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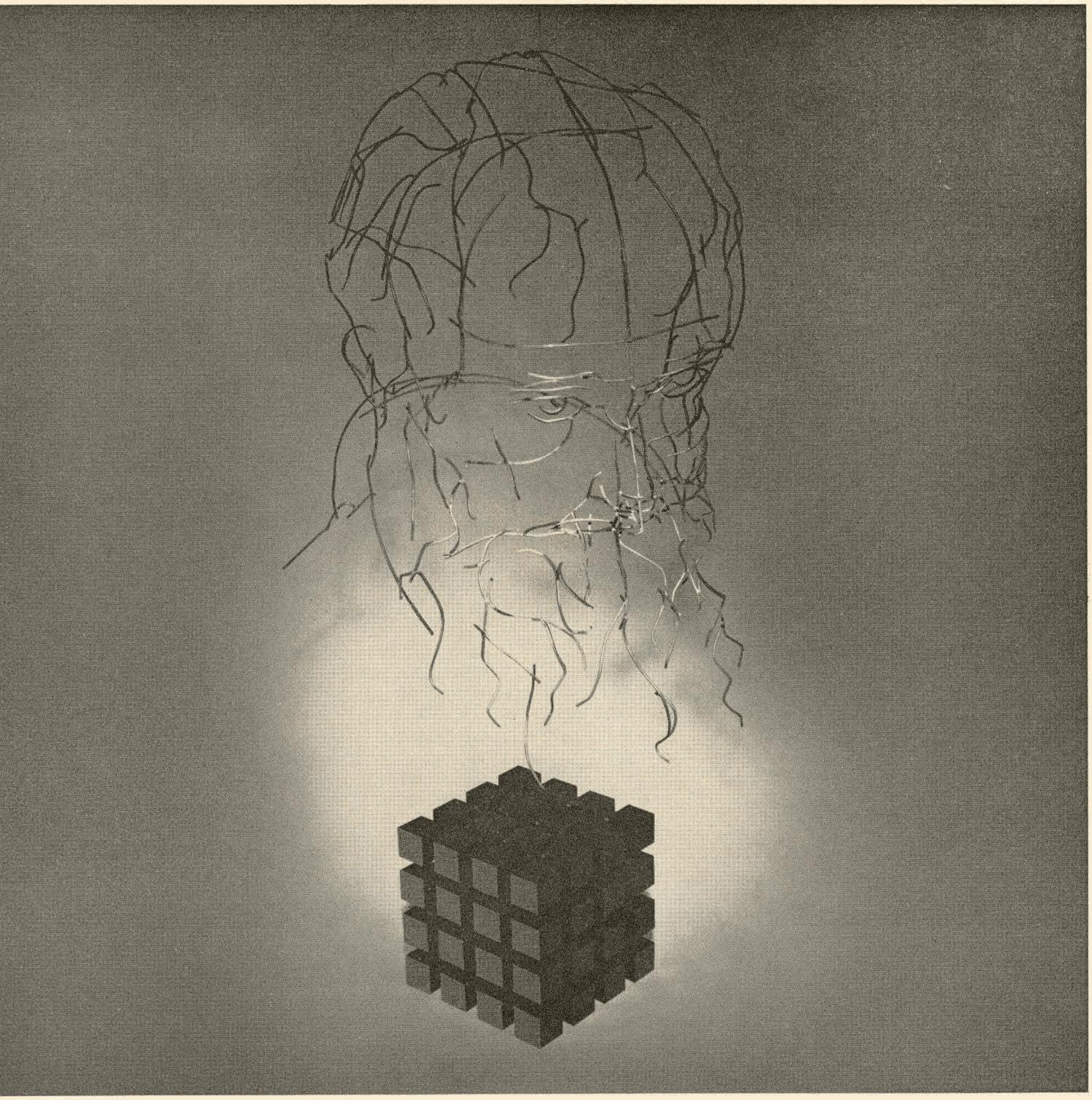
ENGINEERING AND SCIENCE



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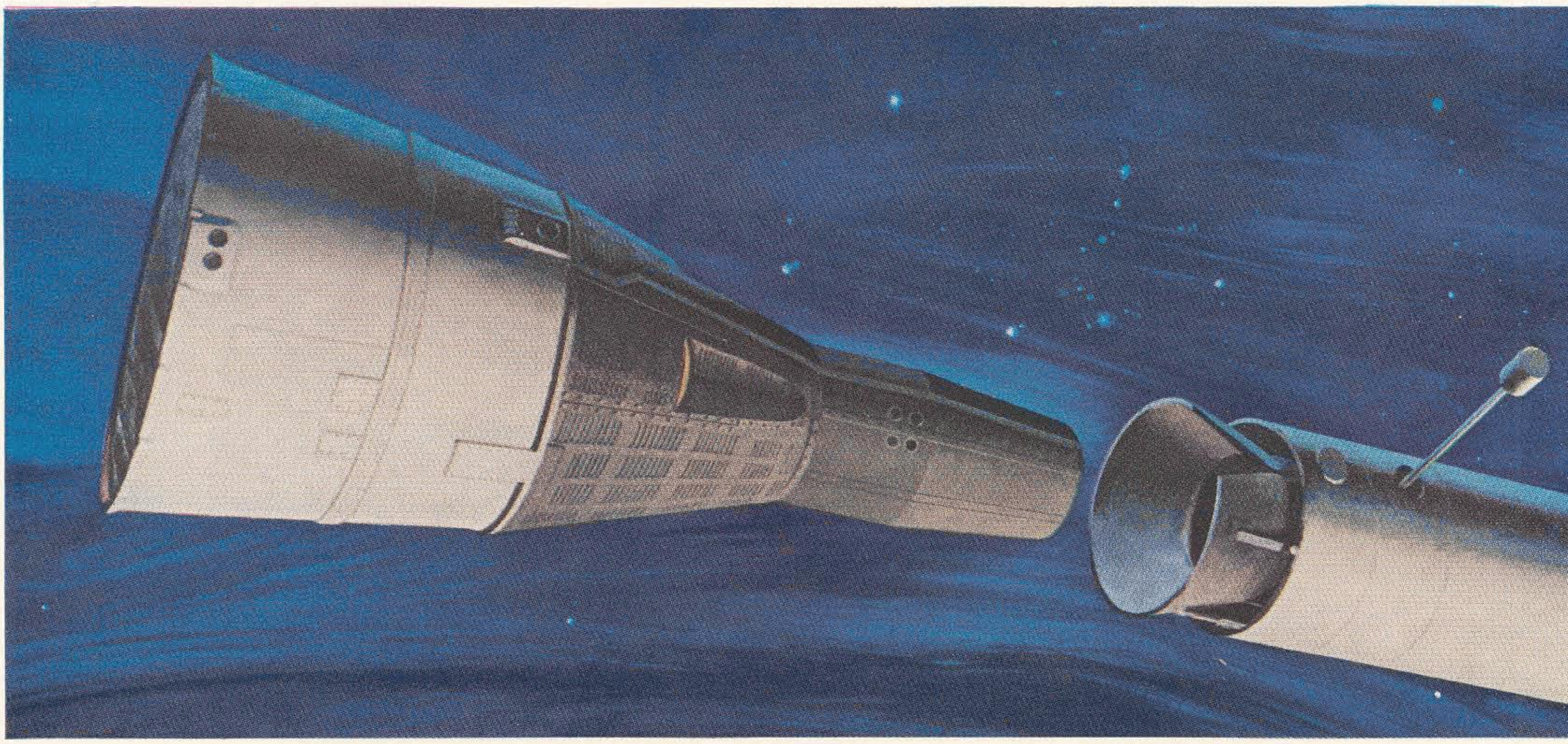
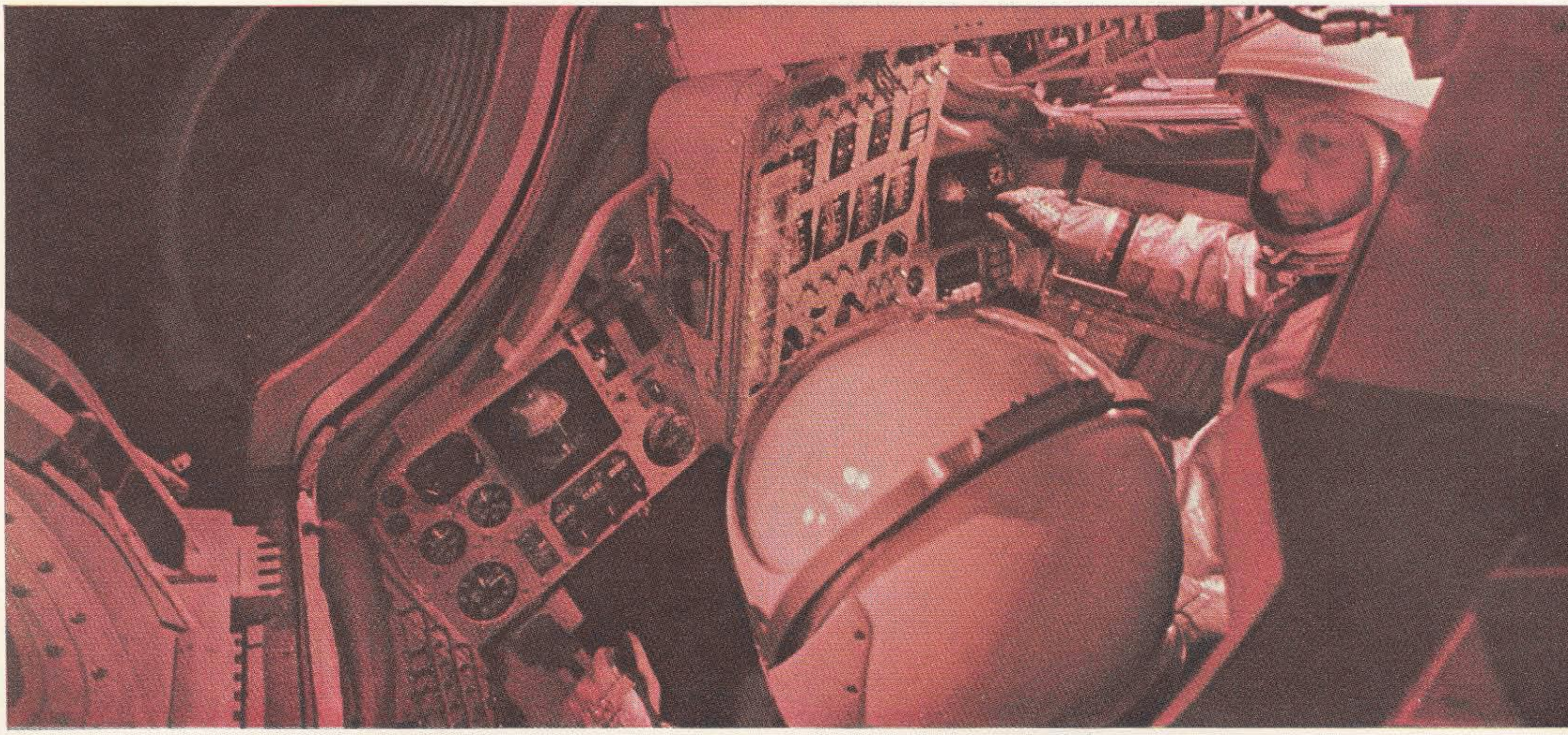


Moon shot rehearsal: when the Gemini spacecraft meets its target



Westinghouse radar will guide the astronauts to this meeting in outer space

When the Gemini two-man spacecraft lifts off, a dramatic dress rehearsal for the first moon trip will begin. The astronauts' mission: to maneuver their spacecraft and join it with an Agena rocket already orbiting the earth at more than 17,500 miles per hour.

