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The San Gabriel Mountains . . . page 12

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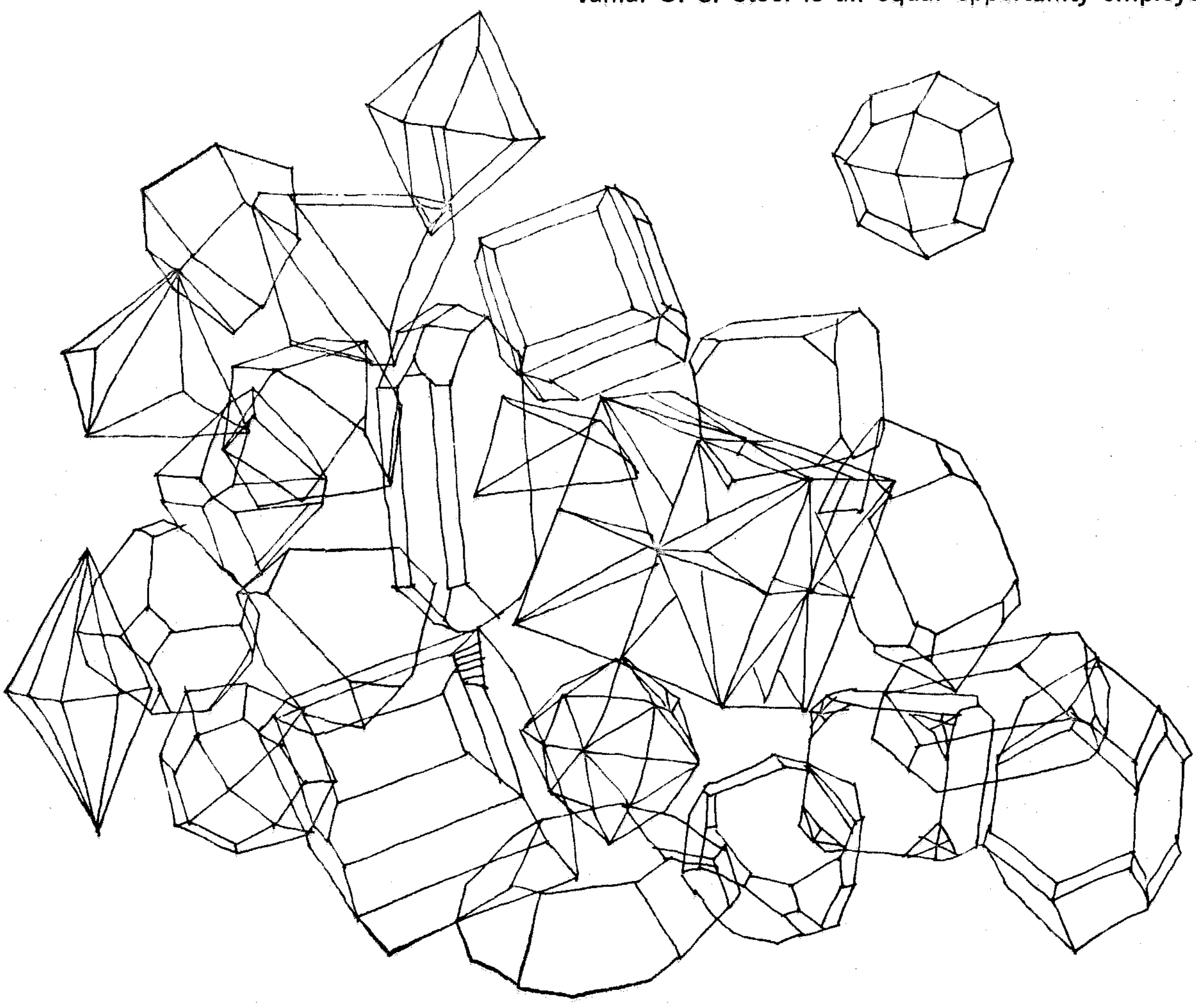

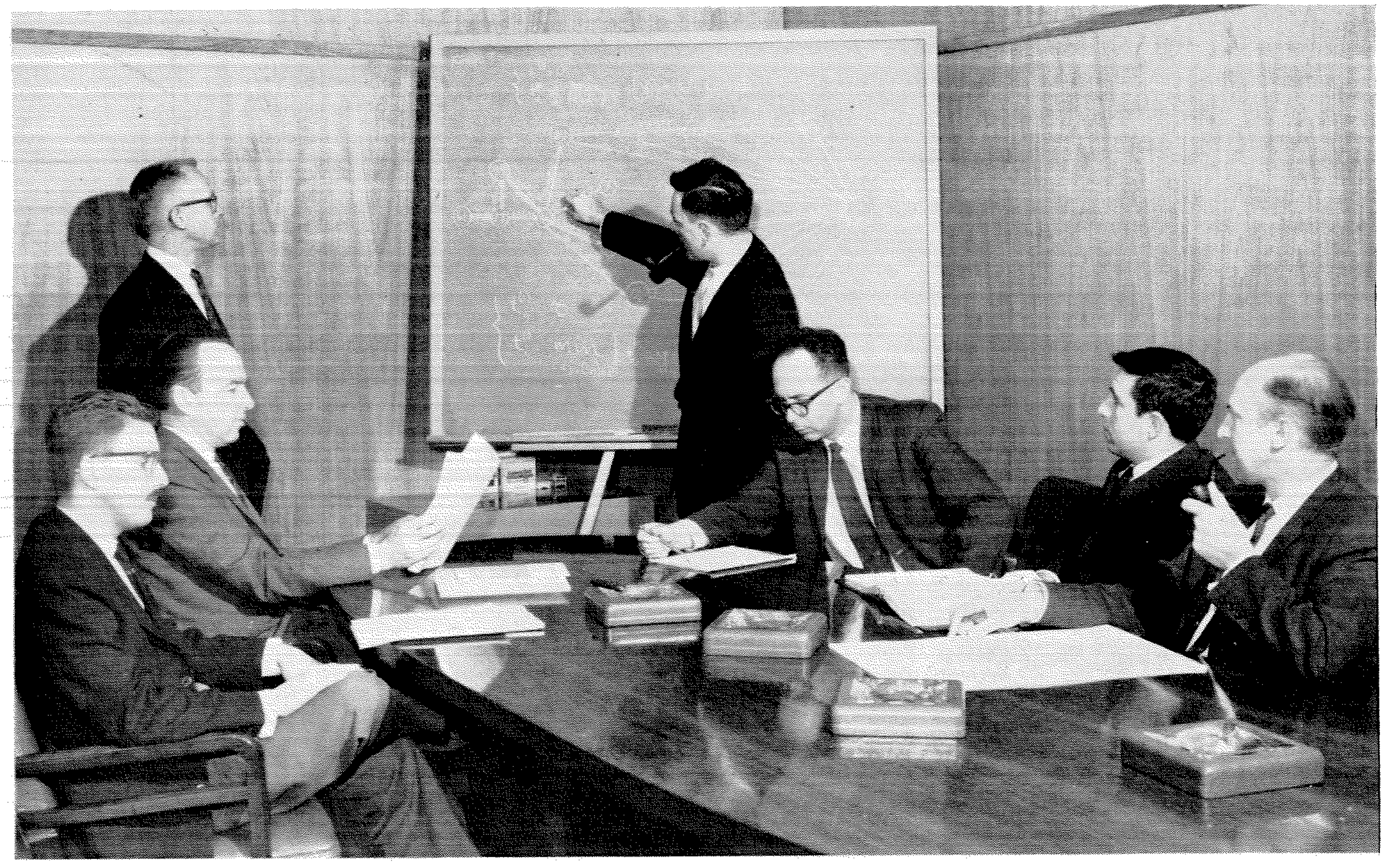

ENGINEERING | AND | SCIENCE

MAY 1962 *VOLUME XXV* *NUMBER 8*

On Our Cover

the San Gabriel Valley, with Caltech in the foreground, and the San Gabriel mountains forming "a beautiful but potentially dangerous backdrop." The quote is from Henry Hellmers' article in this issue – "The San Gabriel Mountains."

