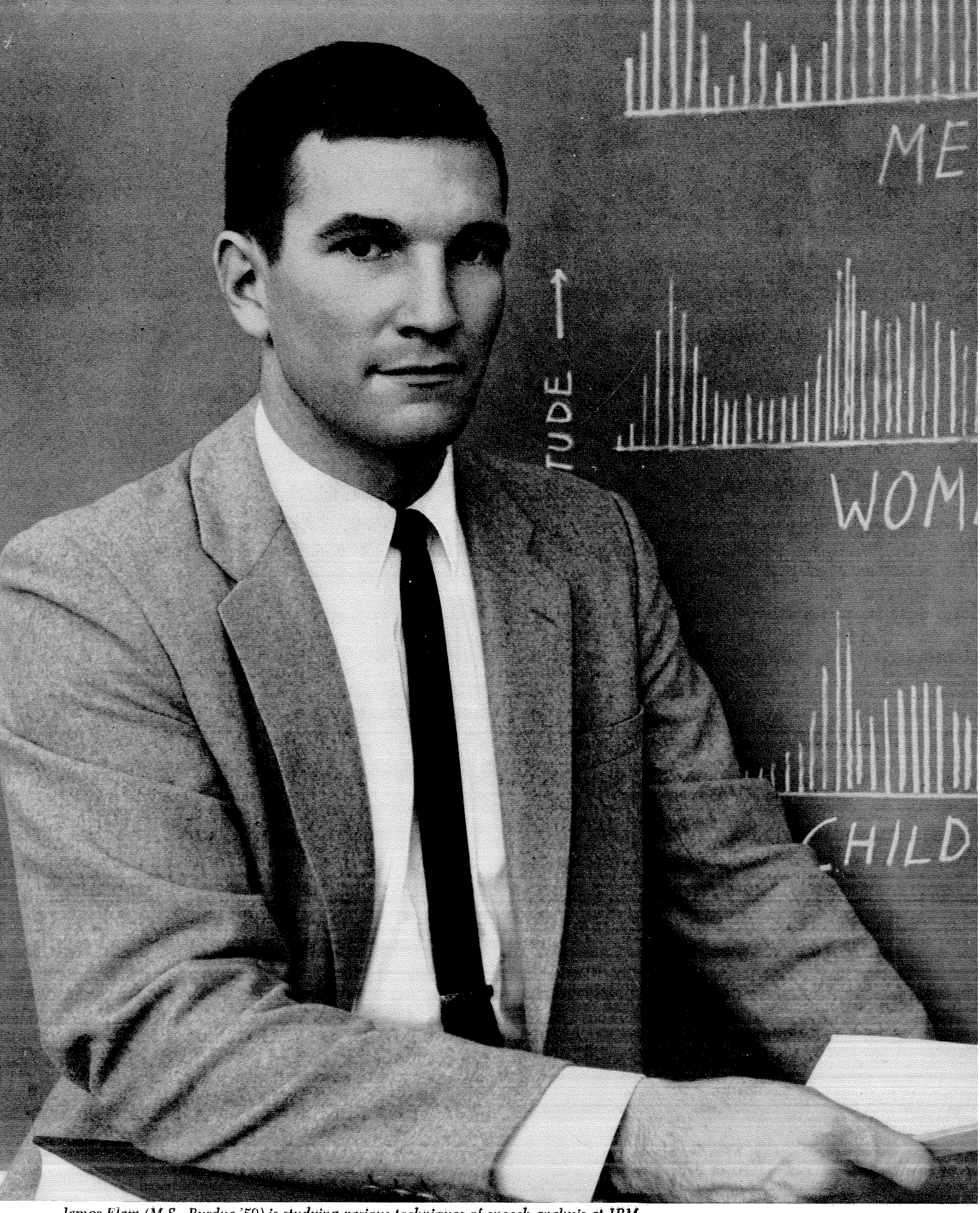
Senior research fellow Justine Garvey and the "Marsman," a complicated collection of glass tubing used to grow tissue and produce antibodies in vitro. Dr. Garvey holds the core of the "Marsman," where nutrients are fed to the tissue.

Research fellow Arthur A. Hirata, who is also studying antibody formation, has found that antibody concentration in the blood of neonatal chicks is much lower than in chickens six weeks old. Apparently antigens injected into neonatal chicks go directly to various tissues and there suppress antibody production. The same effect occurs in adult animals if they are given massive doses of antigens.

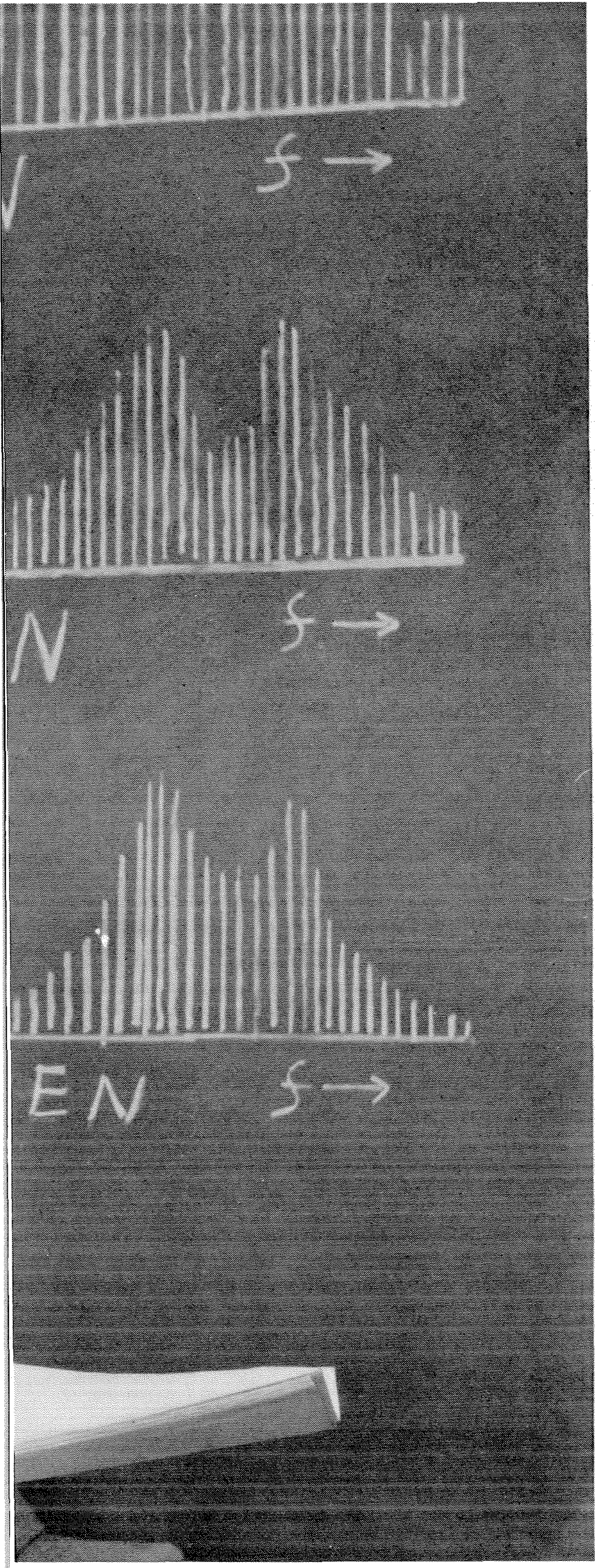
The problems being explored by Drs. Garvey, Ainis, and Hirata may have great application to medicine, since human babies as well as chicks apparently are unable to make antibodies. This often leads to severe staphylococcus infections among infants, since an antibody for staph bacteria is not included among the ones a baby receives from its mother before birth. Similarly, adult humans seemingly lose the ability to synthesize antibodies to certain substances after long exposure to them.