A new Westinghouse radar system will guide the chase. Locating the target, the spacecraft will send out radar pulses. Computer-translated responses will guide the astronauts until the target is reached.

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ENGINEERING AND SCIENCE

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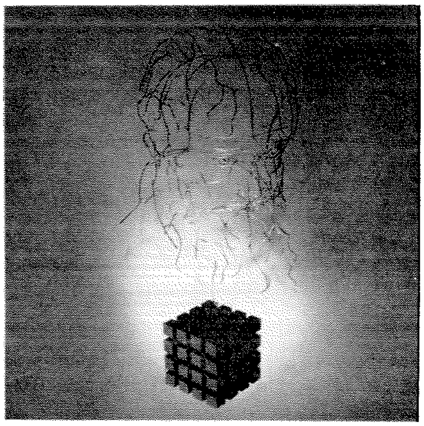


On Our Cover

A wire sculpture done by a local artist, Joseph Henry Police, for the Bunker-Ramo Corporation, depicts the man-machine concept which forms the basis of "The Coming Technological Society," on page 9. This is an adaptation of a talk given by Simon Ramo at the Los Angeles Town Hall on November 10. Dr. Ramo is vice chairman of the board of directors of Thompson Ramo Wooldridge, Inc., and president of the Bunker-Ramo Corporation. He received his PhD from Caltech in 1936, and is now a research associate in electrical engineering at the Institute, and a member of the Caltech board of trustees.

Alumni Survey

"The Caltech Experience," on page 20, is the fifth and last of a series of articles on Caltech's 1963 alumni survey by John R. Weir, associate professor of psychology. Throughout this survey project, the data processing and most of the statistical analysis has been done by Dr. Weir's research assistant, Barbara Brown. She also assisted in the preparation of the survey questionnaire and this series of survey articles.

Books

Basic Principles of Organic Chemistry

by John D. Roberts and Marjorie C. Caserio.

W. A. Benjamin, Inc. $13.90

Reviewed by George S. Hammond, professor of chemistry

This basic textbook of organic chemistry has been developed with loving care by two authors who are highly respected as researchers in and teachers of organic chemistry. (Dr. Roberts is professor of organic chemistry and chairman of the division of chemistry and chemical engineering at Caltech; Dr. Caserio is a senior research fellow in chemistry.) The product is a book that is certain to have a major impact on teaching in the field. Despite the existence of an unusually large number of competitive texts, I predict that *Basic Principles of Organic Chemistry* will achieve popularity with both students and teachers; moreover, many of the innovations are certain to be copied by future authors.

Perusal of the Table of Contents furnishes only an inkling of the novelty of the book. Chapter 2, "Spectroscopy of Organic Molecules," is a surprise; and Chapters 5 and 9, which deal with modern structural theory, are not yet commonplace in organic texts. Otherwise the presentation of subjects seems fairly conventional. However, the reader will be surprised, and probably pleased, with the extent to which the methods and concepts of physical chemistry are blended with classical organic chemistry. Major emphasis is placed on spectroscopy in every chapter. Students who use this text will find it hard to believe that Kékulé did not own and operate a nuclear magnetic resonance spectrometer! Thermodynamic concepts are woven smoothly into discussions of both structure and reactions, and reaction mechanisms are presented as a natural consequence of man's concern as to "How does it happen?"

A dedicated critic can always find grounds for questioning even plenary scripture, but he will be forced to admit that the text by Roberts and Caserio provides superb treatment of structural chemistry and is far above average in its treatment of chemical reactivity; the iconoclast will, however, maintain that students will obtain no real concept of the intricacy of synthetic chemistry. Many reactions are discussed, but little emphasis is placed upon the problems involved in weaving them together to form coherent synthetic sequences, and little attention is given to the special problems presented by polyfunctional compounds. This is a real problem in presentation of the "principles of organic chemistry" and I, for one, feel that no author has yet solved it.

The format of the book is very attractive in view of the fact that an economical method of production has been used. Many figures and formulas have been reproduced directly from what must have been marvelous typescript. The product is clear and tidy but may jar the sensitive soul because of the obvious discontinuity between the format of text and figures. The authors have apparently chosen to sacrifice conventional, type-set production in favor of a couple of hundred more pages of text. The authors recognize the fact that there is more material in the book than can be covered by students in most beginning courses. Consequently, sections bear titles and numbers to facilitate selective omission of material by hard-pressed instructors. An especially attractive feature is the large number of exercises, found both at the ends of the chapters and interspersed at strategic points in the body of the text.

Students who are introduced to organic chemistry by this text will be impressed with the quality of scholarship in the field and the versatility of tools available to its practitioners.

The Biosynthesis of Steroids, Terpenes, and Acetogenins

by J. H. Richards and J. B. Hendrickson

W. A. Benjamin, Inc. $18.50

Reviewed by Morris Brown, Arthur A. Noyes research instructor.

This book is authored by two Caltech people – John Richards, associate professor of chemistry; and James Hendrickson '50 (currently associate professor of chemistry, Brandeis University). Both men have been active in the area of biogenesis and their book is certainly the best on the subject to date.

Following an introductory chapter, Chapter 2 deals with general principles of biogenetic theory, Chapter 3 with the acetate hypothesis, Chapter 4 with a statistical survey of natural compounds presumed to be acetogenins, and Chapter 5 with experimental verification of the acetate hypothesis. These chapters are mainly the work of Dr. Hendrickson. They are all clearly written and certainly make very informative and stimulating reading. Chapter 4 seems to emphasize numbers and percentages far too heavily and the usefulness of Tables 4-3 and 4-6 is surely obscure.

Chapters 6 through 13 deal with various classes of terpenes and steroids and their formation from isoprenoid precursors. These chapters are mainly the responsibility of Dr. Richards. The liberal use of well drawn structural formulas throughout these pages makes some fairly complicated transformations easy to understand. These chapters are also clearly written and give more than adequate coverage to the area.

The authors are to be complimented for producing such a fine work. Unfortunately, the price will preclude its purchase by many.

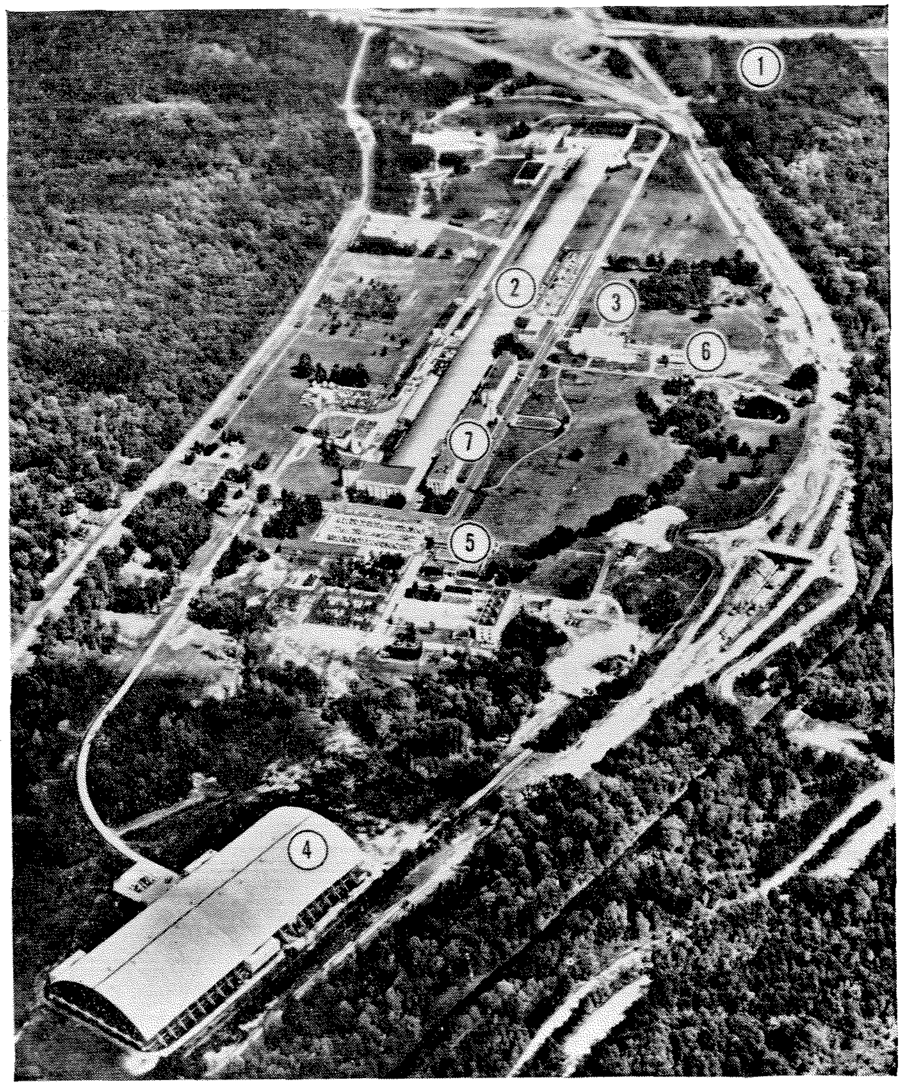
College Chemistry

by Linus Pauling

W. H. Freeman and Co. $8.25

This is the third edition of the basic textbook by Linus Pauling, now serving as research associate in chemistry at Caltech. It has been completely revised, has additional material, and introduces a number of new topics.

You are high over the Potomac River just 12 miles from the White House... and viewing 186 acres of extraordinary research activity



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ENGINEERING
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December 1964, Vol. XXVIII, No. 3

The Coming Technological Society

by Simon Ramo

We are all aware now that we are in rapid transition to a new, highly technological society and we look forward eagerly to the promise of future new accomplishments and experiences for man. But we have reason to be apprehensive, if not alarmed, at the obstacles and pitfalls already discernible just ahead. Even if the coming technological society is accepted as an eventual blessing, the transition to it threatens to be chaotic.

Learning how to release the energy of the nucleus has already given man the possibility of improving the surface and the weather of the earth. We are beginning to use near-in space to broaden the efficiency of our two-dimensional surface civilization, and we are on the threshold of extending man's habitable reaches into the vast three-dimensional outer space around us. We are penetrating to a new depth of understanding of the secrets of the life process itself, with more than a hope of bettering the species and at least dramatically increasing man's ability to control disease. We are moving rapidly toward a semi-automatic society in which man's material needs can be satisfied in ample, required quantities, with little effort by man himself. If science and technology are used to the fullest in the interests of man, his future happiness and progress seem assured.

However, to attain these rewards will require solving tremendously difficult problems of readjustment of our society. This would be true even if we had a socially mature civilization today. Were our social problems under excellent control, and the top brains of mankind engaged in full-time supervision of the application of all new scientific discoveries to the improvement of man's lot on earth, it would still be a tough job. But the dislocation will be more and the adjustment harder because we do not have a sufficiently advanced society. There is instead an enormous mismatch between technological acceleration and social lag.