Dr. Hellmers, a senior research fellow in biology at Caltech, is a plant physiologist with the Pacific Southwest Forest and Range Experimental Station of the U. S. Forest Service. He came to Caltech in 1949 to work on a cooperative program of the Institute and the Forest Service to improve the sparse plant cover on critical areas in the rugged San Gabriel mountains. Dr. Hellmers' current research, on the effect of temperature and light on tree growth, is part of a reforestation program. His article on page 12 has been adapted from a Friday Evening Demonstration Lecture, October 27, 1961.

President DuBridge

is the author of "Our Best Freshmen Are Getting Better" on page 9, an adaptation of a talk given at a conference sponsored by the Joint Committee of the National Education Association and the Magazine Publishers Association in cooperation with the National Association of Secondary School Principals in New York on April 25.

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Books

Science and the Nation: Policy and Politics

by J. Stefan Dupré and Sanford A. Lakoff
Prentice-Hall . . . . . $3.95 cloth
$1.95 paper

Reviewed by Lee A. DuBridge, President, California Institute of Technology

This interesting and illuminating book had its origin, according to its preface, in a course introduced in the Department of Government at Harvard University on the subject of "Science, Technology, and Politics."

This subject obviously is a vast one, and no finite-sized volume could cover all its aspects. This book, however, does an excellent job in illuminating a number of important topics in this field.

To start with, there is an informative discussion of the history of science in government, tracing the developments from the early and turbulent days of the Coast and Geodetic Survey to the vast government participation in science characteristic of the 1960's. There is a similar history of the growth of research in industry, stressing the relation between industrial research and government financing, particularly in military areas.

The third chapter deals with the relation between universities and government with emphasis on the recent thorny problems of indirect costs, loyalty, security requirements, the financing of capital facilities, and the question of whether the government has or should have a general policy on its role in higher education.

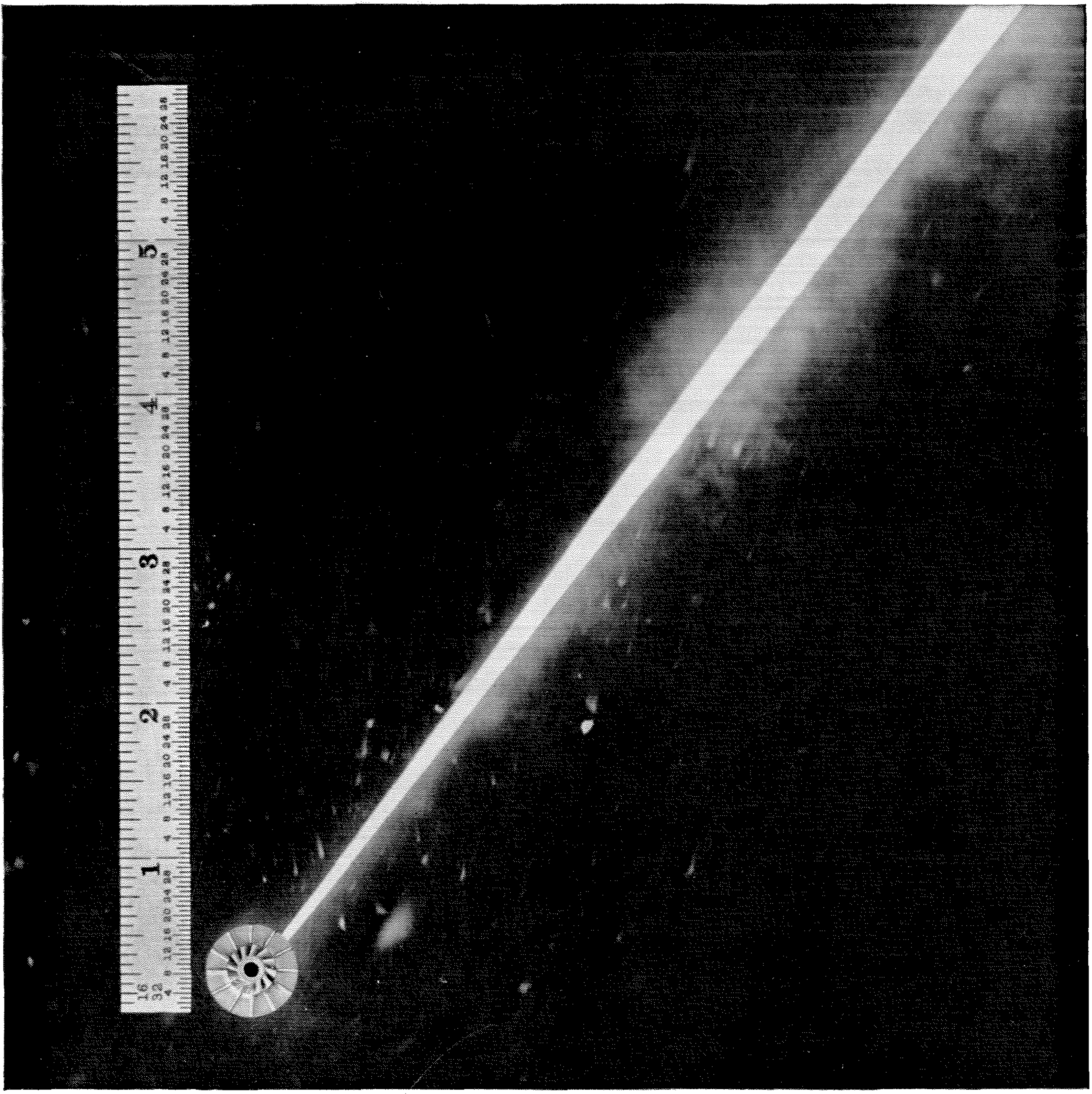
This is followed by a discussion of how science policy is formulated within the government, with a history of some of the principal science advisory bodies which have performed various functions in these postwar years. An account of the difficulties and successes of these scientific bodies is treated with sympathy and understanding in spite of the necessity for brevity.

Part Two of the volume devotes itself to the subject of politics, although the boundary line between politics and policy is clearly difficult to draw. It is largely concerned with the problems growing out of the development of the atomic bomb and the struggles to develop a military policy and program suitable to the atomic era.

It is pointed out how scientists have advised on policy in these matters, based upon their technical knowledge, but the decision-making has always still been in the hands of responsible government officials. Scientists, indeed, were not always unanimous in the advice which they rendered on policy matters – illustrating clearly that scientists have political leanings too.

Illustrating the problems of loyalty and security, there is a lengthy discussion of the hearings in the case of J. R. Oppenheimer, bringing out clearly the fact that the final disposition of this case really had nothing much to do with either loyalty or security.

The book concludes with a plea for greater public understanding of the relations between government, the universities, and the scientific community. The volume can serve as an admirable contribution to this end.



Engineering And Science
May 1962, Volume XXV, No. 8

OUR BEST FRESHMEN ARE GETTING BETTER

by L. A. DuBridge

There are three questions any college asks about a prospective freshman:

1. How bright is he?
2. How well prepared is he?
3. What kind of person is he?

The first two questions are easier to answer than the third. But if we have plenty of bright and well-prepared candidates to select from, then we can select the ones that appear to be honest, earnest, hard-working, imaginative, ambitious, and reasonably easy to get along with.

How do we know how bright a high school senior is? We can ask his parents of course, but we haven't found that very helpful. We can ask his teachers – and that turns out better. Indeed, if you can talk to the teacher face to face, instead of just asking for a letter of recommendation, you can often learn a lot about a student – even how good a guy he is. (Even here, however, one must be careful. You would be surprised how many students we have admitted at Caltech who were described by their teachers as budding young Einsteins – who flunked out in their first year.) Then we can look at a student's grades. That helps too – but, as everyone knows, "A" grades don't always mean the same thing at different schools.

And, finally, we can look at the results of certain tests.

And here I must digress for a moment to talk about testing. A report on testing was issued last February by a committee representing several large associations of school administrators. This report very properly brought out certain misuses and abuses of large-scale national, state, and local testing enterprises. It noted that no test is perfect, that tests can never tell the whole story about a student's qualifications or abilities, and that blind reliance on numbers and statistics can be misleading–and even tragic to individual students. Also, testing requires a certain amount of time.