Caltech's immunochemists are also studying the effects of the well-known plasma constituent, gamma globulin, on antibody formation. And they are investigating the possibilities of immunizing animals against their own tumors. By means of this slow, painstaking research and the discoveries these researchers are making about the behavior of immunochemical reactions, we may reach an increased understanding of immune reactions that occur in many diseases.

– Lance Taylor '62



James Elam (M.S., Purdue '59) is studying various techniques of speech analysis at IBM.
The objective of this work is voice-machine communication.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Psychologist Carl R. Rogers, visiting Caltech on the Leaders of America program, talks with student leaders.

The Month at Caltech

Leaders of America

Dr. Carl H. Rogers, professor of psychology and psychiatry at the University of Wisconsin, was on the campus from April 18-20 as the second visitor in this year's Leaders of America Program, sponsored by the Caltech YMCA.

Dr. Rogers is the originator of a unique type of psychiatric treatment called client-centered therapy, a treatment built on two central ideas: 1) Every individual has the capacity to understand what factors in his life are causing him unhappiness, and the capacity to reorganize himself so as to overcome these disturbing elements. 2) The person under treatment can recognize his ability to use these powers if the therapist can establish a warm relationship, one that is accepting and understanding.

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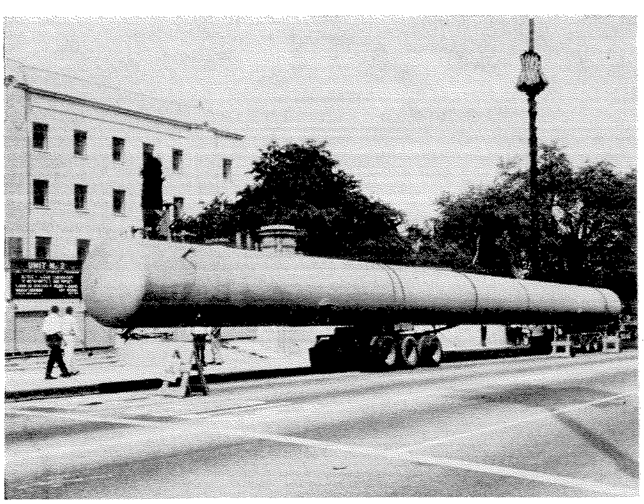
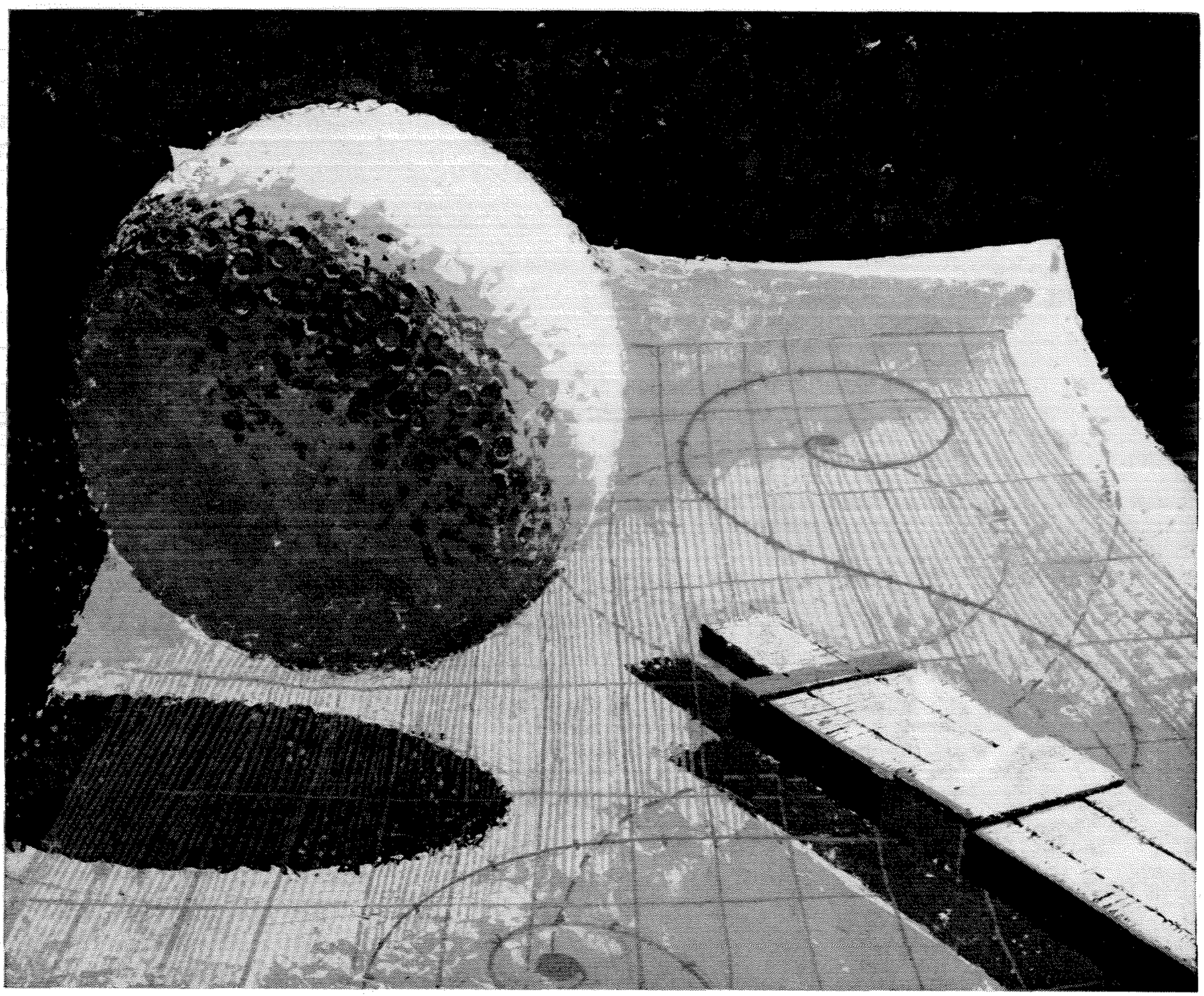


TRAFFIC-STOPPER *Caltech bought a 110-foot storage tank this month to hold nitrogen for the 10-million-volt tandem accelerator in the new Sloan Laboratory of Mathematics and Physics. The arrival of the 35-ton tank, and the complicated operation of hoisting it over the 15-foot California St. wall, was the high point of the month for Caltech's sidewalk superintendents.*



Client-centered therapy does not try to diagnose the client's difficulties or to evaluate his personality, nor does it attempt to suggest a particular type of treatment. Instead, the client, under the protection of therapy, begins to reorganize his own life structure in relation to reality, and thus free himself.