Thus, it is true that we have learned how to release huge quantities of energy in a split second, but so far the big impact on the world has been the threat of civilization's being wiped out before we develop means to ensure that such man-made destruction will not happen.

We have many pieces of equipment in space and we are planning more. However, today's large U.S. space effort did not come about because our society recognized a need and an opportunity and organized a plan of high priority to meet the requirement. Instead, the program became big and important on a sort of emergency basis to answer a prestige challenge handed us by another nation contesting our world position.

Biologists' researches have now deeply penetrated the nucleus of the basic cells of living matter, but at the moment that does not seem nearly as important as the population explosion problem, in view of society's inability to arrange birth control measures on an acceptable, practical, world basis.

Electronic information systems can literally make the physical operations of the world perform with such automatic efficiency as to multiply by severalfold the value of our natural resources and the brainpower of our skilled population to produce for all of man's needs. But such a possibility is overshadowed by the attendant fear of mass unemployment and dislocation of the American working force because we are not, in timely anticipation of this benefit, working out means for assuring its smooth embodiment and containment.

The imbalance between technological and social advance may well be regarded by future historians as the number one problem of the twentieth century. But it is not insoluble. There is hope. Discussion of a single area of technology – probably the most significant of this century – brings into quick focus the changes required in our thinking if we are to try making the transition to the new technolog-

"Discussion of a single area of technology — probably the most significant of this century — brings into quick focus the changes required in our thinking if we are to try making the transition to the new technological society a tolerably livable one."

ical society a tolerably livable one. This scientific area is the extension of the human intellect by technological devices. It is the use of electronics to acquire information, remember it, and retrieve it — to compare, sort, categorize, and process facts into forms suitable for decision and control, and to communicate and display information.

All of this will be used to change the way man operates the activities of the world that depend on intellect and information. It is the automatic handling by electronic systems of all of the information basic to the professions, to the operating of business and government, the supervising of finance and transportation, and to all other of the operations of our busy society.

In the past two or three centuries we have absorbed the great impact of the use of artificial devices to extend man's muscles — his natural force-producing capability — by machine. That industrial revolution completely changed our way of life and the position of nations. We are now beginning to take a vastly bigger step, the creation of synthetic intelligence so that the total brainpower of the world can grow by orders of magnitude.

The need is great, and technology has an answer to this need. The only question is how much confusion and dislocation will result.

Consider, for example, the basic job of keeping track of everything that goes on to assure that it is in accordance with the laws, the rules of our society. In a few decades, when two individuals or two corporations want to make a legal arrangement, or if someone wants to apply for a license to do something, or if property changes hands, the information that applies to the actions will be introduced on a console-like electronic device. Immediately, the information will be transmitted to a national center, where the information and rules pertinent to such actions will be instantly available, again electronically. An answer will immediately come back saying that the action is approved and properly recorded, or more information is needed, or perhaps that the proposed action described is illegal. If the situation requires higher deliberations because of complexities not fully covered by the stored logic and data, then the system will automatically prepare the basic raw material in a form that saves much human effort.

All of this is technologically feasible today; the next few decades will make it economically feasible as well. In addition, the increasingly complex and fast-paced society in the coming years will present us with an avalanche of paper work, red tape, communication, and interaction. Our operations would virtually come to a halt through indigestion if not rescued by some kind of electronic information handling system.

Medical practice in the future will be aided by information technology to a degree comparable in its significance with the advent of surgery. A practicing physician will introduce the data on a patient, his own observations, tentative conclusions, and proposed treatment, into a national medical informational network, through an input device in his office. He will immediately receive a custom-assembled compendium of pertinent reactions to these data and diagnoses. He will obtain the equivalent, in part, of consultations with thousands of physicians on similar situations, on the relationship between cause and cure, on statistics regarding drugs and treatment, and, over-all, a great backup to his own intellect and knowledge. He will, of course, introduce his experiences regularly into the network. New professions, as specialties of medicine, will arise to create, maintain, improve, and operate such a network to extend the brainpower of the highly trained human medical practitioner.

The managers of business will have available facts on their operation, so well displayed, tied together, and processed that management can be confident the operation is close to the optimum plan they desired. Electronic control of this information will enable the skilled, more creative human managerial intellect in business to be applied to the difficult policy and planning problems and to the arrangements among businesses. The machine will take on the job of storing, pondering, and providing all needed information, on call, and in numerous quickly changed forms.

The stupendously fast processing of mundane data in huge batches, the delivering of that information anywhere in the world at the push of a button – these are facets of intellectual-information activities for which the human brain is not suited. This capability, when matched with man's remarkable capability to associate and contemplate complex interrelationships, will make for a new superior level of business and industry operation.

Electronic education

In education, information stored in electronic systems can be presented efficiently to students, who can be asked to provide their push-button response. In accordance with stored rules, the presentation can be automatically speeded up, slowed down, repeated, or shifted to other material, depending upon the apparent ability of the student to understand, as indicated by his answers. This "closed-loop," sympathetic feedback between the nature and speed of presentation of material and the student's response represents a whole new dimension in teaching aids. Students of our century may one day label it as of equal significance to the invention of the book.

Educators will find other tools in electronic information systems. They will be able to obtain detailed records on individual students automatically, on a moment's notice. They will be able to synthesize a custom presentation and test for a single student, even as they process statistics on millions. The educational profession, aided by a synthetic intelligence system that takes the burden of the mass handling of the more mundane intellectual tasks, will be able to rise to a new, higher level of intellectual attainment.

Financial and acounting operations will be revolutionized by electronic information networks. Personal checks, and even currency and coin, will be delegated to a few rural areas or museums. When you buy a necktie or a house, your thumbprint in front of the little machine will identify you, subtract from your account, and put it onto the seller's account; all through electrical signals. The data will be assembled according to rules, the government will take its cut in taxes, and all accounts will be kept straight by the pervasive electronics information system of the future.

What we have been describing, had we continued in detail, would disclose itself to be a major redoing and up-dating of most of the physical resources of the businesses and industry of the world. We are talking about not mere millions, but rather trillions of dollars of investment in new technological equipment, systems, and procedures affecting and improving the way factories, steel mills, railroads, banks, schools, and the professions are run. Tens of millions of people will have their individual jobs altered in detail. So the impact of technological change, particularly when man's brainpower is extended by machine, is bound to become a major, if not dominant, political issue of the century. The retraining and relocation of people, and all other arrangements to make certain that rapid technological change does not destroy the economy, will be subjects of heightening discussion. Under such circumstances it is unavoidable that the government will be involved. We will go on arguing about how *much* it should be involved, but involved it certainly will be, and in a very ubiquitous way.

As in the telephone and power utilities, which are government-granted monopolies, so the careful assignment of roles and missions among different contributing segments of our nation in information-automation will also require government chairmanship and refereeing. The government must allocate radio frequencies for communications. The language and format for electronic information systems must be universal. The input and output devices for man to use, the interconnections, central station devices, the locations for processing of the information, and the control of all the stored information for business, medical, legal, and other uses will require organization, planning, standardization, and compromises.

Government, the biggest customer

The decisions will involve many semi-autonomous groups, some operating industry, some designing and manufacturing the equipment, and others operating the networks. The government is itself already the biggest customer. It has more information to handle, and is involved in more detailed day-to-day decisions than any other single entity. As a leading customer, it will in any case have a very large voice in deciding how to design and arrange the system that it will be using.

Finally, the investment required for the changeover is so great, even when spread over decades, that the government will probably end up being the main financial backer.

With electronic systems helping to control the operations of private business and industry through information that is complete, automatic, up-to-date, and utilized fully, management can rise to a new

"Historians some thousands of years from now may call the last decades of the twentieth century the most significant in the history of the human race. It may become the period when man learned how to increase his intellectual capacity and, from then on, to utilize science and technology to the fullest for society's advance."

higher level of competence. Managers will spend a greater fraction of their time in planning and in arrangements with the outside world that affects their operation, confident that the internal operation is under close control. As more and more of American business and industry begins to be dependent upon, and becomes a part of, the information network, its day-to-day operations will be more tightly controlled in accordance with a plan. An increasing number of separate organizations will be tied together electronically to assure optimum operation between them, so that what one does constitutes a planned and agreed response in view of the activities in the other. As top management works out these relationships, taking care of unforeseen emergencies as part of the understandings and rules that are set up, a larger and larger fraction of the total American economy becomes, for all practical purposes, a planned operation.

The web will become increasingly intricate, complete, and solid, reaching every small operation and assuring that all materials and information are in the right place at the right time. A highly efficient operation is thus approached, with top management moving increasingly toward higher level problems. Private management's preoccupation with goals, bigger interconnecting arrangements, and international relationships will link it more closely to the top of government — which begins to become indistinguishable from the top of industry.

Now, what kind of organization of society does this projected trend of technological advance bring with it? Are we ultimately forced, knowingly or unknowingly, to accept that dreaded "planned economy," the very antithesis of free enterprise?

A planned economy concept, as we know, usually engenders negative connotations. It is associated with the thought of a small group in government presuming to plan for the individual, usurping the rights and destroying the American habits of the citizen to freedom of choice, and interfering with the natural forces that might otherwise give us a more energetic, thriving economy.

On the other hand, a natural, unfettered, free enterprise, which automatically gives us the benefits of individual initiative, competition, incentives, personal creativity, and freedom from government control and interference, seems hard to associate realistically with the highly controlled operations which appear to be inherent in the future society's inevitable way of life. Aside from having the government as a certain, pervasive partner, the optimized automatic arrangements for operation of all activities implies circumscribed, rigid, formal controls. The individual participants will find it difficult to go off freely in newly conceived, personally initiated directions.

Do we find ourselves, then, forced to choose between something we don't want and something which can no longer take place? Is there a third possibility?

I think there is. And I think that it is more likely than the other two. I hope I do not disclose myself as too much of an optimist in describing this third approach not only as probable, but as a have-your-cake-and-eat-it-too possibility.

Nothing approaching a true planned economy is conceivable in the future unless we postulate in that future an efficient, universal network of information-acquisition and dissemination. No dictator or central group in government would get anywhere, even if we willingly handed them the task of planning and controlling all our activities, unless they had this national mass fact compiler. They would also need its counterpart, the means for disseminating signals to control everything down to the depths of the details of the economy of the nation. Otherwise, direct as they might, there would be random, uncontrolled responses to their directives, and a tremendous amount of independent action. In fact, most of the details that in the end would really control the economy would represent actions completely outside the scope of their limited coverage. Unless they were able to gather enough of the facts on an on-line, real-time basis, process these facts in accordance with detailed, stored plans, and get the control directions out in like detail, they would not be able to assure adherence to their control at all.

Now a large, fully developed, national electronic information network, necessary for a true planned economy, is not just a means for acquiring the facts, or even for disseminating and displaying directions. It has to be a system for processing facts and stored logic into alternative courses of action, which are compared and communicated. A system that makes real planning and control possible, also makes managerial knowledgeability possible; more important, it also makes citizen knowledgeability possible.