These things are well known. But to go a step further, as the report did, and cast aspersions on all testing procedures – including the valuable College Entrance Examination Board tests – is to throw a frightfully damaging blow at the cause of good education. For the College Board tests have, on the whole, been an extraordinarily useful and reliable instrument for selecting from high schools all over the country those students particularly able and particularly well prepared to undertake a rigorous college or university program. No major college or university seeking exceptionally talented students could possibly do its job so effectively without such nationally administered tests. And, if there are incidental problems and abuses, these shrink to insignificance alongside their great values and proven worth.

So we use College Board tests to help us find the best students in the country to admit to Caltech. And so do other leading institutions I have looked at. On the basis of these test scores, it is concluded that the freshmen these institutions have been admitting have greatly improved in quality in the past five to ten years – and their performance in college has improved in direct proportion.

Let me cite a few Caltech figures to illustrate:

In 1951 our freshman class turned in scores on the verbal aptitude test (which measures ability to use and understand the English language) which ranked the average freshman at the 75th percentile of all those taking the tests in the country.

In 1961, in these same tests, our average freshman was at the 97th percentile. That is, half of our freshmen were above 97 percent of all college applicants, and half below.

In the mathematical aptitude test our average freshman in 1951 was at the 89th percentile; in 1961, at the 99th. In the physics achievement test the average rose from the 82nd to the 97th percentile. In the advanced mathematics achievement test, it went from the 68th to the 96th. And in English (even though we are a school of science and engineering) our average freshman was at the 68th percentile in 1951; at the 89th in 1961.

There is no way on earth we could have found a group of students in the top 1 or 2 or 3 or 4 percent of the entire country if we had not had something like the College Board tests to go on. The experience at Harvard, Yale, Princeton, MIT, and Stanford is similar – a rise of from 10 to as much as 40 points on the percentile scale for the average freshman in the past ten years. Princeton reports that their entire list of applicants last year was above the level of those actually *admitted* ten years ago.

The old-style admissions procedure for some old-line universities was to depend on graduates of a few fine old-line private schools – ignoring a host of graduates of public schools – because there was no adequate yardstick for comparison. Today the typical university draws students from high schools of all types all over the country. Our 182 freshmen last year came from 173 high schools, only 25 of which were private schools. And nearly half of our freshmen came from schools east of the Mississippi River. MIT reports that its 900 freshmen came from 615 high schools – 87 percent of them public schools. And 87 percent of their students came from outside of New England. And so it goes. Never could we have spotted these bright students from all over the nation if we did not have some nationally administered testing procedure.

College performance

And have these students performed in college in a way to bear out their high test scores? They have indeed. We find very close correlation between college performance and entrance test scores. And, as the freshmen have improved, we have had to advance the quality and content of our college courses in order to keep up with them. Most of our freshmen of ten years ago would have flunked dismally in competition with our freshmen of today – except, of course, if the freshman of ten years ago could have gone to the high school of today, he would have done better also.

Thus, on the basis of both test scores and college performance, we can say that the freshmen at these institutions are on the average brighter than they were ten years ago. That, of course, is because we can be more selective than we used to be.

But there is an even more important matter – namely, the quality of preparation which these students have received in high school has been rapidly improving too.

The CEEB advanced mathematics achievement test was so adjusted 15 years ago that a "perfect" score was 800 – and was attained by very, very few high school seniors. Today thousands of them hit the ceiling at 800. Half of all our freshmen got scores above 762 – which is so close to 800 that it is not worth arguing about. The MIT freshmen were right up there too.

But that is only the beginning. The old advanced mathematics tests covered only algebra, trigonometry, and geometry. Today thousands of high school seniors are taking courses in calculus. And so a whole new test series had to be devised to cover that subject.

This is one part of another contribution of CEEB. Ten years ago a group of universities set up a special commission to study high school mathematics teaching and concluded that many students could profit greatly by taking so-called advanced placement courses, so they would be further ahead when they reached college. High school and college teachers cooperated in preparing such courses, and special tests were constructed by the CEEB so that colleges could give advanced credit to those who passed successfully.

Advanced placement

Last year 9 percent of the MIT freshmen entered with advanced credit for the first semester of their calculus course, and 11 percent more got credit for the whole year, and several for a full two years – as a result of advanced placement courses in calculus which they took in high school. Twenty percent of the Caltech freshmen were able to skip the first half of our calculus course – and that is a far more advanced course than it was six years ago.

The advanced placement program spread to other subjects, physics and chemistry particularly, and advanced English and history are now being developed.

Ten years ago only a few high schools offered such courses. But in 1961 some 13,000 students from 1200 high schools took advanced placement tests. Many more schools are preparing to enter the program. Still more have substantially improved their regular courses.

The colleges have, of course, responded to these better freshmen. A few years ago we completely revamped our freshman chemistry course at Caltech because most of our students had covered that material in high school, some in advanced placement courses but mostly in regular high school courses. We put most of the old sophomore course and some junior work into the freshman year. And the present freshmen are eating it up.

Our physics course is just now being thoroughly reorganized. We begin the course now with the introduction of basic principles and concepts of modern physics: atomic theory, conservation of energy, relativity, and quantum theory. We no longer need to review the stuff about pulleys and levers and inclined planes.

This is possible because of the improved physics courses in high school, and the improved mathematics courses. As I have said, 20 percent of our freshmen have had high school calculus. The rest are so well prepared in geometry and trigonometry that we no longer spend weeks reviewing those subjects, but plunge into calculus the first week of the freshman year. So the physics teachers can start using calculus immediately, greatly improving the approach to basic physical ideas.

And what about English? We hear that "Johnny can't read" — and that engineers never could read. Well, ours can!

We used to give remedial reading instruction for the 20 percent of our freshmen who needed it. There are almost no takers today. We abolished our old freshman English course a few years ago because all of our freshmen proved they could qualify at once for the advanced course in literature — one that used to be reserved for juniors. We always had a few students good enough to qualify for that course on entrance; but in the past five years the percentage admitted grew from 10 percent to 100 percent. And to see and hear those freshmen reading, discussing, and writing about the basic ideas to be found in the best English literature is an astonishing experience indeed. One of our professors gives a course in Shakespeare for those who have completed the present freshman course. These science and engineering students do as well in that course as his *senior* English *majors* used to do a few years ago in a famous liberal arts college where he then taught.

Our history faculty has abandoned the old introductory college history texts and in the sophomore year now gives a solid introduction to the history of ideas as revealed in the best scholarly books on the subject.

This story is repeated in greater or lesser degree at Harvard, MIT, Princeton, and Stanford. And more casual inquiries at other colleges with high entrance standards tell the same story.

Advanced students

At Harvard last fall 540 of their 1200 freshmen passed 1396 advanced placement tests — nearly three each. One hundred thirty-four of these freshmen did so well in enough subjects that they were offered full sophomore standing. As a matter of fact, Harvard now admits freshmen to advanced courses *without* tests, but solely on examination of the record. They have, I am told, a new type of advanced student called TYWI: "Talk your way in."

Harvard, like Caltech, has also dropped its former remedial courses in mathematics and English. They are no longer needed. At Princeton the situation is similar. A *majority* of their freshmen this year entered one or more courses in advance of the normal freshman level. The same is true at Yale, which also reports great improvement in the foreign language preparation of its freshmen.

At MIT last fall 224 of the 900 freshmen received college credit in 504 semester courses — mostly in calculus, in physics, in humanities, and in foreign languages. Furthermore, many freshmen courses have been advanced in level and the old remedial courses designed to make up for high school deficiencies are no longer needed.

I think you can see why I say our best freshmen are getting better — getting better *fast*.

Thousands of our best high schools are now actively and effectively seeking out their gifted students, counseling them more adequately about preparing for college, and providing challenging solid courses for them, which makes them far more mature college freshmen than were their counterparts a dozen years ago.

I have been talking about the best high schools and their best students. There are thousands of schools which lag far behind. There are many thousands of talented boys and girls who have no chance to prepare themselves for first-class colleges. Our educational system still has far to go. But those who say it is not even on the way are ignoring the story I have been telling you.