Dr. Rogers started at the University of Wisconsin as an agriculture major but ended up by getting a BA in history in 1924. He received his PhD in psychology in 1931 from Columbia University's Teachers College. For the next 12 years he worked with juvenile delinquents, and his distinctive method of treatment evolved from this work. Dr. Rogers has been at the University of Wisconsin since 1957.

Retirement Meeting

Caltech's Industrial Relations Center held a day-long conference on March 22 on "Industry's Interest in the Older Worker and the Retired Employee." More than 200 personnel officials of southern California industries, and authorities in the personnel field attended the conference. James T. O'Connell, Under Secretary of Labor, in his speech on "The Concern of Government and Business with Problems of Older Persons," stressed the fact that freedom of choice, both for the worker and for the employer, should prevail in all questions of hiring and retiring older workers.

Louis Kuplan, executive secretary of the State Citizens' Advisory Committee on Aging, recommended in another talk that counseling on retirement should being at least 15 years before the worker retires.

Michael T. Wermel, director of research of Caltech's Benefits and Insurance Research Center, acted as chairman of the meeting, assisted by Professor Robert D. Gray, director of Caltech's Industrial Relations Section.

Symposium on Missiles

A two-day meeting at Caltech on March 28 and 29 brought astronomers, physicists and military men to the campus for a symposium on quantitative spectroscopy and selected military applications. Most of the discussions were concerned with basic problems in detecting the launching and flight of missiles. The symposium was sponsored by the Office of Naval Research, the Air Force Office of Scientific Research, the Institute for Defense Analysis, the Air Force Cambridge Research Center, and the California Institute of Technology.

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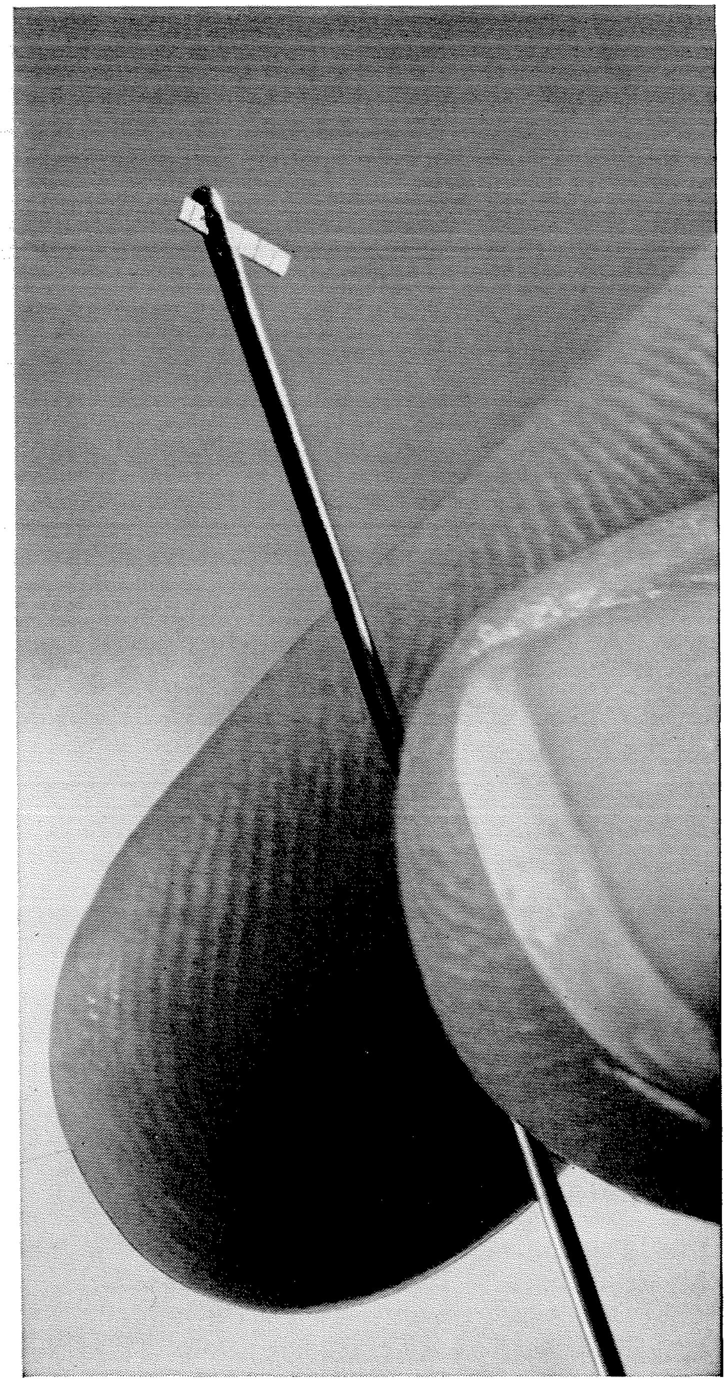

Needle's eye holds electronic "brain" cells— Photograph shows how new RCA "logic" element can be contained in the eye of a sewing needle.

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Getting Along In the World

From the very first day that he passes through the golden portals, the Caltech undergraduate is faced with a strange contradiction. Although he is constantly being reminded that he is a superior individual, he is usually not at the top of his class; and even if he *is* at the top of the class, he is considerably lacking in other desirable virtues. The situation becomes stranger (or perhaps more normal) as the years pass; the Caltech undergraduate believes he is superior to anyone who doesn't go or hasn't gone to his alma mater. He no longer needs to be convinced. All around him he finds blatant evidence of the stupidity of the rest of mankind.

What is this rationalization for the rest of the Techman's failures based on? Obviously (to quote a phrase), on his unquestionably high IQ. Or, to use a less theoretical index, on his College Board scores. And anyway, everybody at Caltech knows how successful Techmen are after they graduate, or after they switch schools. The most lowly freshman can feel himself a king . . .

Caltech in action

I bring the question of superiority to the fore merely as an introduction to a story of Caltech in action against other colleges. At the beginning of this month, as it has done for the last six years, ASCIT sent a delegation to the West Coast Model United Nations. Caltech represented Israel – and, almost by coincidence, Caltech's rival on the athletic field, Oxy, became Israel's rival, the United Arab Republic, at MUN. Out of this rivalry, played to the hilt by both parties, came most of the excitement at the meetings. And although Caltech walked away with many honors and many friends, perhaps the most important realization of the delegation was that there were an awful lot of bright people who didn't go to Caltech.

The group of Techmen who went to Berkeley for the meeting actually were not the ordinary undergraduates, and in many ways this left an unfair picture in the minds of hundreds of inferior students. These Techmen were willing to pay to meet other people of obviously lower intellect than themselves. They were willing to cut four days of precious classes and homework hours. They were willing to throw themselves into a new environment and a new group of students. Most of the delegation even became interested in parliamentary procedure and the problems of Israel. All were willing to give up sleep to talk to a girl – an inferior individual . . .

It soon became evident that success at the MUN depended on how fast you could persuade people that your position on issues coincided with theirs. It became an immense Student House rotation. Naturally, it was sheer folly to deal with the Arab nations or the Soviet bloc; Israel found itself on the fence between the Western bloc and the East Asian bloc, with the South American nations a standby ally.

Gung-ho – with credit

When the delegation arrived on Wednesday afternoon and began to talk to arbitrary people, we realized that, wherever we went, the Oxy delegation had been before. They were gung-ho. (It wasn't until later that we discovered they were getting college credit for the work they put in against us.)