A network that possesses the information to control a nation's physical operations, that is designed to disclose the trade-offs of benefits among possible decisions, also can readily make these alternatives known to the people at large. Moreover, a well planned economy that derives from a good information network is one that is planned to match with needs. It is a matter of good design that the plan should be compatible with the desires of the consumers, the users of the results, the mass public, for whom the economy is being operated, and for whom it will operate with much greater success if those consumers understand and have participated in choosing the alternatives.

Some speculative inventing

Citizen participation is technologically feasible in the world of the future to a much greater extent than today. Will it happen? Is it practical? Let us do some speculative inventing to show quickly that it can be done.

Imagine for the moment that the society of the future could include, as part of our everyday pattern of living, that we "vote" during a few very significant minutes each day on our choices amongst alternatives. We might all be connected to the national information system through an electronic box at home, which might even be integral with our TV sets. Instead of the commercials, or (more realistically) in addition to them, every 10 or 15 minutes we will have displayed to us candidate products for the future – proposed new automobiles, places to go for vacation, kitchen equipment designs.

We might be shown four or five different automobile designs for a year hence, with the stated prices dependent upon the quantity chosen, the extent of unanimity of decision, whether two-door or four-door, and whether large or small. We might even be asked to "put our money where our votes are" by agreeing to purchase a car a year ahead, such a decision giving us a reduction in price. Our push-button responses on the spot would go into the national information system and the results would become an important ingredient, in many ways a starting or determining parameter, of the "planned economy." Our financial commitments would become binding, and our votes would become a part of the decision-making, the financing, the scheduling of production and employment, and the phasing of deliveries.

Thus we see two ways, in principle, that our society can benefit from the technological revolution in the handling of informational and intellectual activities. One is in the improved management and control of all of the material requirements of our society, with a man-machine, on-line partnership providing us with our goods and services, keeping everyone supplied, everything straight and everything moving.

The other is to make possible a new level of interaction between the economy and the citizens. Within the new, broadened realm of technological feasibility, an increasing number of citizens could learn enough and be heard from easily enough so that it would be natural and likely for them to express their interests, their curiosity, creativity, and desires. Proposed alternatives could be dealt with quickly, and the results communicated to all. The decades ahead could become ones in which the citizens are more informed, more interested, and are more spirited, active participants. We could have "on-line" democracy. This could happen, remarkably enough, despite the fact that the response to the citizens' whims and interests could be regarded in another sense as a controlled, carefully meshed, precision-operated society.

Social advance and technological acceleration

Social advance has not been keeping pace with technological acceleration. But maybe that trend will be curbed. Technological change has been giving us too great a mouthful to swallow. On the other hand, science seems to be able to give us more and sharper teeth to help get that mouthful down. With synthetic electronic intelligence taking the big load of mundane data handling off of the human intellect and extending our brainpower, we may have the opportunity to rise to a new level of human attainment. Maybe that new total of intellect, natural plus synthetic, will be sufficient to enable us to speed up social advance to reach the balance required. Historians some thousands of years from now may call the last decades of the twentieth century the most significant in the history of the human race. It may become the period when man learned how to increase his intellectual capacity and, from then on, to utilize science and technology to the fullest for society's advance.

The Month at Caltech

Freshman Grades

The Institute's new policy of giving no grades to freshmen (E&S – November 1964) has resulted in the establishment of a new freshman faculty-adviser system. Sixteen senior faculty members will serve as counselors to freshmen for discussion of academic progress, goals, and extracurricular activities. Initiative in making use of the system will rest largely with the students, except when they may clearly be threatened by academic trouble.

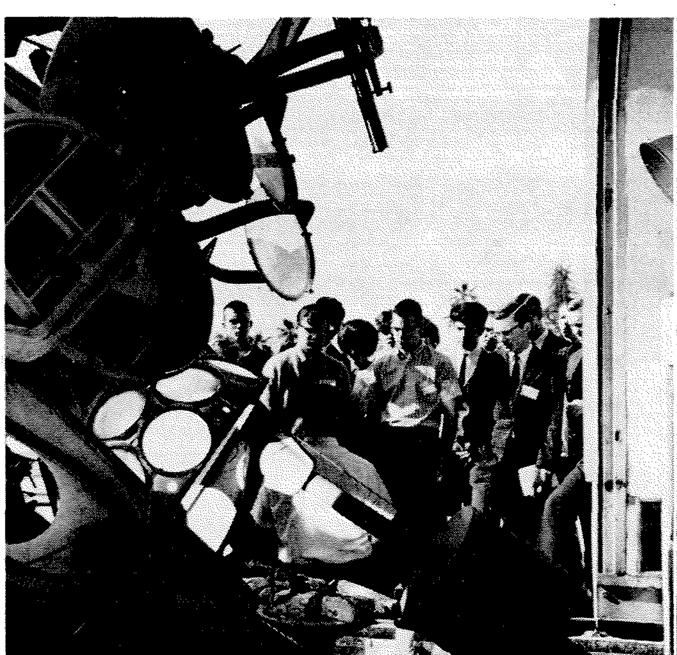
The new policy does not imply changes in the nature of Caltech's courses or teaching methods. There will still be homework, classroom tests, and mid-term examinations, and these will be graded as in the past. The student's performance in this work will provide part of the basis for his ultimate Pass or Fail.

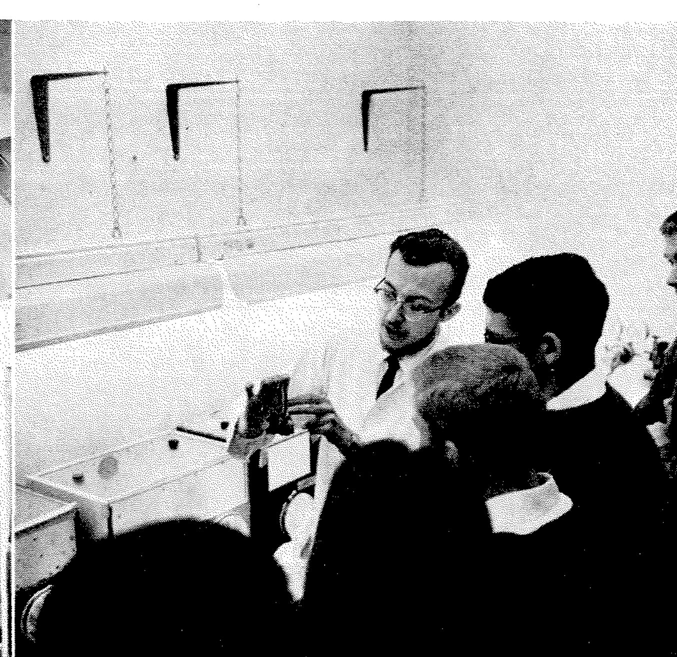
Honors and Awards

Robert B. Corey, professor of structural chemistry at Caltech, received an honorary degree on October 7 from his alma mater, the University of Pittsburgh, for his work on amino acids and peptides.

President L. A. DuBridge has been elected to the board of directors of National Educational Television. He is also currently chairman of the board of Community Television of Southern California, which operates KCET, the education television station in Los Angeles.

Giles S. Hall, Jr. has been appointed to the newly-created position of assistant director of the Caltech Industrial Relations Center. Robert D. Gray serves as director. Mr. Hall has served as personnel di-





STUDENTS' DAY, 1964

Over a thousand southern California high school students and teachers came to the campus on December 5 for the 15th annual Students' Day. The all-day program included a series of lectures by Caltech faculty members and a tour of current research projects at the Institute (more than 40 exhibits in all) such as (left) the solar furnace on the roof of the Robinson Laboratory of Astrophysics; and (right) work on living nervous systems, conducted jointly by electrical engineers and biologists in the Booth Computing Center.

DUMOND SPECTROGRAPH GOES TO THE SMITHSONIAN

Thirty-three years have elapsed between these photographs of the same two scientists, Jesse DuMond and Harry A. Kirkpatrick, working with an instrument that proved a vital theory of physics in 1931. The instrument, called a multi-crystal spectrograph, was designed by Dr. DuMond, now professor of physics emeritus at Caltech, to prove his theory that an electron moves about the nucleus of its atom and is not a stationary object, as some physicists believed. Dr. Kirkpatrick, who was DuMond's first graduate student, and is now doing research at USC, spent more than a year aligning the instrument's 50 calcite crystals so that spectral photographs could be taken to prove the electron's motions. At right, the men are preparing the instrument, resurrected from a Caltech basement last month, to take its place among other distinguished pieces of apparatus in the Division of Electricity at the Smithsonian Institute in Washington, D.C.

rector and assistant secretary of Consolidated Electrodynamics Corporation in Pasadena.

Richard L. Mooney, buyer supervisor at Caltech, has been promoted to purchasing agent. He came to the Institute in April 1964, from the Ryan Aeronautical Company in San Diego.

William H. Pickering, director of Caltech's Jet Propulsion Laboratory, was awarded the Columbus Gold Medal for 1964 for "deeds of high human significance in interplanetary exploration" in Genoa, Italy, last month.

Bruce H. Sage, professor of chemical engineering at Caltech, has been named editor of the *Journal of Chemical and Engineering Data,* a quarterly publication of the American Chemical Society. He assumes his editorial duties with the January 1965 issue of the journal.

Maarten Schmidt, staff member of the Mt. Wilson and Palomar Observatories, received the Helen B. Warner Prize from the American Astronomical Society this month for his spectroscopic studies of quasi-stellar sources and of radio galaxies. The prize is offered annually to a North American astronomer under 35 who has made a significant contribution to astronomy.

Robert P. Sharp, chairman of Caltech's Division of Geological Sciences, has won the Kirk-Bryan Award, one of the three top awards presented by the Geological Society of America, for his article "Wind Ripples," published in the *Journal of Geology.*

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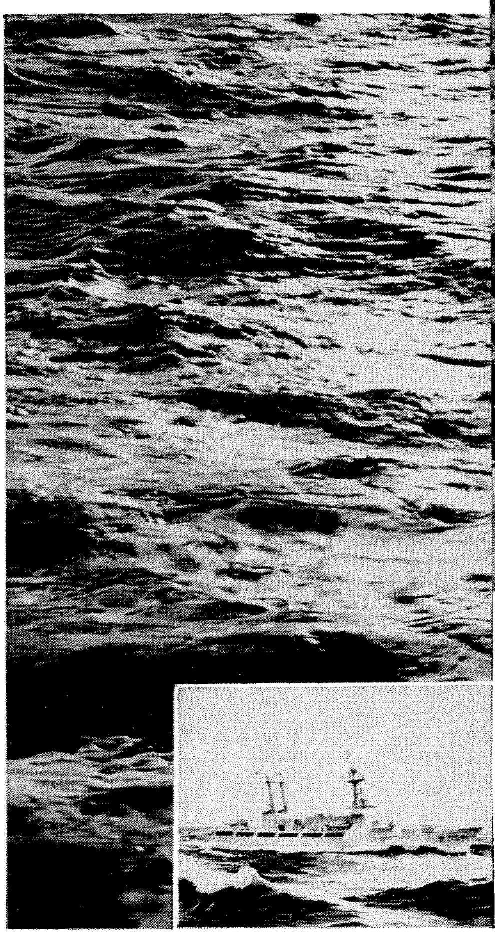