Colleges face another problem: The high schools that do not give advanced courses, or even very good courses, may still have some very bright students. Colleges hate to turn these students down. Yet they face a serious problem in offering them special "catch-up" work, or letting them face a serious preparation gap compared to their more fortunate colleagues. One college officer reports that many bright freshmen (just because they were bright) were allowed to take a lighter load of work in their high school senior year — substituting credits for participating in the band, the student council, or the year book for solid college preparatory subjects. "This," he says, "constitutes cruel mistreatment of a bright boy who will face five substantial courses when he enters college."

Some college officers inform me they fear that the advanced program might be carried too far. The prestige value of advanced courses may cause schools to outrun their teaching competence, or force impossible tasks on unqualified students. Then, too, some fear that young students, quite able to grasp mathematics, science, and foreign languages, may be unable to cope with advanced work in literature, history, or philosophy which requires greater maturity of mind. The result of this might be the emergence of intellectual snobbishness and cynicism.

Encouraging talented students

In spite of these fears — and of other fears which have not yet materialized — the conclusion is that an important but little noticed ground swell is under way in hundreds of high schools throughout the country. These schools are trying to find their most talented students; they encourage them and offer them opportunities for better college preparation. The colleges (at least some of them) see these students coming in rapidly increasing numbers; they have welcomed them into advanced college courses, and are rapidly altering their curricular programs to meet this new situation. Clearly we have neglected our talented high school students too long. But clearly, too, we are finding a way out of this intolerable situation.

THE SAN GABRIEL MOUNTAINS

MAN AND NATURE IN CONFLICT

by Henry Hellmers

THE SAN GABRIEL mountains form a beautiful but potentially dangerous backrop for the city of Los Angeles and its many suburbs along the foothills.

As the population increases in the foothill area, residences are continually being built farther and farther up the slopes and the notches cut to form level spots for homes resemble a giant stairway, as man attempts to scale and conquer the 5,000-10,000-foot peaks.

The higher man goes in the mountains the more problems he faces. Fire, flood, erosion, and earthquake are ever-present threats. The way he deals with such threats will determine whether man is really going to win this conflict with the mountains – or whether nature will win out in the end.

The San Gabriel mountains were formed when they were literally squeezed upward due to great lateral pressures between the Pacific Basin and the North American continent. The mountain range has an east-west orientation as compared to the north-south axis of most mountains on the continent. The San Andreas fault, which extends from the Salton Sea into the Pacific Ocean north of San Francisco, forms the northern boundary of the range. While this fault is the best known, it is only one of many in the San Gabriels; the mountains have been fractured by so many earthquakes that all the fault lines have never been mapped. The rocks of the entire range are literally shattered due to earthquake activity.

Back in the Pleistocene age, some of the pressure on the faults was relieved by either the valley dropping or the mountains being raised. (Evidence of such an event can be seen in the huge debris cone at the mouth of the Arroyo Seco which today forms the hill behind the Jet Propulsion Laboratory.) This action started a new wave of geological erosion which is still progressing up the mountains.

In the San Gabriels even the streams are steep and the water is rapidly cutting deeper into the underlying rock. This deepening of the stream beds causes a further steepening of the side slopes. Consequently, in the Los Angeles River drainage, one of the largest in the mountains, over half of the slopes are at the angle of repose (which is 70 percent) or even steeper. On these steep slopes everything that isn't mechanically held in place will fall into the canyon bottom. The mountains are extremely sensitive to activities and noises around them. One can actually sit quietly and hear the mountains falling apart. A bird scratching on the face of a slope, or a plane flying by with its motors out of synchronization, can start stones rolling and debris sliding. The only reason that the exceedingly steep stream banks are standing is that rock outcrops and vegetation are holding them in place – or because they have not had sufficient time to erode away.

The steepness of the slopes and the fractured rock in the San Gabriels result in the most dangerous mountain-climbing conditions in the country. Practically every week the newspapers testify to this fact by reporting the heroic efforts of the mountain rescue teams in retrieving stranded hikers. In fact, the ruggedness of the terrain has practically prevented any detailed geological study of these mountains.

A tremendous amount of debris has come out of these mountains over the years. Much of the Los Angeles metropolitan area, including Pasadena, is set on a deep layer of this debris. The debris-filled basin on which Pasadena stands is rimmed by a mountain range, of which only the top can now be seen. It extends past the Huntington Hotel, the Huntington Library, and through the Arboretum. The low hills in the Arboretum are actually the tops of buried mountains. There are more than 20 of these debris-filled basins between the San Gabriel mountains and the ocean.

In addition to sharing the cool wet winters and the warm dry summers of southern California, the San Gabriels have a weather pattern of extremes. The average annual rainfall increases with elevation. Pasadena, at the foot of the mountains, has an average rainfall of approximately 20 inches, while the top of Mt. Wilson – 6 miles away and 4,500 ft. higher –receives an average of 35 inches of rain. The rain often comes in high-intensity storms and two world records have been recorded at different points in the range. At Opid's Camp 0.65 inches of rain fell in one minute

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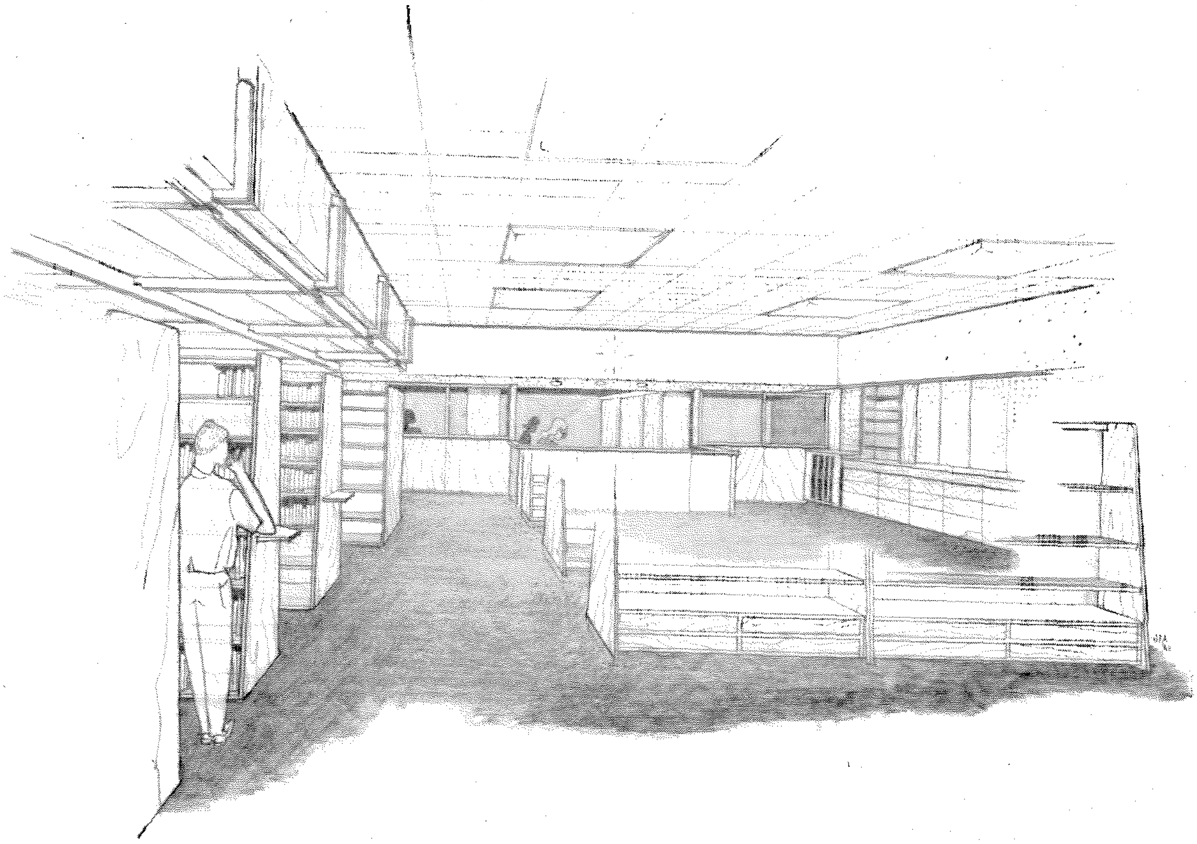
McGraw-Hill Congratu



Space capsules are fine for housing astronauts — but not for selling books. For the past 17 years Caltech's bookstore has operated valiantly in capsule-like quarters. Despite this handicap Mrs. Esther Green and her staff have managed to serve from 400 to 500 people a day.