The very first thing that U.A.R. tried to do was to kick Israel out of the Afro-Asian bloc caucus on Wednesday night. The caucus was so disorganized and so long drawn out, that somehow Israel retained the right to remain on a questionable second ballot. The next day, when there were individual committee caucuses, the confusion became more intensified; on some Afro-Asian caucuses, Israel was asked to leave; on others, the Arab bloc stalked out indignantly when Israel was voted to stay. Nobody was quite sure what bloc Israel was in, and thereby hung success. The rules that the delegation had to remember were very few in number: 1) never vote against France or the U.S.; 2) never vote with the U.A.R.; 3) Israel is a less-developed country.

The effectiveness of this relatively non-committal strategy showed itself in the results of the committees. The Social and Humanitarian Committee passed a British-sponsored, pro-Israel resolution in regard to Arab refugees. The Economic and Financial Committee defeated several Arab-sponsored proposals directed at Israel, and passed an Israeli resolution establishing a long term development loan fund. Israel helped lead the Trusteeship Committee to the passage of a Western power resolution on Southwest Africa. France's friendship was amply rewarded on the questions of nuclear testing in the Sahara and the Algerian problem. Israel was known by almost everyone at MUN, and that in itself can be regarded as proof

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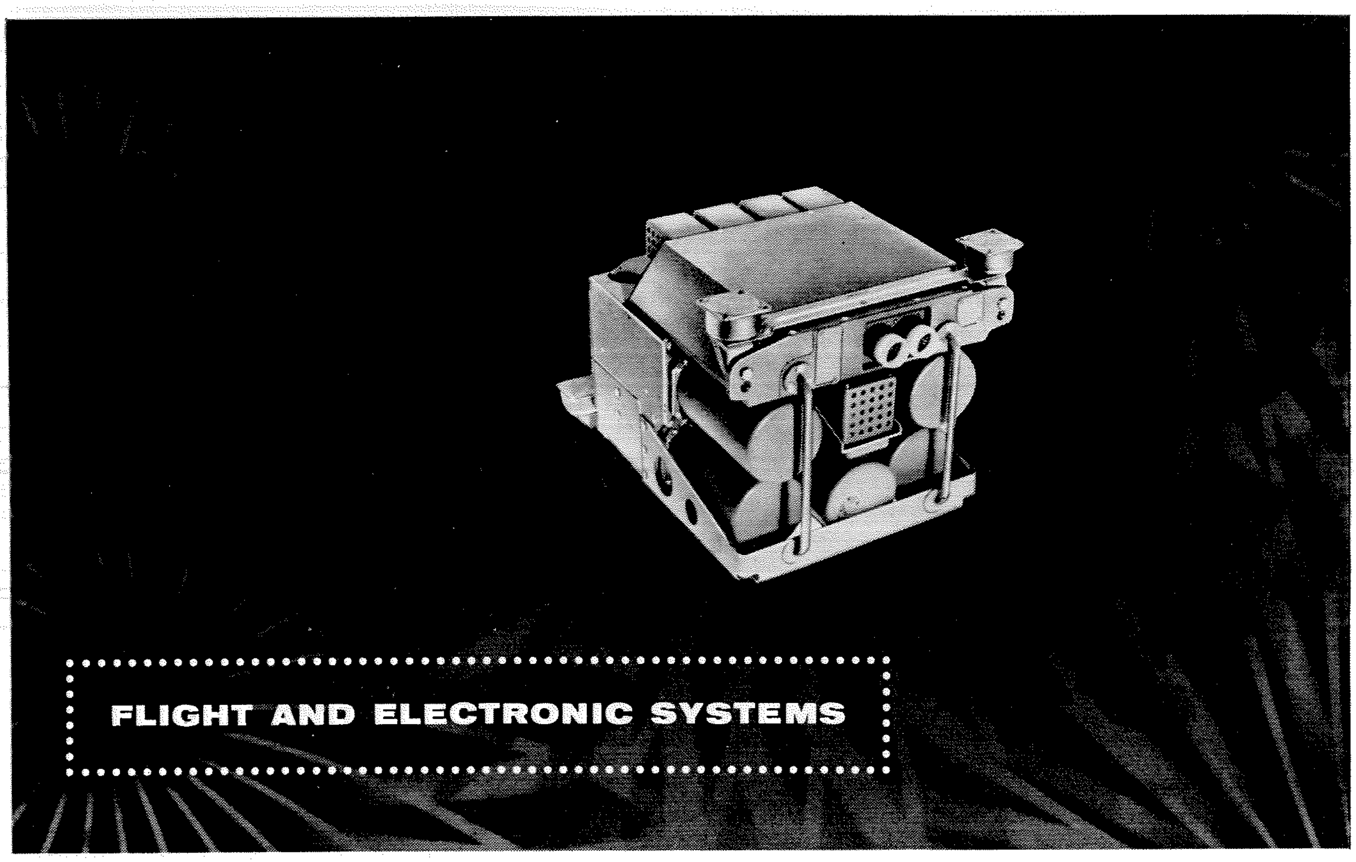

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In the future, under the direction of the National Aeronautics and Space Administration, pioneering on the space frontier will advance at an accelerated rate.

The preliminary instrument explorations that have already been made only seem to define how much there is yet to be learned. During the next few years, payloads will become larger, trajectories will become more precise, and distances covered will become greater. Inspections will be made of the moon and the planets and of the vast distances of interplanetary space; hard and soft landings will be made in preparation for the time when man at last sets foot on new worlds.

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"We do these things because of the unquenchable curiosity of Man. The scientist is continually asking himself questions and then setting out to find the answers. In the course of getting these answers, he has provided practical benefits to man that have sometimes surprised even the scientist.

"Who can tell what we will find when we get to the planets? Who, at this present time, can predict what potential benefits to man exist in this enterprise? No one can say with any accuracy what we will find as we fly farther away from the earth, first with instruments, then with man. It seems to me that we are obligated to do these things, as human beings."

DR. W. H. PICKERING, *Director, JPL*

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of success. Unfortunately, this is not the same as saying that the Caltechmen were liked by everybody, for they were not.

Why opinion was divided on the Caltech delegation is a question which may never be answered. We rarely stressed our superiority (we felt it was quite evident – it's difficult to forget years of brainwashing at the hands of such experts as the deans) and College Board scores were only mentioned under the most profoundly intense questioning. Perhaps those who did not like us were simply jealous of our incredible intellects.

Whether they liked or disliked Caltech, everyone seemed more than willing to dispose of Israeli refreshments at the nightly parties thrown in room 420. The parties usually started at about 12 midnight, after the last caucus was over, and lasted until some poor Israeli fell exhausted to his bed. An effective way, it was found, to make people leave the premises, was to first cut short the supply of beverage, and then to lure the girls out of the room. There just wasn't anything left for the hangers-on to do.