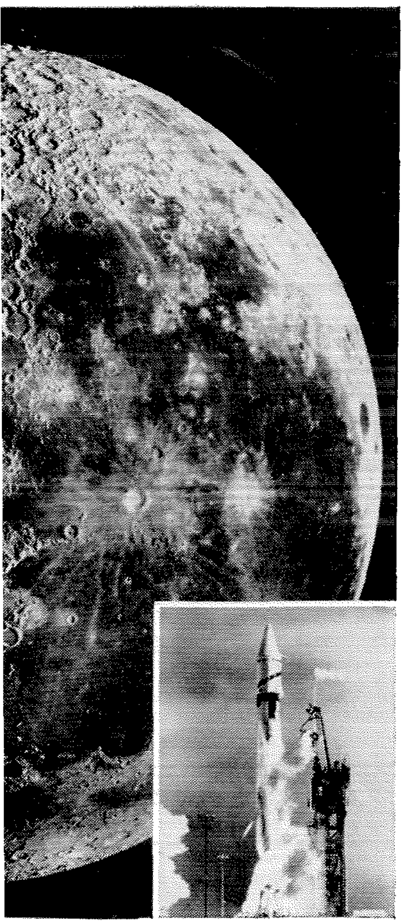

THE ORIGIN OF COMETS

Astronomers find evidence that comets may have been formed in about the same region of the solar system as the earth

Two astronomers – Jesse L. Greenstein, professor of astrophysics at Caltech, and Antoni Stawikowski, visiting research fellow from the Nicolas Copernicus University of Poland – have found evidence that comets may have originally been created in the vicinity of the earth. The evidence is a rare form of carbon, found in the spectrograph of the comet Ikeya, which suggests a definite link between the solar system and the many comets out in space. The ratio of this carbon (carbon-13) to that of the common form of carbon (carbon-12) is essentially the same in the comet as it is on the earth in such creatures as humans. The ratio is one atom of carbon-13 to every 70 of carbon-12, which is similar to the terrestrial ratio of one to 90.

The new find lends credence to the theory that comets were formed in about the same region of the solar system as the earth, and were blown into their present, vast elliptical orbits by the solar wind as the sun brightened to its present brilliance.

Using the 200-inch Palomar telescope, the two astronomers studied the comet Ikeya last year, when it was so bright that it could be seen with the naked eye. This fact, plus two nights of exceptionally good seeing on Palomar with the great light-gathering power of the world's largest telescope, gave enough illumination from the comet to reveal details never seen before in a comet's spectral pattern. The research is sponsored by the Air Force Office of Scientific Research.

The amounts and kinds of chemicals found in the sun, on the earth, and now in comets, suggests that the solar system was formed from a whirling cloud of hydrogen and other gases that later condensed into the members of the solar system. Magnetic fields wrapped in the swirls of gas could have served as natural atom-smashers, accelerating hydrogen atoms to high enough velocities to interact with other nuclear particles.

These processes could have produced certain elements that are rare in stars, plus the rare form of carbon, thus indicating that nuclear fires in stars may not be the only manufacturer of elements heavier than hydrogen.

Comets are composed of great blocks of frozen gases, such as carbon dioxide and ice, which could have been the first solid material in the solar system. Each comet is composed of a collection of these celestial icebergs, and astronomers believe that they have been able to survive for a comparatively long time because they are out in the refrigerator of space, far beyond the outermost planets and beyond the eroding effects of the solar wind.

During the brief periods that they approach the sun, the ice blocks heat up a little and evaporate some of the frozen gases. These evaporations form the spectacular long tails, which point away from the sun because the solar wind blows them that way. The tails are not fiery, as the ancients thought them to be, but are made of vapor, which is made to fluoresce by the sun.

The findings on Ikeya not only tend to link comets closer to the earth and to our neighboring planets; they may, in the future, shed light on the birth of the solar system, and particularly the nuclear events that occurred in the early days of the system.

CALTECH'S 1963 ALUMNI SURVEY

V. *The Caltech Experience*

by John R. Weir

A majority of Caltech alumni (59 percent of those stopping at the BS level, and 67 percent of those going on for advanced degrees) are now in the occupations they planned to enter when in college. What's more, they expect to continue in these occupations in the future. Only 30 percent of the BS's and 22 percent of those with advanced degrees have followed occupations different from those originally planned.

College graduation is worth all the time and effort it entails. This is the conclusion we can draw from alumni opinions. Eighty-two percent of those who did their undergraduate work at Caltech, and 76 percent of those who went elsewhere and came to Caltech for graduate work only, say that their undergraduate courses helped them a lot in their present occupation. Sixteen and 22 percent, respectively, say they helped some; and only 2 percent think they helped very little.

Similar opinions obtain at the graduate level. Eighty-three percent of those earning graduate degrees at Caltech and 80 percent of those earning them elsewhere say their graduate courses have helped a lot in their present occupations. Fifteen percent say they have helped some; and only 3 percent say they have helped little.

Even some of the alumni who say that their college courses only "helped some" in their present occupations are quite satisfied with their education, since 86 percent are satisfied with their undergraduate major and 90 percent with their graduate major. These percentages are similar to those in the 1952 survey. They were higher than the percentages among graduates from other technical colleges then, and are probably also higher today.

If it is safe to generalize from the replies to our questionnaire, we can conclude that the college or university one attends becomes to that person the best of all possible schools. Caltech alumni were educated in many different institutions, varying widely in size, location, quality, variety of offerings, and cost. Yet most of them would do their undergraduate work at the same institution if they were to do it over again, and those with graduate degrees are even more loyal to the place where these degrees were obtained. The alumni responded to the following question in this manner:

In the light of your post-college experience, and if you had it to do over again, would you	*% under-graduate*		*% graduate*	
	At CIT	*Not at CIT*	*At CIT*	*Not at CIT*
Attend the same college?	86	74	90	76
Attend a different college?	14	26	10	24

The figures indicate a somewhat greater degree of satisfaction with attendance at Caltech than at other institutions. Since we only offer degrees in science and engineering, we might expect a strong bias among alumni in the direction of a highly specialized curriculum. But this is not the case. Among those who attended CIT as undergraduates, 40 percent think their education was just right. Among the 60 percent who would prefer a change, five times as many would prefer it to be more general as would prefer it to be more specialized. Even at the graduate level, where one would expect an almost complete preoccupation with highly specialized study, the half that prefers a change is evenly divided between wanting more generalization and more specialization.

Alumni satisfaction with their own college backgrounds is surely best expressed in what they would

want for their own sons, and 80 percent of Caltech's alumni would encourage their sons, if properly qualified, to attend Caltech as undergraduates; while 91 percent would encourage them to come here to graduate school.

It is apparent that where qualifications to the general satisfaction occur, they are largely in the direction of a desire for a broader, more generalized college experience, particularly in the undergraduate years. This theme was reiterated many times in the written comments volunteered by alumni.

Educational Limitations

On the last two pages of the questionnaire, we asked the alumni to name the factors which limited or interfered with their education and those that contributed most to their life after graduation. We also invited comments on the survey or on Caltech. By this means we hoped to gather information that would aid in evaluating many different aspects of a Caltech educational experience.

The response was gratifying, if somewhat overwhelming. More than 9,600 separate replies and comments were sent in.

In reply to the question: *What factors or events at CIT limited or interfered with your educational experience?* approximately half (2,354) of the alumni sample noted one or more items. (An additional 845 wrote "None," implying a kind of blanket approval of their experience.)

The "limitations" fell into five broad groups: Institutional (783), Personal (725), Curricular (619) Instructional (521), and Financial (428). The numbers in parentheses are the frequency with which that kind of limitation was mentioned. A few other kinds of limitations named were chiefly due to external circumstances which could not be influenced by the Institute or the student—such as World War II, or the stepped-up wartime V-12 program. Even smog was cited 24 times.

The most frequent limitation cited in the Institutional category was the intense competition and the emphasis on grades (137). Next came problems of student housing: 136 felt it was a definite handicap to have to live off campus; 32 felt the student housing was inadequate. On the other hand, another 32 felt that living in the student houses, with the horseplay and other distractions, had interfered with their progress in school. There were 194 complaints illustrating the desire for a less restricted and narrow environment: the absence of co-eds (91), limited social activities (65), and the lack of variety in the student body (38). Lack of vocational guidance (68) or psychological counseling (32), and inadequate advisors (55) came in for considerable criticism. There were 94 miscellaneous statements that referred to the atmosphere and administration of the Institute. However, the Deans, those perennial targets of criticism in most colleges, were mentioned only three times!

In the "Personal" category, the more frequent limitations included immaturity, lack of motivation or self-confidence (236), inadequate academic preparation and poor study habits (90), too many extracurricular activities (68), problems of dating, marriage, and parenthood (64), and physical illness (50). Seventy-four wrote the equivalent of "my own making."

Almost half (286) of the inhibitors mentioned in the "Curricular" category were attributed to specific defects in some required courses, including P.E., or in a given department such as engineering. (A frequent comment was that the engineering courses were not practical.) Next most frequent were comments again evidencing the desire for a broader, more heterogeneous undergraduate experience: the courses requisite for a degree left no time for broadening the student's cultural base (63); there was a dearth of arts courses, a narrow curriculum (55); specific courses – and these were principally nonscientific – which the student would have liked to take were not offered (70). Last, but scarcely least (there were 145 of them), came comments on the work pressure: "lack of time" (66), "excessive homework" (25), and "study load too heavy" (54).

Most of the items in the Instructional category questioned faculty competence (307), about half of these criticisms being specifically directed at graduate student instructors. Another 88 comments spoke of faculty aloofness and indifference, and there were 37 who felt that the general faculty preference for research over teaching was a drawback to the quality of instruction. Too frequent and irrelevant examinations, or personality conflicts with faculty members, were also mentioned.

Financial limitations were mentioned 428 times. Exactly equal numbers listed the lack of adequate funds (199) and the need to work (199) as interfering in their college career. An additional 30 listed having a family to support.

Some of these limitations no longer apply to Caltech because of the changes that have been made over the years. As a matter of fact, when we divided the sample into three groups—pre-1940, the war

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period (1940-1952), and post-war (1953 to the present)—and tabulated some of the most frequent criticisms, we found definite decreases in certain areas. Financial limitations have steadily lessened, as have criticisms of the lack of guidance and counseling, and inadequate housing. In the curricular area, the absence of specific non-scientific courses is being mentioned less in recent years, and the complaints about the impracticality of engineering courses have dwindled.

On the other hand, comment on many limitations has increased in recent years: the recognition of personal factors has gone up sharply, and so have criticisms of the emphasis on grades and the competitive pressure. Dissatisfaction with the restrictions of a rigid scientific environment has grown.

Lifetime Contributions

Since 98 percent of the alumni believe that their college courses helped in their present occupation to some degree, can we assume that participation in athletics, campus politics, and social activities also had beneficial effects? To find out just what are the important experiences, we asked: *What non-academic activities or experiences during your undergraduate college years contributed most to your life after graduation?*

The most frequently mentioned contribution (913) was the formation of personal friendships with other students – made through many different contacts, including the student houses, campus politics, and social events.

The second most frequent was athletics, with 649. Usually this activity was valued because it taught the alumnus how to get along with other people and how to function as a member of a team.

The third most frequent, with 317, was learning to get along with a wide variety of people by working with them on a job, and successfully making one's own way.