Happily, the days of claustrophobia will end on or about June 1, when the new bookstore opens in the Winnett Student Center. Here, in approximately 4,000 square feet of space, students, faculty, alumni, and administrative personnel will be afforded all the services of a truly modern bookstore. Not only will textbooks and the usual supplies be readily available, but — for the first time on campus — there will be a large reference book section devoted to volumes of consequence in science, engineering, and the humanities. Also for the first time — a wide variety of paperbacks will be available.

McGraw-Hill will be well represented in the new store's reference section by more than 500 outstanding titles, plus forthcoming important books.

In McGraw-Hill's somewhat biased view, bookstores and libraries are special places in our society. They are even more important in an academic setting, where they provide an intellectual focal point within an intellectual community. Thus, Caltech's new bookstore should serve a great institution well, and McGraw-Hill predicts many pleasant hours of browsing for the Caltech community.

In the San Gabriels even the streams are steep and the water is rapidly cutting deeper into the underlying rock, making the side slopes steeper.

The San Gabriel Mountains . . . *continued*

in April 1926, and in January 1943 a rainfall of over 26 inches in a period of 24 hours was recorded at Hoegee's Camp.

Dry thunderstorms develop in the summer in contrast to the wet cloudbursts that can occur in winter. As their name implies, there is no rain in these dry storms. This is because the precipitation evaporates before it reaches the ground. Unfortunately, the lightning is not dissipated and many forest fires result from lightning strikes during the dry season.

Other unique meteorological phenomena of the mountains include high velocity Santa Ana winds that frequently sweep over the peaks and down the canyons from the desert. These warm dry air masses greatly increase the fire danger in the area.

The canyon winds on occasion are affected by a phenomenon known as the Catalina eddy. The presence of such offshore islands as Catalina at times affects the winds that occur in the San Gabriel mountains. The air mass moving down the coast sweeps around the island, forming an eddy that brings ocean air into the mountain canyons, such as the Arroyo Seco.

The vegetation attests to the prehistoric role of fire in the San Gabriels. The slopes are clothed in a vegetation that is defined as a "fire type"— a type that develops from or follows fire. The brush cover, or chaparral, is composed of species that readily sprout after fire or have seed that require a heat treatment before they will germinate. Many brush species which cause the fires to burn rapidly and with high intensity contain volatile oils.

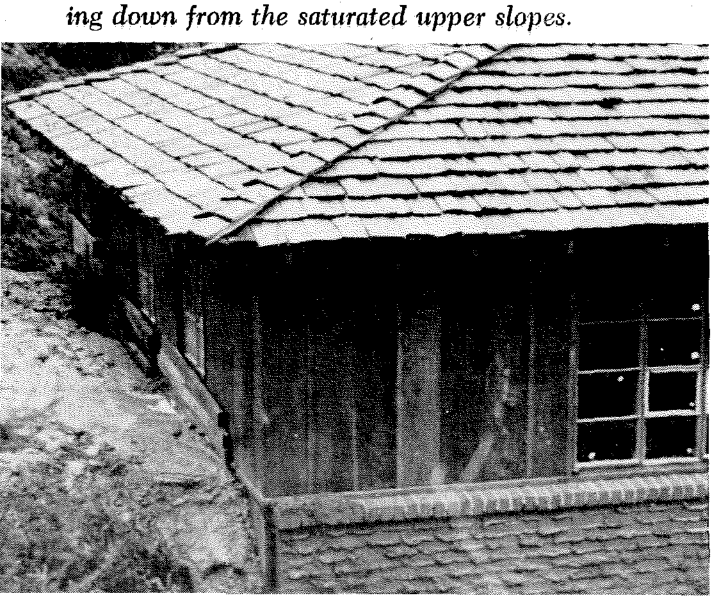
The trees that occur on the tops and north-facing slopes have characteristics that protect them from destruction by fire. The pines, with their thick bark, occur in open park-like areas such as Messenger and Browns Flats and the heat from the low vegetation, usually grasses, can do little damage. Oaks and even big-cone Douglas fir have the ability to sprout along the main stem and branches after all the foliage has been completely burned.

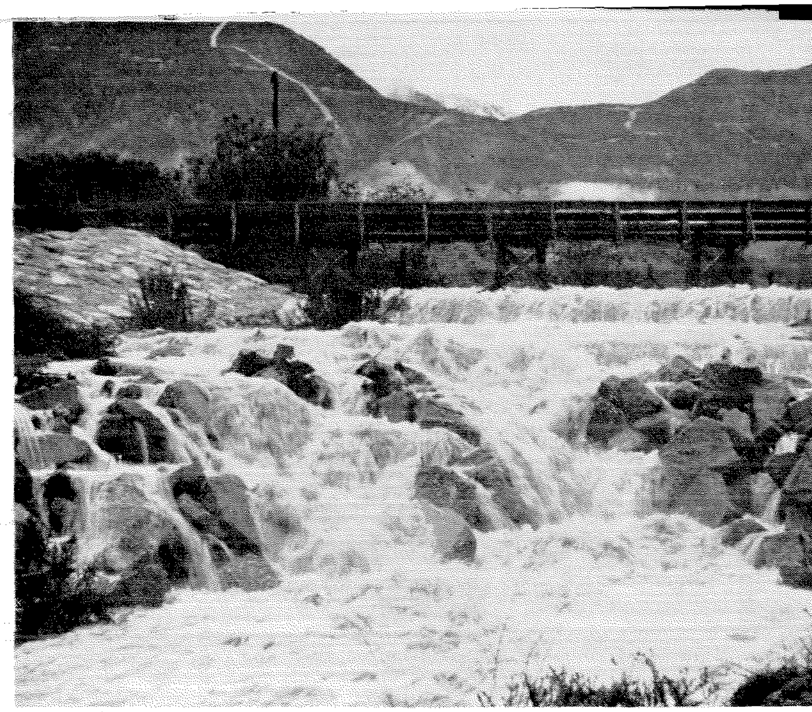
In the recent past most of the slopes have been swept by fire on the average of every 30 to 50 years. There are some areas that haven't been burned that frequently but such areas are small. For instance, the 1960 fire that burned in the Arroyo Seco consumed the brush in at least one canyon that had not been burned in over 80 years. The fire history of the local mountains is closely correlated with the weather. The recent dry years have left their mark in the form of extensive fire scars, which serve as reminders of the magnitude of the problem if man is to change the fire pattern.

Some new and very powerful means, not yet discovered or invented, are needed to completely control fire in the San Gabriel mountains. The brush, with its volatile oils and thicket-type growth, produces fires of high intensity and with rapid burning rates.

Energy released by the Monrovia Peak fire in 1953 that burned 14,135 acres in 6 days was equivalent to about five of the atomic bombs that were dropped on Hiroshima. One fire, fanned by a Santa Ana wind, burned approximately 10,000 acres in the west fork of the San Gabriel drainage in 1957 in a couple of hours. A section of the canyon literally exploded. The intense heat on one side of the valley distilled the volatile oils from the brush on the facing slope and when the gas-filled air reached the ignition point the fire leaped across the valley with a roar. Lightning started the fire that destroyed the entire San Dimas Experimental Forest in 1960. Before anyone could do much about it, except get out of the way, the fire had wiped out the 17,000 acres of experimental forest, and had burned over the ridge into the San Gabriel River canyon.

Canyon homes are frequently inundated by mud rolling down from the saturated upper slopes.