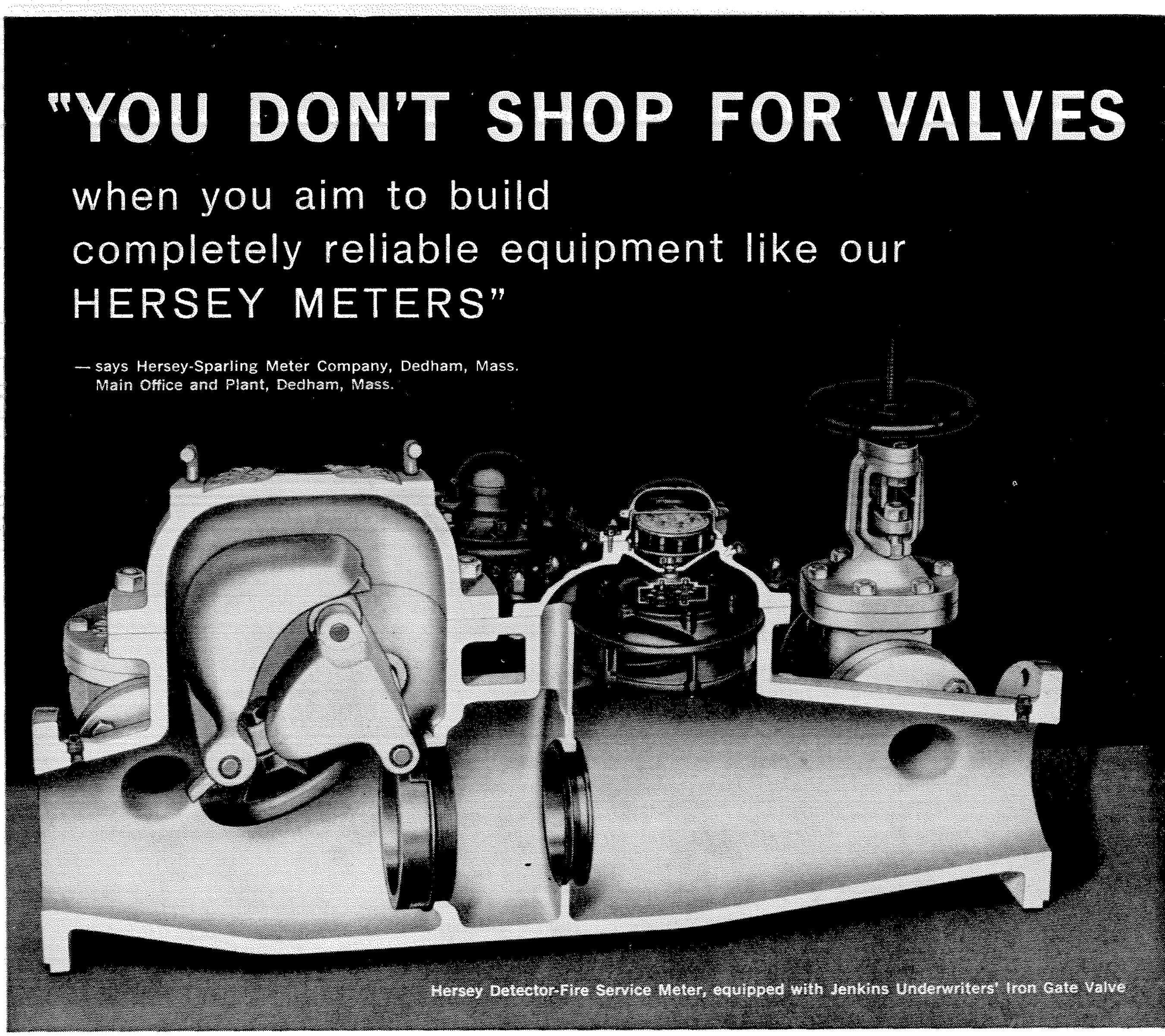
Japan threw a wonderful affair on Friday night, and as a result got the MUN for 1962. The Arabs also had nightly parties, but except for occasional Techmen (who seemed to be everywhere), they only admitted Arabs. Israel had no such policy – everyone was welcome, provided they were willing to donate something to the party besides their sparkling personalities.

There was realism and there was farce at the MUN. Some nations – such as U.A.R., Lebanon, the Union of South Africa, and France – did a great job of playing the role of their nation. On the other hand, the many Arabs who were representing other countries just couldn't seem to understand that they weren't Arabs anymore. In the Economic and Financial Committee, Norway somehow consistently voted with the Arab bloc. Another strange alliance was Peru's appearance at the Afro-Asian caucus (over half the delegates were from Moslem countries). This type of incident was one of the great imperfections in the MUN, and there is no way to alleviate it.

Friday night was International Ball night. The couples danced very well, but for the most part the couples dancing did not have American faces; dancing is fast becoming a lost art among college students. Nevertheless, the Israeli delegation appeared in force. The comment was overheard: "Gee, I never knew Caltech boys were like this. I always thought they looked real studious – you know, emaciated and with thick glasses. Gee, gosh, they're not like that at all . . ."

If only she knew.

– Martin Carnoy '60



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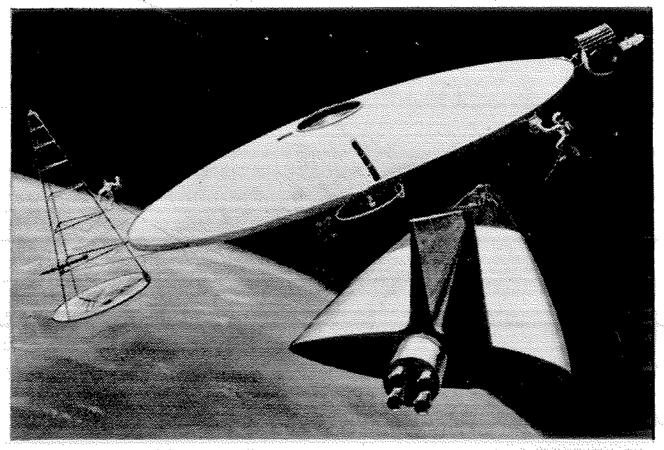
Century-old Hersey-Sparling Meter Company does everything possible to make good its slogan — *You can't buy a better Water Meter than Hersey*. One example is seen in a rule that any part of the meter not made by Hersey must be obtained from sources which have Hersey's own policy of making the *Best*. For valves, Hersey's standard for quality has been JENKINS for 35 years.

Hersey-Sparling's customers, like the buyers of any equipment that incorporates valves, see the famous Jenkins DIAMOND trade-mark on the valves as a sure sign that nothing has been spared in assuring reliability and low maintenance costs. Architects, engineers, contractors and operating men are bound to respect equipment that carries the valves they so often specify to assure trouble-free piping systems.

Of course, valves of less quality can be had for a little less money. But it is worth remembering that Jenkins Valves, so widely known for reliability, cost no more than any *good* valves. Jenkins Bros., 100 Park Ave., New York 17.

JENKINS VALVES JENKINS SINCE 1864 *Jenkins Bros* **MOST TRUSTED TRADE-MARK IN THE VALVE WORLD**



Personals

1921

John D. Lyon writes that "I grew oranges for 40 years in Glendora, and was on the boards of the Glendora Citrus Association for 30 years, and on the Glendora Fruit Exchange and the Upland Citrus Board since January 1958. My new address is San Luis Rey Heights, Fallbrook, where I grow avocados along with *Frank Capra* '18, and *Douglas Stromsoe* '23. I'm also vice president of the San Luis Rey Mutual Water Company.