In fourth place, with 216, were various kinds of social activities. The value most frequently mentioned was the help these activities gave the alumnus in feeling more at ease with other people.

It seems very significant that these four contributions are all valued because they helped the alumnus become more at ease and more skillful in human relations. The high frequency with which Caltech alumni attain managerial positions may account for the value they now place on this skill, as indicated by the fact that these four groups contained 2,095 statements. This is more than half of all the "contributions" that were mentioned in the survey.

Musical activities was the next most frequently mentioned contribution to life after graduation. They were listed by 197 alumni. With the exception of athletics, music was mentioned more frequently than any other traditional extracurricular activity.

Athletics	649
Music	197
Student government	127
Newspaper, writing	97
YMCA	87
Debate, public speaking	83
Drama	49
Professional societies	48

In sixth place, with 170, was the social facility developed from meeting girls, going out on dates, and meeting the girl one later married. An additional 81 listed the encouragement and understanding they received from their wives as being of major importance.

Military service was next (130). Here the contributions to later life were attributed to physical conditioning, learning to live a disciplined life, and learning to live and work with many different kinds of people.

Next in order was a wide variety of hobbies (127), ranging from poker through judo to mountain climbing. Church attendance was mentioned 122 times, as were contacts with professors.

Suggestions for the Future

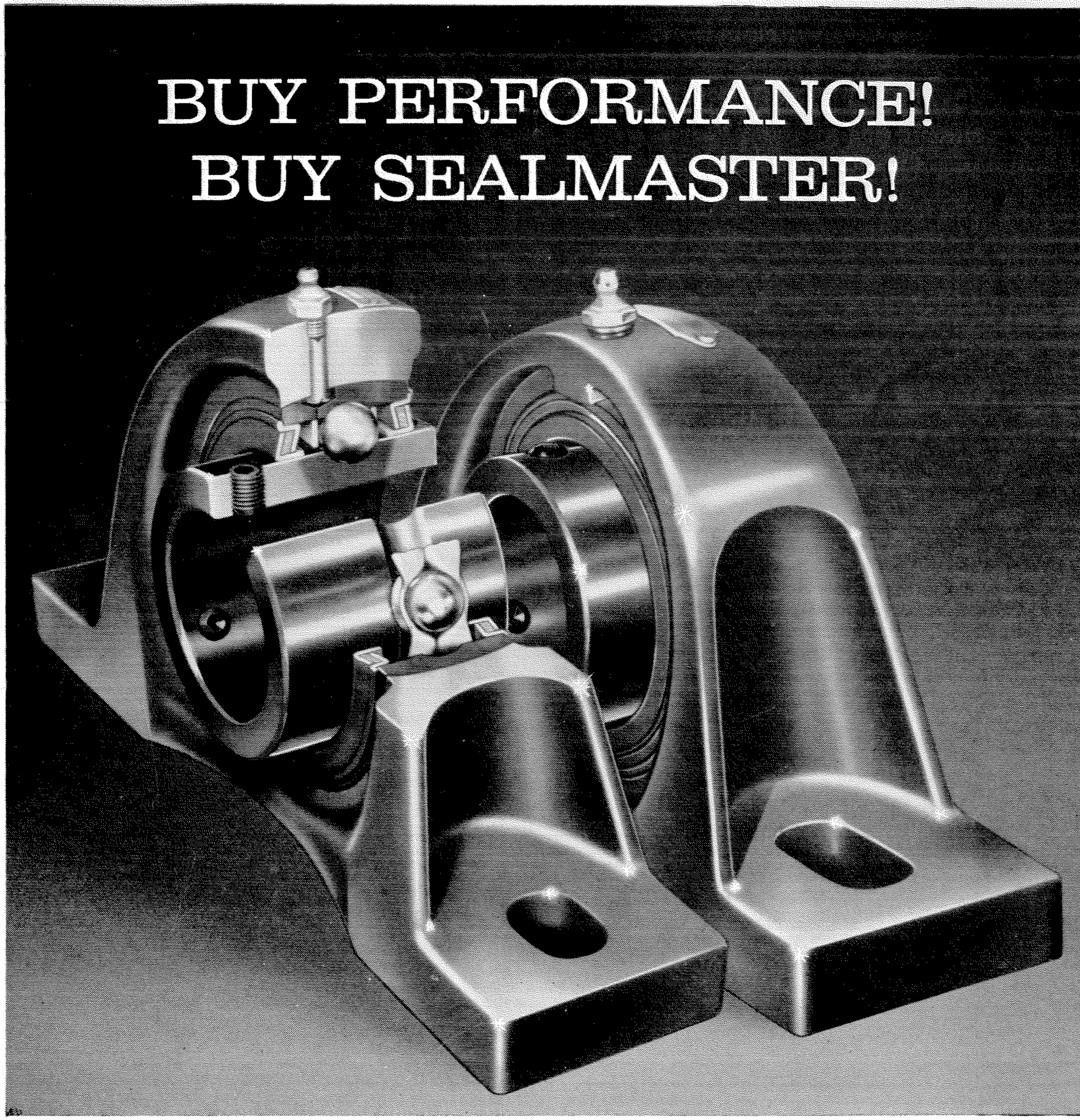
The last page of the questionnaire booklet was left blank, with the heading:

We would be pleased to receive any further comments you would like to make concerning either the California Institute or this Alumni Survey.

A total of 1,007 alumni made additional comments. Many added several pages of discussion and suggestions—at the end of a very detailed 12-page questionnaire!

These comments were extremely varied and most difficult to classify. About a quarter referred to the questionnaire or the survey, a quarter were critical of some aspect of Caltech, a quarter praised Caltech, and a quarter offered suggestions for change of one sort or another.

Most of the criticisms of the survey were directed toward the opinion statements that required an "agree," "disagree," or "no opinion" reply. They were thought to be biased, black-and-white, oversimplified, and ambiguous. As one alumnus put it, "They sound as if they came right out of *Time* magazine." He was nearly correct. These statements were first used in a survey of U. S. college students



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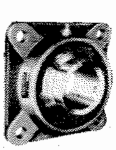
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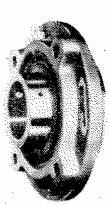
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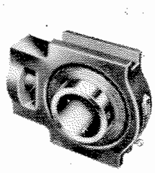
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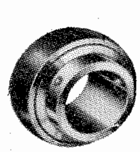
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instigated by *Time* in 1948. Many items from this study were used in our 1952 survey so that we could compare Caltech alumni with other students. We retained several items in the 1963 survey to look for changes in attitudes and opinions since 1952.

A few alumni questioned whether the survey was in fact truly anonymous. It was, of course, in that no names or code numbers appeared on the questionnaires. In fact, considerable time and money was expended to achieve that degree of anonymity. On the other hand, the survey required a large amount of detailed personal data, so it might have been possible to identify a respondent if one cared to undertake the necessary detective work. But the effort required would make a top-secret-security-clearance investigation seem cursory by comparison. We certainly have no such inclination.

A total of 320 criticisms of Caltech were received. Many of them (140) referred to teaching and counseling needs, and they are included in the discussion of these "limitations." Among the remainder, the most frequently mentioned criticism (59) was labeled for purposes of analysis, "Humanization of Students." Although expressed in many different ways, this is essentially an objection to an overemphasis on technical subjects, a need for more liberal arts, and for more attention to human feelings and values. The socially impoverished atmosphere was blamed for producing graduates who are socially unaware and uninterested. Many times the desirability of Caltech's becoming coeducational was stressed as a way to meet these criticisms.

Some alumni thought there should be more humanities courses, and a wider variety of them, including more of the social sciences.

There were 341 statements of approval of the Institute. Alumni are proud to have gone to "the best technical school in the country," and they enjoy the prestige of being Caltech graduates. They like its being small and of high quality, they like its atmosphere of truly scientific research, and its emphasis on basic principles. There were 121 such comments.

Another 39 were especially appreciative of the humanities program and the contribution it made to their personal success after college. Individual professors in the humanities division were frequently cited as having profoundly stimulated the alumnus's thinking, or as having awakened him to new interests.

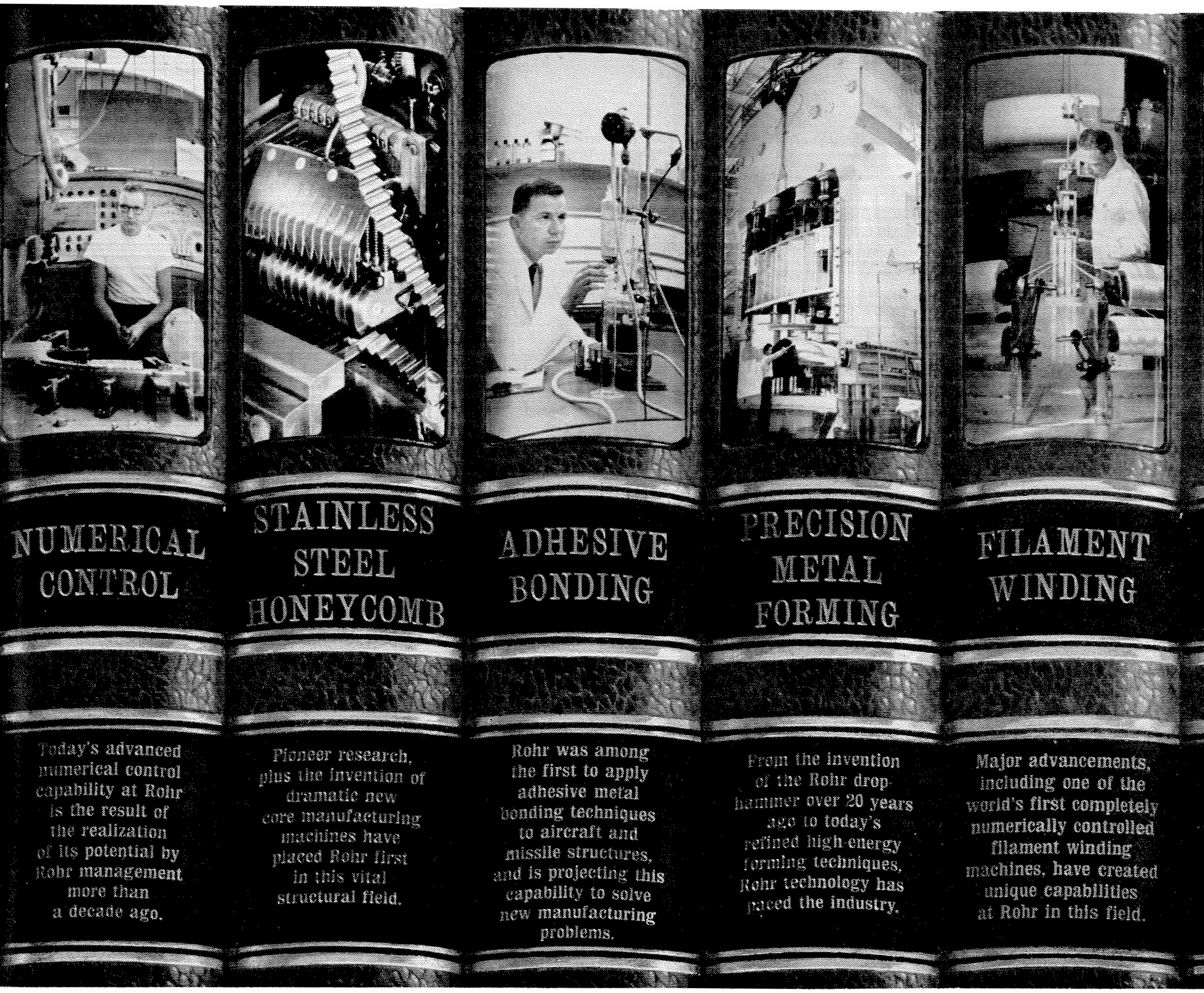
Another sizable group (71) approved of the many opportunities at Caltech for growth and development outside the classroom. For some it was the autonomy and freedom for self-direction given the students by the Administration. For some it was the operation of the honor system. For some it was the student house organization. And for some it was the varied programs and speakers brought to the campus by the Caltech YMCA.