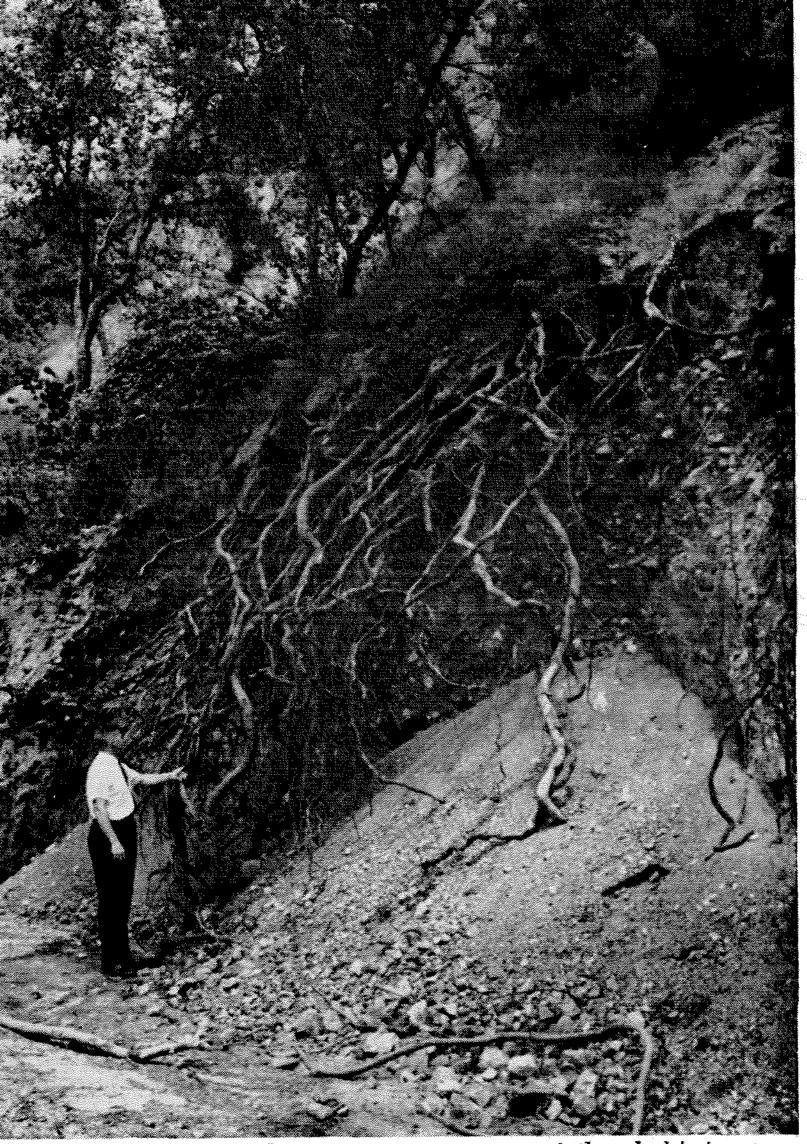


After the ground is saturated, even a little rainfall brings a torrent of muddy water and debris out of the mountain canyons.

Fire and the steep terrain are potential dangers to the relatively few people who live or hike in the mountains, while floods are a threat to a much larger portion of the population. The flood of 1862 washed out the mining town of Eldoradoville in the east fork of San Gabriel Canyon; the 1934 New Year's Day flood killed 30 people and destroyed 483 homes in La Crescenta and Montrose. This flood was the result of the combination of fire followed by heavy rains. The brush on the slopes of Mt. Lukens had been burned in November and a month later nearly 600,000 cubic yards of debris rode out to the valley in the water from a 12-inch rainfall.

Erosion on the steep slopes of the mountains is a year-long process and does not require rainfall. The summer erosion or "dry creep" builds debris cones in the canyon bottoms as does erosion caused by small storms. Only infrequent and large storms produce sufficient water to flush out the channel bottoms, resulting in major catastrophes such as the flood of 1938 that did extensive damage and cut all lines of transportation out of the Los Angeles area.

Vegetation on the slopes tends to slow the rate of water movement out of the mountains and to reduce the rate of erosion. Storm flow from a completely burned area may be as large as 50 to 200 times that which would be expected had the vegetation not been burned. The great variation is due to the storm characteristics and the soil condition. Vegetation protects the soil from erosion by several processes. First, the vegetation absorbs the force of the falling raindrops, a force of approximately 100 horsepower per inch of rain per acre. On bare soil this energy is expended in splash erosion which destroys the porosity of the soil. Second, an average of ten percent of the annual



Deep and extensive root systems fail to hold the slope in place when the soil is washed away by an undercutting stream.

rain is used to wet the vegetation. This water returns to the air without ever touching the ground. Third, another ten percent of the rainwater flows down the stems of the plants into what is normally a very porous soil area. Fourth, the standing stems and the fallen litter form countless obstructions in the path of the small trickles of water flowing over the land surface, reducing their velocity and thus reducing the sediment-carrying capacity. These small dams are also a factor in helping to divert the water below the ground surface.

Fifth, the deep and extensive root systems tend to bind the soil mass together. Sixth, between storms the plants transpire, thus removing water from the soil mass and creating a reservoir to be filled by the following storms. It has been estimated that to saturate the soil mantle of the San Gabriel mountains after the dry summer requires nine inches of rain. The soils only become saturated during very large storms because much of the rain from small storms is removed by evaporation and transpiration between storms.

As the population increases and moves farther up the brush-covered mountains the need for protection increases. Fire prevention programs have greatly reduced the number of man-caused fires in relation to the number of people that are in the area. Efficient fire fighting organizations have controlled most of the fires early. Additional protection from fire and flood is continually being developed. However, in spite of active fire prevention campaigns and efficient fire suppression organizations, forest fire remains one of the very real potential dangers. The occurrence of exceptionally dry years and dry lightning storms are hazards yet to be conquered.

Once a mountain slope is swept by fire it is seeded with rapidly growing annual plants to obtain a protective vegetation cover for the soil as soon as possible. A mixture of black mustard and rye grass that was developed in the Earhart Laboratory here at Caltech is used almost exclusively. Plants of this combination of species were found to germinate and grow rapidly under the cool winter conditions. If weather conditions follow the average pattern, the gentle early season storms will furnish sufficient water and the foliage will then protect the soil surface from the larger storms that come in midwinter. Unfortunately, nature doesn't follow the average every year.

Flood prevention work that started with fire control efforts in the mountains at the turn of the century, followed by flood control dams on the main streams, has continued to expand. Straightened and concrete-lined channels to facilitate the moving of the flood waters from the mountains to the ocean have been built. Small channel barriers to maintain the level of the channel bottoms, and thus stablize the slopes, are being built in many of the mountain drainages.

How well man succeeds in conquering and controlling the mountains and their danger potential is dependent upon the sequence of natural events, many of which man has not yet learned to control.

The timing and violence of the next earthquake cannot be predicted. Whether it raises the mountains, thus making the slopes steeper, or just shakes the peaks down a little, the erosion potential will be increased.

Storm predictions are increasing in accuracy but little has been accomplished in altering the duration or intensity of a storm. Like the earthquake, the date of the so-called "hundred-year storm" — the big, big one that has a "once-in-a-hundred-years" frequency — is unknown. Maybe the storm of '38 was it and maybe it wasn't.

While the problems involving the San Gabriel mountains are unique to some extent, the Los Angeles area is not unique in having problems. All areas are exposed to the forces of nature, be it earthquake, tornado or whatever. Judging from the influx of population into the Los Angeles area and the ascent of the population area up the mountains, a lot of people agree that the benefits outweigh the potential dangers.

The Month at Caltech

African Project

Caltech launches its first research project in the field of the social sciences next month when six Caltech professors leave for southern Africa for a three-month study of the area lying south of the Congo and Tanganyika. This is the first step in a three-year research project on the process of economic development in southern Africa.

Edwin S. Munger, professor of geography who has spent most of the past 16 years in Africa, and Robert W. Oliver, associate professor of economics, are co-chairmen of the project. Accompanying them to Africa this summer are Frederick C. Lindvall, chairman of the division of engineering; Horace N. Gilbert, professor of business economics; Robert Sigafoos, senior research fellow in economics; and Robert Huttenback, assistant professor of history.