1924

Harold O. Springer died in his sleep on March 5 at Santa Rosa, Calif. He was 61. Harold was making an automobile tour of the country after retiring in January as senior engineer from the Bridge Department of the City of Los Angeles. He had worked for the City since 1924.

1926

Daniel G. Dinsmore died on February 22 in Downey of acute coronary occlusion. He was secretary-treasurer of the Christie Electric Corporation in Los Angeles and had worked for the company since 1930. He left his wife and a son and daughter.

1929

Andrew V. Haeff, MS, PhD '32, has retired as vice president of the Hughes Aircraft Company and director of their research laboratories, and is now doing independent research and consulting work in electronics and physics.

1931

Edward H. Uecke is now chief engineer of the newly-created developmental engineering department of Capitol Records, Inc., in Hollywood. He will be responsible for advancing the technological position of Capitol in sound recording, reproduction, and other manufactured products.

1932

Brian O. Sparks, MS '33, MS '40, has been appointed deputy director of Caltech's Jet Propulsion Laboratory. He was formerly general manager and acting director of the space and missiles division of the Interstate Electronic Corporation in Anaheim.

1939

James C. Ritchey, department manager of the Firestone Tire & Rubber Company of California's guided missile division in Los Angeles, recently received a 25-year service pin and a check for $100 from the company. The Ritcheys and their three children live in Downey.

continued on page 40

We have the facilities; the know-how is free

Consider these three, of many, reasons why it is to your advantage to let us fabricate your laminated plastics parts.

First, we have the facilities for the job. Saws, millers, drills, lathes, punch presses, planers, sanders. Hundreds of them. Many are standard machine tools modified to machine laminated plastics quickly and easily. Others are special, designed primarily for the high-speed production possible with laminated plastics.

Second, behind the machines are people who know practically every trick in the book for turning out a first-class job fast. They also know what to avoid doing.

Finally, it will hardly pay you to handle your own fabrication—in terms of money, in headaches, in possible errors, waste or delays. Call a Synthane representative near you for a quotation—you'll find him in any principal city or write Synthane Corp., 13 River Road, Oaks, Pa.

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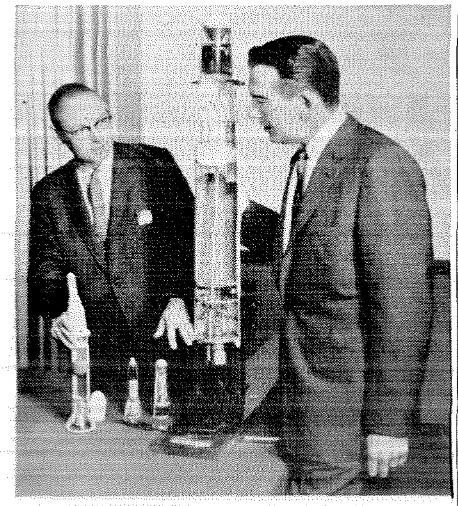
You furnish the print—we'll furnish the part



Personals . . . *continued*

1942

Robert E. Anderson writes from Guatemala that "after completing four years of active duty in the Navy following graduation, I joined the Signal Oil and Gas Company as a geologist in 1946. For the first ten-plus years, I spent most of my time in California, with brief sojourns in some of the other western states. Following a few months in Oklahoma in 1957, I was assigned as chief geologist to our Venezuelan subsidiary, first in Maracaibo and later in Caracas. About a year and a half ago, I was transferred to Signal Exploracion de Guatemala as manager of operations.

"We are enjoying foreign living, particularly here in Guatemala. This is a scenic country, but one of contrasts. It is hot and tropical along the coasts and in the north and much of it is covered with dense, sparsely populated jungle, as compared to the highlands studded with magnificent volcanic peaks and lakes and the eternally springlike climate.

"Fortunately, Guatemala City is situated in the latter province, although trips to the jungle areas are required frequently. To this setting, add the ancient Mayan culture, the happy descendants thereof, quaint villages and modern cities, marimba music and a multitude of crafts, and you have the ingredients that make up Guatemala.

"I'm married to Ruthelen List, Stanford '41. We have no children but we have a medium-sized parrot as a pet which answers to the name of Pica (short for Picarillo or 'little rogue') which he is.

"I'm a member of the Guatemala City Lions Club. I received an MS in petroleum engineering in 1955 at USC. And I'm a devoted but not very good bowler."

Emerson L. Kumm has resigned from his position as technical engineering manager at Curtiss Wright's Santa Barbara facility to take a technical staff position in the preliminary design department of the AiResearch Manufacturing Company in Phoenix, Arizona. The Kumms are building a new desert home in Paradise Valley near Phoenix where they and their two children, Keith, 10 and Karen, 8, will try to keep cool with a swimming pool during their first summer in the desert.

1943

Arthur B. Pardee, MS, PhD '47, professor of virology and biochemistry at UC in Berkeley, recently received the Paul-Lewis Laboratories Award in Enzyme Chemistry, sponsored by Paul-

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Lewis Laboratories, Inc., in Milwaukee, Wis. Arthur is credited with outstanding research on the complex factors controlling conversion of food to products that support cell growth. He was co-discoverer of "enzyme repression" and "feedback regulation," two principles involved in the suppression of enzyme synthesis in the body. He has been at UC since 1949.

1944

Rufus B. Pearce, Jr., writes that "I'm presently assigned as chief of the aerodynamics sciences section of the missile division of North American Aviation. My other activities include being scoutmaster for Fullerton Troop 11, treasurer for the Fullerton Tennis Club, and enjoying recreational tennis and skiing. We have two boys – 13 and 6."

Maurice E. Ford, Jr., has been manager of the Escondido Mutual Water Company since April 1956. The Fords have four children – 3 girls (Marilee, Judy, and Gale) and one boy (Dennis).

1947

Robert B. Harris, MS, associate professor of chemical engineering at the University of Michigan in Ann Arbor, was appointed secretary of the Column Research Council last year and has also been elected 1960 vice president of the Michigan Section of the American Society of Civil Engineers.

Sam Naiditch, PhD, is now president of Unified Science Associates, Inc., a basic research and development company in Pasadena.

1948

Richard A. Ferrell, MS '49, is on a sabbatical leave from the University of Maryland where he is professor of physics. He is spending most of his time in Geneva, Switzerland, where the European Organization for Nuclear Research (CERN) has recently inaugurated the largest particle accelerator in the world, a 29-Bev proton synchrotron.

R. J. S. Brown, research physicist at the California Research Corporation (Standard Oil of California), writes that he still lives in Fullerton with his children, Eleanor, 6, and Sid, 5. He's working on nuclear magnetism oil well logging.

1951

Harold F. Martin, project engineer with the IBM Corporation in San Jose, is now technical assistant to R. G. Mork, director of development engineering for the IBM World Trade Corporation in Paris. Harold was married last September to Miss Sarah Ann Schaeffer of West Hartford, Conn.

1952

Robert E. Stanaway is now plant manager of the West Coast Components division of the Fairchild Controls Corporation in Pasadena.

Boyd P. Israelsen, MS '53 is now doing research and development on low-noise traveling wave tubes at the Watkins-Johnson Company in Palo Alto. He was formerly a research assistant at Stanford Electronics Laboratories. Before getting his PhD at Stanford, Boyd was a senior research engineer at Caltech's Jet Propulsion Laboratory, where he worked on components for missile guidance systems.