Out of a total of 279 recommendations for changes, 153 wanted curriculum changes, 37 related to non-academic student life, 29 suggested raising faculty salaries rather than buildings, 12 favored becoming coeducational, 11 suggested night and extension courses, and 11 suggested equating the Caltech grading system with those of other colleges.

There is no longer any basis for many of the sources of criticism, and suggestions for change that have been discussed here. There are now adequate financial resources to enable any deserving student to attend Caltech. The Institute now has a full-time psychologist available for personal and vocational counseling. Three more undergraduate and three graduate student houses have been completed, permitting all undergraduates and most graduate students who so desire to live on campus. Sports and athletic facilities have been expanded, and physical education requirements have been reduced. The undergraduate courses and curricula in physics, mathematics, and chemistry have been drastically revised, and the engineering program has become much more oriented toward basic principles. Undergraduate course requirements in many options are more flexible and permit many more electives in the sophomore, junior, and senior years. The number of humanities elective courses offered has doubled in the last decade. And, most recently, the Institute has begun a two-year experiment in which freshman grades have been abolished.

These are all very significant changes that have occurred in the last few years. They meet many of the criticisms of our older alumni. But they do not satisfy all the criticisms we received in our questionnaires. Nor do they represent all the changes suggested.

But neither are we finished with the survey suggestions. All criticisms and suggestions have been specially coded in terms of their content. These will be assembled into further analyses and studies that will then be circulated among the appropriate Institute faculty and administrative officers for further consideration. The Institute will certainly continue the process of self-examination and self-evaluation that led to the changes described, but from here on it will also have the benefit of the thinking and opinions of its alumni, expressed through the 1963 questionnaire.



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Alumni News

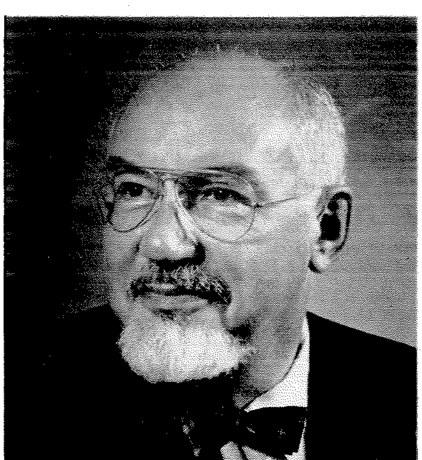
George W. Downs (1911-1964)

George W. Downs, Ex '34, widely known electronics engineer and instrument manufacturer, died suddenly in Pasadena of a heart attack on November 8, 1964.

Born in South Dakota on January 29, 1911, George lived most of his life in southern California, primarily in Pasadena. He entered Caltech as a freshman in 1930, but the pinch of the Depression forced him to seek employment in 1932. He never completed his Caltech education, yet through diligent self-study to satisfy the continuing demands of an active, perceptive mind, George became an oustanding alumnus. His loyalty to Caltech was truly exceptional and his gratitude for his early education and continuing association with the Institute was boundless.

The professional record of George Downs began with James Lansing in the Lansing Manufacturing Company where, in the development of the original Lansing sound systems, George made original contributions to the design of speakers and amplifiers and had an opportunity to satisfy his instincts for high quality of design and performance of equipment. Then, and throughout his life, the things which George did bore the mark of quality.

After four years with James Lansing, George joined the William Miller Corporation, Pasadena, builders of oscillographic recording equipment and related transducers. There he served as Development Engineer until August 1941, when he joined the Division of War Research of the University of California at San Diego. His work there was concerned primarily with problems of underwater acoustics and sonar.



George W. Downs

The San Diego experience caused George to become interested in Caltech's wartime activity in the improvement of aircraft torpedoes and the problems of their water entry after launch. He joined the Caltech Torpedo Project in 1943, in charge of electronics and instrumentation, and his ingenuity and experience in instrument development were highly effective here. Similarly, in 1944, when Caltech was asked to assist in certain engineering features of the Manhattan Project, George made further contributions by dividing his time and creating a new electronics group to support critical developments in progress at Los Alamos.

In September 1945 George returned to the Miller Corporation as Executive Vice-President and Chief Engineer. He continued in this activity until 1954, when the corporation was merged into Consolidated Electrodynamics Corporation. Concurrently, he participated with Howard Cary, BS '30, and William Miller in the formation of the Applied Physics Corporation, in which George served as Vice-President. This company, started in Pasadena, soon outgrew its facilities and moved to Monrovia.

In addition, George was president of the Research Instrument Corporation of Pasadena, and a director of the following corporations: Research Instrument Corporation, Applied Physics, Preco, ADCOM, Electra Motors, Dynamic Instrumentation, and Superweld.

Professionally, George was a Fellow of the Acoustical Society of America and the Institute of Electrical and Electronic Engineers, a member of the American Physical Society and the Optical Society of America. He was also a member of the Jonathan Club of Los Angeles.

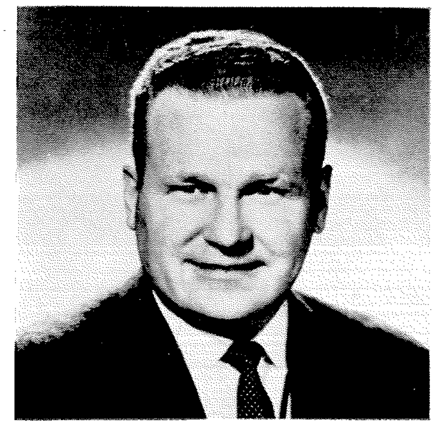
At Caltech, George Downs held a faculty appointment as Associate in Engineering and, on a part-time basis, participated in the courses in engineering design. In addition, many segments of the campus benefited from his helpful suggestions, technical assistance, and generous contributions of specialized equipment and instruments. On the cultural side, George found much satisfaction in serving as a director of the Coleman Chamber Concerts Association. He was also a member and director of the California Institute Associates.

George had, during this past year, following the death of his wife Beatrice, been in process of rearranging his business affairs to give him more time for his hobbies, travel, and his Caltech interests. On September 1, 1964, George and Rosalyn Tureck were married in London. Miss Tureck, famed concert pianist and interpreter of Bach, had been a friend of George's for many years, and Mr. and Mrs. Downs planned to have a home in Pasadena.

In addition to Mrs. Downs, George is survived by a brother, Lemuel Downs, of Costa Mesa, California; and a sister, Mrs. H. M. Piper, of South Dakota.

—F. C. Lindvall

All-America Award



Don L. Walter, '40, MS '41, vice-president and general manager of the power systems division of the Marquardt Corporation, has been elected to *Sports Illustrated's* Silver Anniversary All-America. This is an annual award by the sports magazine to 25 men on the basis of their career success and community service in the intervening 25 years since their senior football season at college. Nomination for the honor is made by each candidate's alma mater, and election is by a panel of eminent judges.

As a Caltech undergraduate, Don Walter was a three-sport letterman, captain of the 1939 football team, and an honorable mention all-conference player.

After receiving his MS from Caltech in 1941, Don worked at Douglas Aircraft in power plant engineering until 1945, when he joined Roy Marquardt '40, MS '42, at the newly formed Marquardt Aircraft in Van Nuys. In June 1947 he returned to Douglas as chief engineer of the testing division, then rejoined Marquardt as chief engineer in 1948. He is now considered one of the country's leading experts in rocket and advanced propulsion systems.

Why become an engineer at Garrett-AiResearch? You'll have to work harder and use more of your knowledge than engineers at most other companies.

If you're our kind of engineer, you have some very definite ideas about your career.

For example:

You've worked hard to get a good education. Now you want to put it to work in the best way possible.

You will never be satisfied with run-of-the-mill assignments. You demand exciting, challenging projects.

You not only accept individual responsibility – you insist upon it.

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Our business is mainly in sophisticated aerospace systems and subsystems.

Here, research, design, and development lead to production of actual hardware. That means you have the opportunity to start with a customer's problem and see it through to a system that will get the job done.

The product lines at AiResearch, Los Angeles Division, are environmental systems, flight information and controls systems, heat transfer systems, secondary power generator systems for missiles and space, electrical systems, and specialized industrial systems.

In each category AiResearch employs three kinds of engineers.

Preliminary design engineers do the analytical and theoretical work, then write proposals.

Design engineers do the layouts; turn an idea into a product.

Developmental engineers are responsible for making hardware out of concepts.

Whichever field fits you best, we can guarantee you this: you can go as far and fast as your talents can carry you. You can make as much money as any engineer in a comparable spot – *anywhere*. And of course, at AiResearch, you'll get all the plus benefits a top company offers.

Our engineering staff is smaller than comparable companies. This spells opportunity. It gives a man who wants to make a mark plenty of elbow room to expand. And while he's doing it he's working with, and learning from, some of the real pros in the field.

If the AiResearch story sounds like opportunity speaking to you – don't fail to contact AiResearch, Los Angeles, or see our representative when he comes to your campus.

We'll be happy to talk to you – about *you* and *your* future.

And put this in the back of your mind:

In a field where meeting challenges pays off in rewards...

AiResearch *is* challenge

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Personals

1926

RAYMOND F. CHILDS, retired engineer from the Standard Oil Company, died on October 26 of cancer in Redwood City, Calif. He is survived by his wife.

1927

JAMES BOYD, president of the Copper Range Company in New York, has also been elected chairman of the White Pine Copper Company, a subsidiary producing copper in White Pine, Mich.

1934

GUY O. MILLER died on September 12 of cancer in Osage Beach, Mo. An engineer with the Phillips Petroleum Company in Bartlesville, Oklahoma, he had retired in 1951 to the Lake of the Ozarks in central Missouri.

1935

GORDON R. EWING is now directing corporate planning for all divisions of the Meredith Publishing Company in Des Moines, Ia. He is also a vice president, a member of the company's executive committee and board of directors, and has served as vice president and general manager of Meredith Printing, the firm's manufacturing division. He has been with the company since 1961.

1936

CDR. DAVID M. WHIPP has been promoted to Captain in the commissioned corps of the U.S. Coast and Geodetic Survey. He is now serving as C&GS liaison officer at Fort Sill, Oklahoma. A veteran of 25 years, he has spent more than 11 years aboard seven ships of the Survey's "white fleet" engaged in hydrographic surveying and charting. The Whipps have two daughters – Patricia, a physicist at General Dynamics Research Laboratory in Pomona; and Dorothy, a junior in high school in Fort Sill.