Southern Africa was chosen for this project because it represents an excellent laboratory for a broad look at varied economic problems. The nations in this area range in educational development from Mozambique, without a single university and no real industry, to the Republic of South Africa, with several excellent universities and an advanced industrial technology.

Southern Africa covers an area nearly equal to that of the United States, and has a population of 35,000,000. It is probably the richest part of the world in minerals and has a tremendous range of cultures from traditional tribal barter economies to highly complex societies.

Even though the area's steel mills sell to Texas, and its power, agricultural exports and entrepreneurial skills overshadow the rest of Africa, there has been little study on southern Africa as a unit.

Once the groundwork has been done on this study by the six-man research team this summer, it is highly possible that Caltech scientists and engineers also will find it possible to contribute to the research effort in such areas as the nutrition problems of people living in the more undeveloped areas, in water resources, and in building construction.

Lawrence Award

Richard P. Feynman, Richard Chace Tolman Professor of Theoretical Physics, has been awarded the Ernest Orlando Lawrence Memorial Award by the Atomic Energy Commission for significant contributions to nuclear science. He is best known for his work on quantum electrodynamics and his currently developing quantum theory of gravitation. The award, consisting of a medal and a grant of $5,000, was specifically given to Dr. Feynman for his contribution toward the understanding of the behavior of subnuclear particles.

ACS Awards

Laszlo Zechmeister, professor of organic chemistry, emeritus, and Harden McConnell, professor of chemistry, received high awards from the American Chemical Society at its 141st national meeting in Washington, D.C., this spring.

Dr. Zechmeister received the ACS Award in Chromatography and Electrophoresis. Dr. Zechmeister was one of the early developers of these separation techniques which are used to purify complicated materials of natural origin.

Dr. McConnell received the ACS Award in Pure Chemistry which is given annually "to recognize and encourage fundamental research in pure chemistry carried out by young men and women." The recipient must not have passed his 36th birthday. Dr. McConnell specializes in the electronic structure of molecules and solids.

National Academy

William H. Pickering, director of Caltech's Jet Propulsion Laboratory, was elected a member of the National Academy of Sciences this month. Election to the Academy, one of the highest scientific honors in the nation, is in recognition of outstanding achievement in scientific research, and membership is limited to 500 American citizens and 50 foreign associates. There are now 37 Caltech staff members in the Academy.

Dr. Pickering, a native of New Zealand, received his BS from Caltech in 1932, his MS in 1933, and his PhD in 1936. He has been a member of the teaching staff at Caltech since that time, and is currently professor of electrical engineering on leave of absence.

From 1935 to 1942 Dr. Pickering conducted research work in cosmic ray physics and instrumentation with the late Robert Millikan and H. V. Neher, professor of physics. During World War II he served on the Scientific Advisory Board of the U.S. Air Force. He joined the Jet Propulsion Laboratory staff in

1944 as a section chief, and in 1951 was appointed chief of the guided missile electronics division. He was directly responsible for the development of the Corporal, the first U.S. operational guided missile, and for the FM-FM telemetry system now used on all military rockets and space vehicles. He also developed the first radio command guidance system for ballistic missiles.

Dr. Pickering became director of JPL in 1954. Under his leadership the Laboratory produced the Corporal; its second-generation successor, the Sergeant; the first successful U.S. earth satellite, Explorer I, and others in the Explorer series; Pioneer IV, the first successful U.S. space probe; and the Microlock communications system.

William H. Pickering

Mathematics Honors

A Caltech undergraduate team won third place in the 22nd annual William Power Putnam Mathematical Competition last month, and three Caltech undergraduates took three of the top 10 individual honors in the competition. Richard Emerson, a senior, and two juniors, John H. Lindsey and Roger C. Hill, made up the Caltech team. Emerson, Lindsey, and Edward Bender, a junior, ranked in the top ten individually. Over a thousand contestants from colleges and universities in the U.S. and Canada attended the competition which is sponsored by the Mathematical Association of America.

Sorensen Switch

An electric switch invented 39 years ago at Caltech by Royal Sorensen, emeritus professor of electrical engineering, and the late Robert A. Millikan, has just received two major honors. The device, modified and improved, has finally been put into test operation by electrical utility companies, and the original model has been accepted for permanent display at the Smithsonian Institution in Washington, D.C. The switch in its modern version represents a breakthrough in electrical engineering that is expected to provide a much simpler, smaller, and more effective circuit breaker for electrical distribution systems.

White House Dinner

Three Caltech Nobel laureates and President L. A. DuBridge were guests at the White House on April 29 at a dinner honoring the 61 living Nobel prizewinners of the Western Hemisphere. The Caltech men among the 173 guests who attended the function were Carl Anderson, who won his prize in 1936 for the discovery of the positron; Linus Pauling, who received the prize in 1954 for his research into the nature of the chemical bond and its application to the elucidation of the structure of complex substances; and Rudolph L. Mössbauer, honored last fall for his discovery of the radiation effect that bears his name.

The event was the first of its kind to ever be held at the White House, and is part of the President's program of encouraging achievement in cultural and scientific fields by recognizing those who have made important contributions.

Honors and Awards

Harrison Brown, professor of geochemistry, and Frederick C. Lindvall, chairman of the division of engineering, have been named by the White House to a 12-man committee to select recipients of the new National Medal of Science. As many as four medals may be awarded in any one year for outstanding contributions in the physical, biological, mathematical, and engineering sciences.

Ivan F. Betts, contract administrator at the Institute, has been appointed assistant to the vice president for business affairs. In his new position he will handle special assignments, including the study of Caltech's business organization and procedures. Frederick W. Hess, contract administrator at JPL, has been transferred to the campus to take Mr. Betts' place as contract administrator.

Herbert A. Gibson, Caltech wage and salary supervisor for the past 6½ years, has been appointed assistant personnel director of the Institute. He is a graduate of Fairmont State College in West Virginia, and took graduate work in industrial management at USC.

Letters

Pasadena, California

EDITOR:

On the inside cover of the April issue you have a US Steel advertisement on the Seattle Space Needle.

The exciting thing about this project which would make the advertisement more valuable to US Steel and of greater interest to your readers is that the consulting engineer on the job was none other than Caltech's own John K. Minasian '38, MS '44.

RICHARD C. GERKE '47

Honolulu, Hawaii

EDITOR:

"The Cold War" by R. L. Minckler in the March issue of *Engineering and Science* is just what we need around here to counteract some of the defeatist literature and ideas that get into the heads of the East-West students at the University of Hawaii. If you have a few extra copies of this issue we would like to plant them among the students.

CARL W. CARLMARK, MS '41

Dabney House, Caltech

EDITOR:

After reading "The Cold War," I feel certain clarifications should be made concerning the following paragraphs which compare Russian and United States economic growth:

". . . I think it is reasonable to expect that our economy can grow at a 4 percent annual rate. On our 1962 base of $560 billion, that is an increase for the first year of $22.4 billion. The present seven-year-plan of the Russians calls for a 7 percent increase in national income. That, on their present base of $210 billion, is an increase for the first year of $14.7 billion. If we increase our production $22.4 billion in one year and the Russians increase their production only $14.7 billion in one year, how are they ever going to catch up with us, even if our rate of growth is 4 percent and theirs is 7 percent? It is a fact that, on a per capita basis, the Russian economy would have to grow at a rate of three times ours for 20 years to catch up with us."

If the Russians were able to maintain their 7 percent growth rate and we our 4 percent rate, by a property of compound interest their GNP (gross national product or national income) would eventually become larger than ours, irrespective of how large ours was to begin with. The mechanism is as follows: In the first year of growth the Russians have added to their GNP seven percent of their GNP, yielding a new GNP. In the following year seven percent of this *new* GNP is added to this new GNP to give the GNP at the end of the second year. If A_0 is the starting value of the US GNP, R_0 the starting value of the USSR GNP, A_n the value of the US GNP at the end of the nth year of growth, R_n the value of the USSR GNP at the end of the nth year of growth, r the rate of growth of the Russian GNP, a the rate of growth of the US GNP, and n the number of years of growth, we may generalize and write the following formulas:

$$R_1 = R_0(1+.07);\ R_2 = R_1(1+.07) = R_0(1+.07)^2 \text{ etc.}$$

In general:

$$R_n = R_0(1+r)^n \ \&\ A_n = A_0(1+a)^n$$

where r and a must be constant for these formulas to be accurate. Using A_0 = $560 billion, R_0 = $210 billion r = 7% (.07) and a = 4% (.04), let us compute some GNPs for different n (years).