1953

Fred Storrer, MS, has been working as reactor physicist at the Societé "Belgonucleaire" in Brussels, Belgium, since April 1956. Last October he was sent to Detroit by contract to work with the Atomic Power Development Associates on the design of the Enrico Fermi Fast Breeder Power Plant in Monroe, Mich.

David J. MacDonald, Jr., MS '54, received his PhD in chemistry at UCLA in January and is now doing postgraduate work there under *Clifford S. Garner*, '35, PhD '38.

1955

Richard N. Wagenseller, MS '56, design engineer at Dynamic Research Inc., in Los Angeles, was married on April 9 to Joan Hawkins at Oneonta Congregational Church in South Pasadena.

1956

John Howell writes that "I am in my first year of medical school at Stanford. There seems to be a Caltech-at-Stanford up here – Techmen all over the place."

Alan M. Poisner will receive his MD degree from the University of Kansas School of Medicine in June, and in July he will start a year's internship at the University of Illinois Research and Educational Hospitals in Chicago.

1959

Andre J. P. Fossard, MS, writes that "after leaving Caltech ten months ago, I took a long and wonderful trip through the States and Canada with three other French fellows. Back in Paris, I worked for two months with the Generale Aeronautique Marcel Dassault, the biggest French aircraft company, in the servomechanisms department. I left France last November to serve in the air force in Morocco and I am training to be a pilot just now."

Important Dates for Alumni

ANNUAL MEETING

June 8, 1960

Reunion of the Classes of 1900, 1915, 1920, 1925, 1930, 1935, 1940, 1950, 1955

Rodger Young Auditorium

ANNUAL PICNIC

June 25, 1960

A real family affair

Tournament Park

IT'S LITERALLY ALL AROUND YOU!

The word *space* commonly represents the outer, airless regions of the universe. But there is quite another kind of "space" close at hand, a kind that will always challenge the genius of man.

This space can easily be measured. It is the space-dimension of cities and the distance between them . . . the kind of space found between mainland and off-shore oil rig, between a tiny, otherwise inaccessible clearing and its supply base, between the site of a mountain crash and a waiting ambulance—above all, Sikorsky is concerned with the precious "spaceway" that currently exists between all earthbound places.

Our engineering efforts are directed toward a variety of VTOL and STOL aircraft configurations. Among earlier Sikorsky designs are some of the most versatile airborne vehicles now in existence; on our boards today are the vehicles that can prove to be tomorrow's most versatile means of transportation.

Here, then, is a space age challenge to be met with the finest and most practical engineering talent. Here, perhaps, is the kind of challenge *you* can meet.

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Twenty-third Annual Alumni Seminar

Saturday, May 7, 1960

Exceptional Evening Program

DINNER – HUNTINGTON-SHERATON HOTEL

"EDUCATION IS NOT EASY" – LEE A. DuBRIDGE

Dr. DuBridge will discuss some of the problems facing higher education in America in the light of rising enrollments and increasing selectivity. These problems lead to serious consideration of the selection process and to the establishment of an educational program in each institution to meet the needs and capabilities of the students it selects.

Special Exhibits

SYNCHROTRON LAB – COMPUTER CENTER

HEMOGLOBIN EXHIBIT – SELECTED DOCUMENTARY FILMS

Outstanding Lecture Program

A choice of four vitally interesting lectures at each of three morning periods will be repeated (with one exception) during three afternoon periods to insure broadest selection and continuity of interest for alumni and for guests.

Alumni outside of southern California who wish to attend the Seminar should write the Alumni Office for reservations.

SEMINAR LECTURES

EXPERIMENTS ON BRAIN FUNCTIONS

9:30 A.M. Only

Mitchell Glickstein, Research Fellow, Biology

The problem of how learning and memory functions are carried out in the brain has remained a mystery for centuries. Even the simpler question of where in the brain learning takes place has resisted a clear-cut solution. The split-brain technique pioneered at Caltech is providing some clues as to localization of the learning process. Eventually it may assist us towards an understanding of how the brain works.

HUNTING BIG EARTHQUAKES IN INDIA

9:30 A.M. and 2:15 P.M.

D. E. Hudson, Professor of Mechanical Engineering

The biggest earthquakes in history have occurred along the Himalayas. The Earthquake Engineering Research Laboratory of the Caltech Division of Engineering is cooperating with the University of Roorkee in India in the study of earthquakes in this region from the standpoint of earthquake-resistant structural design. The Caltech staff has encountered many interesting problems, technical and otherwise, in the course of living and working in India. Some of the problems related to the establishment of field stations, design and construction of instruments, and the training of research personnel in India will be discussed.

SOUTH POLE DEEP FREEZE

9:30 A.M. and 2:15 P.M.

Trevor Hatherton, Research Fellow, Geophysics

One of the two major breakthroughs of the International Geophysical Year was the permanent occupation of Antarctica. Scientists of twelve nations participated in the cooperative effort. The work accomplished by these men, their living conditions and special problems, and the future of the Antarctic continent will be discussed by Dr. Hatherton, who was in charge of the New Zealand group.

EXPLOSIVE AFRICA

9:30 A.M. and 2:15 P.M.

Horace N. Gilbert, Professor of Business Economics

Africa's exploding political nationalism must have an economic foundation in order to have any chance of success. Professor Gilbert spent ten weeks last summer studying the economics of some of the countries comprising Central and Southern Africa. Will there be race riots and intertribal wars, or real economic progress?

NATURE'S MOLDY FACTORY

10:45 A.M. and 3:15 P.M.

John H. Richards, Assistant Professor of Chemistry

The variety of substances produced in nature by simple organisms is astonishing. Many of these substances, which are of great benefit to man, are exceedingly complex organic molecules. A challenging area of chemical research today is to discover the mechanism by which these complex units are formed from simple building blocks. Dr. Richards will discuss some of the techniques used in solving these mysteries.

DESALTING SEA WATER
10:45 A.M. and 3:15 P.M.
Jack E. McKee, Professor of Sanitary Engineering

Considerable publicity has been given recently to the economic potentialities of desalting sea water. Sources of water pose a serious problem for regions with an arid climate. Desalting seawater may be our solution, but is it the best solution? There may be other ways in which potable water can be reclaimed. Professor McKee will review the current status of this problem.

OUR CHANGING CITIES
10:45 A.M. and 3:15 P.M.
Robert W. Oliver, Assistant Professor of Economics

How fast and in what ways are our cities changing and growing? What has been the impact of recent population growth, of the automobile, of changing shopping habits? What happens to the older parts of cities when they are not remodeled to keep pace with changing tastes and technologies. What can be done and is being done about blighted areas? Dr. Oliver will discuss these questions relating to urban redevelopment.

FERROMAGNETIC THIN FILMS
10:45 A.M. and 3:15 P.M.
Charles H. Wilts, Professor of Electrical Engineering

An exciting recent development in solid state physics is the use of thin films of materials as a means of probing further into the properties of matter. It is found that these thin films often exhibit properties not ordinarily found in bulk materials. A particularly interesting example of this is the thin film of a ferromagnetic metal. It provides a device which shows promise as a high speed switching element, logic component and memory cell and at the same time permits a very high density of functional elements, since each film may occupy a volume not greater than 10^{-8} cubic inch.