1940

F. C. BRUNNER, MS '41, writes that he was recently reunited with "an old Alhambra High School friend, Fred Oder, MS '41, when the Brunners stayed overnight with the Oders in their Fairport, N.Y. home on the way to a canoeing vacation in the Canadian Wilderness." Fred Oder is a research manager with Eastman Kodak in Rochester. His oldest son is a medical student at Rochester, after graduating from Harvard. Fred Brunner was recently named head of the chemical engineering department at C. F. Braun's Eastern Division office in Murray Hill, N.J. He has two college junior sons, one at the New Hampshire College of Advanced Science, and one in geology at RPI.

1940

J. B. GLASSCO and S. R. VALLURI, MS '50, PhD '54, are co-recipients, with G. E. Bockrath, of the Wright Brothers Medal, awarded annually by the Society of Automotive Engineers, for the most outstanding paper on aerospace technology. Glassco and Bockrath are both in the Missile and Space Systems Division of the Douglas Aircraft Company. Valluri, who was a consultant to Douglas from Caltech at the time the paper was presented, is now on leave of absence from Caltech as senior professor and head of the department of applied mechanics at the Indian Institute of Technology in Madras, India.

1944

FRANK W. LEHAN, president of Aerojet's subsidiary, Space-General Corporation, has also been elected vice president of advanced systems for Aerojet-General. He has held important posts at JPL and the Space Technology Laboratories, and was a co-founder in 1958 of the Space-Electronics Corporation, which later became Space-General.

WILBUR M. SWANSON, MS '48, ME '51, is now professor of mechanical engineering at Washington University in St. Louis, Mo.

1946

ALLAN B. ELLIOTT, MS, is now assistant treasurer of Top Value Enterprises, Inc., in Dayton, Ohio. He was formerly assistant to the treasurer, and has been with the company since 1961. Before joining Top Value, he had served as assistant regional controller at the Montgomery Ward Company. He is married and has three children.

WILLIAM MOJE, associate chemist and lecturer in the plant pathology department of the University of California at Riverside, died on August 12 of a heart attack. He was 39.

After he received his PhD at UCLA in 1950, Dr. Moje studied for two years at the University of Illinois and worked as a chemist for a year with the Du Pont Company in New York. He joined the UC Experiment Station in 1953.

He leaves his wife and five children.

1947

DAVID L. DOUGLAS, PhD '51, is now director of research and development at Gould-National Batteries, Inc., in St. Paul, Minn. He had been associated with the General Electric Company's direct energy conversion operation as manager of technology planning since 1961.

CLYDE MURTAUGH, MS, engineering manager of the Surveyor Lunar Roving

Vehicle at the Bendix Corporation in Detroit, Mich., is now chairman of the American Institute of Aeronautics and Astronautics, Michigan section.

JOHN R. SCULL is now head of the guidance and control division at Caltech's Jet Propulsion Laboratory. He was formerly chief of the guidance and control analysis and integration section, and has been at JPL since 1949.

1949

JOHN F. KOSTELAC has joined International Consulting Services, Inc., and is now in Turkey serving as division superintendent of utilities and services for the Eregli Iron and Steel Corporation. The newly constructed steel plant was erected by Koppers Associates (a joint venture of Koppers, Westinghouse Electric International Corporation, and the Blaw-Knox Company) on the Black Sea Coast. Kostelac was formerly division superintendent of maintenance and construction with the Crucible Steel Company of America at Midland, Pa.

LT. CDR. ARTHUR R. BENTON, JR., MS '50, has been promoted to Commander in the commissioned corps of the U. S. Coast and Geodetic Survey. He is serving aboard the *Surveyer* as field operations officer and third in command. He has been with the Coast and Geodetic Survey since 1950.

1950

JAMES C. CONLY, PhD, is manager of market development for the Stauffer Chemical Company's research center in Chauncey, N.Y.

DEAN A. RAINS, MS '51, PhD '54, is assistant group director of the newly formed general and systems planning directorate at the Aerospace Corporation's system planning division in Los Angeles. He was formerly with the United Technology Corporation.

1952

COL. JOSEPH F. LOFTUS, MS, is now staff judge advocate for Headquarters, Middletown Air Materiel Area, at Olmstead AFB in Pennsylvania. He was formerly stationed at Griffiss AFB in New York.

1953

CARL A. RAMBOW, MS '58, has been senior engineer with the consulting firm of James M. Montgomery in Pasadena for the past two years. He was formerly assistant professor and assistant sanitary engineer at Washington State University.

1958

W. PHILLIP HELMAN, MS' 60, has just completed requirements for his PhD in physical chemistry at the University of Minnesota and is now a research chemist at the DuPont Jackson Laboratory in Wilmington, Del.

1960

LT. WILLIAM R. VAN SCHMUS writes that "I graduated from UCLA in June with a PhD degree in geology. On August 12 we had a son, Brian, and on September 1, I entered into active duty in the U. S. Air Force. I am stationed at the Air Force Cambridge Research Laboratories in Bedford, Mass., where I am working in the Lunar and Planetary Branch."

M. NAFI TOKSOZ, MS, PhD '63, has been appointed assistant professor of geophysics at MIT.

1964

MELVIN E. MEDOF is a freshman at the USC School of Medicine. He is one of 68 medical students chosen from more than 800 applicants.

WILLIAM C. STWALLEY has been awarded a fellowship for graduate studies in physical organic chemistry at Harvard. The selection, made by the National Academy of Sciences-National Research Council, is supported by the Leeds & Northrup Foundation at Philadelphia.

ALUMNI DIRECTORY SUPPLEMENT

A supplement to the 1963 Alumni Directory will be ready for distribution some time after the first of January, 1965. This supplement will list the names and addresses of those who received degrees in June 1964. Copies of this supplement will be sent automatically to Association members who received degrees in 1964. Other Association members may secure a copy of this supplement by filling in the form below and sending it to the Alumni Office.

Please send the 1964 Supplement of the 1963 Alumni Directory to:

Name..

Address..

City........................State..............Zip Code...........

PLACEMENT ASSISTANCE TO CALTECH ALUMNI

There are two ways in which the Placement Service may be of assistance to you:

(1) To help you seek new employment or a change of employment.

(2) To inform you when outstanding opportunities arise.

This service is provided to Alumni by the Institute. A fee or charge is not involved.

If you wish to avail yourself of this service, fill in and mail the following form:

To: Caltech Alumni Placement Service
California Institute of Technology
Pasadena, California 91109

Please send me:

- ☐ An Application for Placement Assistance
- ☐ A form to report my field and operation so that I may be notified of any outstanding opportunities.

Name .... Degree (s) ....

Address .... Year (s) ....

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Informal luncheons every Thursday at 11:45 A.M.
Contact Mr. Farrar, EX 9-5277, on Thursday morning for reservations.

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And if that's all there were to it, our industrial engineering ranks couldn't possibly hope to deserve alert recruits from engineering colleges that lead rather than follow.

Watching an operator react to the explanation of a new assembly procedure is just one of the more easily photographed of a long series of subtle operations in the mathematics that link psychological, physical, and economic factors into a sense-making structure.

We admire fine intuitions in an engineer. We seek chaps who have involved themselves with nuts and bolts since childhood. Yet the task is to improve on the familiar fruits of intuition. The job consists of upgrading others' work and one's own to higher, more productive levels of abstraction than simple-minded busyness with nuts and bolts.

Kodak is of a size and diversity to afford room for more than one pattern in industrial engineering. A man's successive assignments here are as varied as his college courses. Confidence grows. He finds he has built a solid reputation by carrying a project from design to the stage, years later, where the aim is to squeeze another tenth of a percent into the production efficiency.

We also welcome another type. When a project reaches 80% of completion, this industrial engineering personality won't resent an invitation to form a new team with new counterparts in design and manufacturing engineering to start a new and more stimulating project. Gladly will he retain responsibility for the old one and six or seven that preceded it.

Drop us a line. Industrial engineers aren't all. We need to hear from mechanical engineers, chemical engineers, electronic engineers, chemists, and physicists as well.

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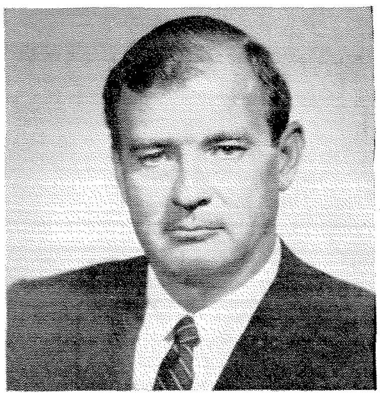
Advancement in a Big Company: How it Works

An Interview with General Electric's C. K. Rieger, Vice President and Group Executive, Electric Utility Group



C. K. Rieger

■ Charles K. Rieger joined General Electric's *Technical Marketing Program* after earning a BSEE at the University of Missouri in 1936. Following sales engineering assignments in motor, defense and home laundry operations, he became manager of the Heating Device and Fan Division in 1947. Other Consumer-industry management positions followed. In 1953 he was elected a vice president, one of the youngest men ever named a Company officer. Mr. Rieger became Vice President, Marketing Services in 1959 and was appointed to his present position in 1961. He is responsible for all the operations of some six divisions composed of 23 product operations oriented primarily toward the Electric Utility market.

Q. How can I be sure of getting the recognition I feel I'm capable of earning in a big company like G.E.?

A. We learned long ago we couldn't afford to let capable people get lost. That was one of the reasons why G.E. was decentralized into more than a hundred autonomous operating departments. These operations develop, engineer, manufacture and market products much as if they were independent companies. Since each department is responsible for its own success, each man's share of authority and responsibility is pinpointed. Believe me, outstanding performance is recognized, and rewarded.

Q. Can you tell me what the "promotional ladder" is at General Electric?

A. We regard each man individually. Whether you join us on a training program or are placed in a specific position opening, you'll first have to prove your ability to handle a job. Once you've done that, you'll be given more responsibility, more difficult projects—work that's important to the success of your organization and your personal development. Your ability will create a "promotional ladder" of your own.

Q. Will my development be confined to whatever department I start in?

A. Not at all! Here's where "big company" scope works to broaden your career outlook. Industry, and General Electric particularly, is constantly changing — adapting to market the fruits of research, reorganizing to maintain proper alignment with our customers, creating new operations to handle large projects. All this represents opportunity beyond the limits of any single department.

Q. Yes, but just how often do these opportunities arise?

A. To give you some idea, 25 percent of G-E's gross sales last year came from products that were unknown only five or ten years ago. These new products range from electric tooth brushes and silicone rubber compounds to atomic reactors and interplanetary space probes. This changing Company needs men with ambition and energy and talent who aren't afraid of a big job—who welcome the challenge of helping to start new businesses like these. Demonstrate your ability—whether to handle complex technical problems or to manage people, and you won't have long to wait for opportunities to fit your needs.

Q. How does General Electric help me prepare myself for advancement opportunity?

A. Programs in Engineering, Manufacturing or Technical Marketing give you valuable on-the-job training. We have Company-conducted courses to improve your professional ability no matter where you begin. Under Tuition Refund or Advanced Degree Programs you can continue your formal education. Throughout your career with General Electric you'll receive frequent appraisals to help your self-development. Your advancement will be largely up to you.

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-11, Schenectady, N. Y. 12305

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