DNA – A CARRIER OF HEREDITY
11:45 A.M. and 4:15 P.M.
Matthew S. Meselson, Assistant Professor of Chemistry

The ordered advance from embryo to adult is the result of the coordinated interplay of many thousands of protein molecules. The master code, which tells an organism how many and what kinds of proteins to build, is contained in the substance of its genes, deoxyribonucleic acid—DNA. Passed down from generation to generation, specific giant molecules of DNA may maintain continuity of living matter. Biologists today are seeking to understand this chemical code of life.

NUCLEAR FURNACES IN THE SKY
11:45 A.M. and 4:15 P.M.
William A. Fowler, Professor of Physics

Astronomical observations have indicated that matter is given off by stars, and that new stars are continually forming from interstellar material. The observed energy outputs of stars and supernovae imply that nuclear transformations are taking place. Experimentation in nuclear physics has led to the discovery of processes by which the lighter elements are converted into heavier elements in the stars. These findings are correlated with what we know of stellar evolution to provide a better understanding of the structure, history and age of our galaxy.

ADVENTURES IN MADNESS
11:45 A.M. and 4:15 P.M.
J. Kent Clark, Associate Professor of English

The autobiography of Goodwin Wharton (1653-1704) is one of the most bizarre documents in the English language. Wharton was an alchemist, spiritualist, diver, soldier, M.P., lord of admiralty, inventor, and part-time lover; he was also the most gullible man in England. He was taken in hand by a lady spiritualist, Mary Parish, the most accomplished liar and determined confidence woman in recorded history. Dr. Clark will discuss some of the high points in Wharton's life and some of the problems faced in editing the manuscript for its forthcoming publication by the Huntington Library.

A NEW LOOK AT THE MOON
11:45 A.M. and 4:15 P.M.
A. R. Hibbs, Acting Division Chief, Space Science, JPL

Now that we plan to send instruments to the moon for an on-site inspection, many of our old ideas about our small sister planet are being reviewed — and found wanting. Is the surface rugged or desert-smooth? Are the Maria lava-flows or planes of dust a kilometer deep? Is the surface unchanged since its formation five billion years ago, or has some process of erosion been steadily altering its appearance?

HOW OUR NERVES WORK
2:15 P.M. Only
A. Van Harreveld, Professor of Physiology

A great deal has become known in the last decade concerning the physical chemical mechanism of nerve excitation and its transmission from a nerve fiber to an end-organ such as a muscle fiber. These studies also extend to much more complicated phenomena in the central nervous system. Dr. Van Harreveld will review recent progress in this field.

CALTECH CALENDAR

ALUMNI EVENTS

May 7	Annual Seminar
June 8	Annual Meeting
June 25	Annual Picnic

ATHLETIC SCHEDULE

Golf

April 22
So. Calif. Tournament at Palm Springs

April 29
Occidental at Caltech

May 2
UC Riverside at Victoria CC

May 6
Pomona at Pomona

Tennis

April 16
Pomona at Pomona

April 21
Pasadena College at Pasadena College

April 23
Whittier at Caltech

April 30
Claremont-Mudd at Claremont

Baseball

April 16
Whittier at Whittier

April 20
La Verne at Caltech

April 23
Pomona at Caltech

April 27
Pasadena College at Brookside Park

Swimming

April 18
Univ. of Arizona at Caltech

April 22
Pomona at Pomona

April 29
Occidental at Occidental

Track

April 22, 23
Mt. SAC Relays at Mt. SAC

FRIDAY EVENING DEMONSTRATION LECTURES

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

April 22
Low Temperature Chemistry
—G. Wilse Robinson

April 29
Artificial Earthquakes for Geology and Oil Findings
—C. H. Dix

May 6
Conditions and Life of the Oceans of the Past
—Heinz A. Lowenstam

May 13
Earthquakes and Mountains
-Clarence R. Allen

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U.S. Navy Electronics Laboratory

One of a series

Interview with
General Electric's Earl G. Abbott,
Manager—Sales Training

Technical Training Programs at General Electric

Q. Why does your company have training programs, Mr. Abbott?

A. Tomorrow's many positions of major responsibility will necessarily be filled by young men who have developed their potentials early in their careers. General Electric training programs simply help speed up this development process.

In addition, training programs provide graduates with the blocks of broad experience on which later success in a specialization can be built.

Furthermore, career opportunities and interests are brought into sharp focus after intensive working exposures to several fields. General Electric then gains the valuable contributions of men who have made early, well-considered decisions on career goals and who are confidently working toward those objectives.

Q. What kinds of technical training programs does your company conduct?

A. General Electric conducts a number of training programs. The G-E programs which attract the great majority of engineering graduates are Engineering and Science, Manufacturing, and Technical Marketing.

Q. How long does the Engineering and Science Program last?

A. That depends on which of several avenues you decide to take. Many graduates complete the training program during their first year with General Electric. Each Program member has three or four responsible work assignments at one or more of 61 different plant locations.

Some graduates elect to take the Advanced Engineering Program, supplementing their work assignments with challenging Company-conducted study courses which cover the application of engineering, science, and mathematics to industrial problems. If the Program member has an analytical bent coupled with a deep interest in mathematics and physics, he may continue through a second and third year of the Advanced Engineering Program.

Then there is the two-year Creative Engineering Program for those graduates who have completed their first-year assignments and who are interested in learning creative techniques for solving engineering problems.

Another avenue of training for the qualified graduate is the Honors Program, which enables a man to earn his Master's degree within three or four semesters at selected colleges and universities. The Company pays for his tuition and books, and his work schedule allows him to earn 75 percent of full salary while he is going to school. This program is similar to a research assistantship at a college or university.

Q. Just how will the Manufacturing Training Program help prepare me for a career in manufacturing?

A. The three-year Manufacturing Program consists of three orientation assignments and three development assignments in the areas of manufacturing engineering, quality control, materials management, plant engineering, and manufacturing operations. These assignments provide you with broad, fundamental manufacturing knowledge and with specialized knowledge in your particular field of interest.

The practical, on-the-job experience offered by this rotational program is supplemented by participation in a manufacturing studies curriculum covering all phases of manufacturing.

Q. What kind of training would I get on your Technical Marketing Program?

A. The one-year Technical Marketing Program is conducted for those graduates who want to use their engineering knowledge in dealing with customers. After completing orientation assignments in engineering, manufacturing, and marketing, the Program member may specialize in one of the four marketing areas: application engineering, headquarters marketing, sales engineering, or installation and service engineering.

In addition to on-the-job assignments, related courses of study help the Program member prepare for early assumption of major responsibility.

Q. How can I decide which training program I would like best, Mr. Abbott?

A. Well, selecting a training program is a decision which you alone can make. You made a similar decision when you selected your college major, and now you are focusing your interests only a little more sharply. The beauty of training programs is that they enable you to keep your career selection relatively broad until you have examined at first hand a number of specializations.

Furthermore, transfers from one General Electric training program to another are possible for the Program member whose interests clearly develop in one of the other fields.

Personalized Career Planning is General Electric's term for the selection, placement, and professional development of engineers and scientists. If you would like a Personalized Career Planning folder which describes in more detail the Company's training programs for technical graduates, write to Mr. Abbott at Section 959-13, General Electric Company, Schenectady 5, N. Y.

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GENERAL ELECTRIC