A_0=$560 billions	R_0=$210 billions
A_1= 582.4	R_1= 224.7
A_{10}=829.00	R_{10}=414.00
A_{20}=1230.00	R_{20}=811.00
A_{35}=2210.00	R_{35}=2250.00

As can be seen from the chart, the Russians would pass us in the 34th year if the growth rates were as stated above for these years. The important question is, can the Russians maintain a higher growth rate than ours?

Mr. Minckler states that the USSR would have to grow at a rate of three times ours for 20 years to catch up. Using our formulas above, we can see that he means three times some specific percent, for the statement is ambiguous otherwise. For instance, a ratio of rates does not uniquely determine n since one obtains one equation in two unknowns! (He may have meant the Russian rate of 7% to be three times ours, for 2 1/3% & 7% yield 20 years above.)

Life again turns out to be not so simple when comparisons of the relative economic position of two countries are attempted. Difficulty is encountered when a common base for comparison is sought (dollars, rubles, etc.). This is the same difficulty encountered when comparisons over time are attempted (1937 prices, 1944 prices, etc.). The problem is clearly compounded when two countries are compared over time. The problem is simply that, in general, each different base yields a different answer. (This is called the index number problem.)

Keeping in mind the effects of compound interest and the indexing problem, we may still conclude that the Russians have a rugged task to catch up to us.

JOHN GOLDEN '62

A reply from R. L. Minckler:

"Mr. Golden's arithmetic is correct, but his interpretation of what I meant to say is not. The same point he makes was picked up by a reader of the Pasadena *Star-News*, in which my article was reprinted, so the safe conclusion can be made that my language was sloppy.

"What I meant to say was that, so long as our absolute growth in GNP in any one year is greater than that of the Russians, they will never catch up to us, regardless of what the rates of growth are. I thought I had made it quite clear at several points in the article that I put little faith in 'rates of growth' as being indicative of future prospects. I referred to them as a 'phony numbers game.' I mentioned the 11.2% increase in Russian automobile production from 1959 to 1960, but then gave the very small actual number of automobiles involved.

"In this matter of comparative economic growth of Russia and the United States, a major study has just been published by the National Bureau of Economic Research *(The Growth of Industrial Production in the Soviet Union: Princeton University Press)*. This book by G. Warren Nutter, University of Virginia economist, deals with industrial output, not gross national product, and comes to the same conclusion I did, that the

continued on page 26

Letters . . . *continued*

Russians are not going to catch up with us.

"Nutter finds that the value of Russian industrial production was about 14% of our level in 1913, dipped to 9% in 1928, and rose to 20% in 1955. Our production in 1913 was $25-30 billion higher than Russia's, in 1928 it was $50-55 billion higher, and in 1955 it was $115 billion higher. There is no evidence of Russia's catching up in these numbers.

"Nutter also points out the difficulty of maintaining high rates of growth as the base of industrial production increases. He comes up with the following historical rates of growth for Russia's Communist industrial production, leaving out the period of revolution and chaos 1918-1928, when there was probably no increase, and the World War II period, when the increase was very small:

1928-37	12.0% per year
1950-55	9.6%
1955-59	7.0%
1959-61 (Plan – not actual	5.5%

"I do not believe that it is possible for Russia and the United States to realize 7% and 4% rates of growth in GNP for the indefinite future. At these rates arithmetic would equalize the two countries' GNP in about 35 years at a level four times our present one. To accomplish this size of a gain for us would require the development of something as important as the automobile (cars, highways, oil, rubber, service stations, garages, parking, motels, suburbia and the other things that go with the automobile) and I see no new thing that big. I am not even sure that such a growth would be good for us.

"Russia could move into the automobile age, as we have, but that would require a change in Russian objectives from world domination to service to the Russian people. It would require a change in their system. I should hope that that is what will happen, and my article was intended to indicate that pressures now being created by successes in the United States and Western Europe (I could have added Canada and Japan and a few spots in Latin America and Asia) and by failures in the Communist world could very well bring that about sooner than we think."

GEORGE TAKES A VACATION

The accounts of Mr. George Stemmeyer, fictional alumnus, which have appeared in numerous *Engineering & Science* issues this year have been the result of our effort to bring a little humor into this business of fund-raising.

Raising money is a ticklish business. Raising money from alumni *can* lead directly to an inferiority complex — or even worse. The lines between suggesting and begging, asking and demanding, humor and poor taste are fine. We hope we haven't crossed any of these lines this year and judging from your letters and your contributions we have not.

The 1961-62 Alumni Fund will be *concluded* on May 30 this year, so as not to conflict with other Association activities. We are hopeful that within the next ten days many of you who have not yet contributed will do so. Significant alumni participation on an annual basis (even though your contribution may be modest) helps provide a base on which the Institute can build from friends, foundations, and corporations. Without alumni support Caltech would soon falter.

The needs of a thriving institution will not decrease but, instead, will grow with continued acceleration. Your support both morally and financially will be greatly appreciated now and in the future.

— Donald S. Clark
Secretary, Alumni Association

ANNUAL ALUMNI MEETING

June 6, 1962

Reunion of the Classes of
1902, 1907, 1912, 1917, 1922, 1927, 1932, 1937, 1942, 1947, 1952, 1957

A Special Talk to Caltech Alumni by
Frank Pace, Jr., National Trustee,
California Institute of Technology

and

Report to the Alumni by Lee A. DuBridge, President
California Institute of Technology

Cocktails at 6:00 – Dinner at 6:30

Rodger Young Auditorium
936 West Washington Blvd., Los Angeles

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Menlo Park

The location of the informal weekly alumni luncheon, which is held on Thursdays at 11:45, has been changed to the 13th floor of the Engineers Club, 206 Sansome Street, San Francisco; Mr. H. Farrar, EX 9-5277, can be contacted for reservations on Thursday mornings.

CHICAGO CHAPTER

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Evanston, Illinois

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Eastman Kodak Company, 1712 Prairie Ave.
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Division of Highways, State of California

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

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Astronautics Div., Convair

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

Kodak beyond the snapshot...

(random notes)

Densitometry in Lilliput

Photography is art, photography is amusement, and more and more photography is a way of packing information and electronic circuitry. The packing calls for thinking very, very small about photography.

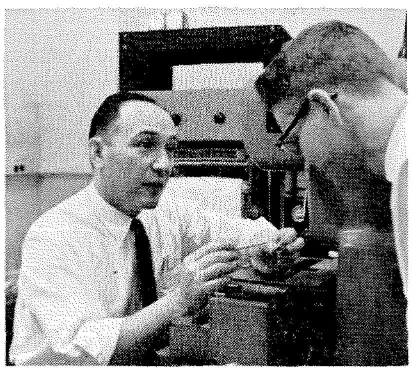
We cannot be blamed for feeling a little wistful as we cheer photography's progress in Lilliput. A remarkably small number of dollars worth of KODAK High-Resolution Plates and KODAK KPR Photo Resist are used up in producing a remarkably large number of solid-state microcircuits.

Fear not for us. We'll make out.

Nowhere will you catch us claiming that this "micro" business is as easy as falling off a log. Indeed, an appreciation of the relationship between the logs of exposure and reciprocal transmittance makes scarcely more than a good beginning toward controlling them on a micro scale. Here the frequency response of a photographic emulsion must be cascaded with the frequency response of the other components in the total picture-handling system.

The game is widely believed to be worth the candle. To shed light on what is really going on, one needs to be able to measure density reliably over an area less than ½ micron wide, scanned in synchronism with a recorder that responds logarithmically.

Not only do we use such instruments, but we build them and sell them for money to others. This benefits science and cheers us up.



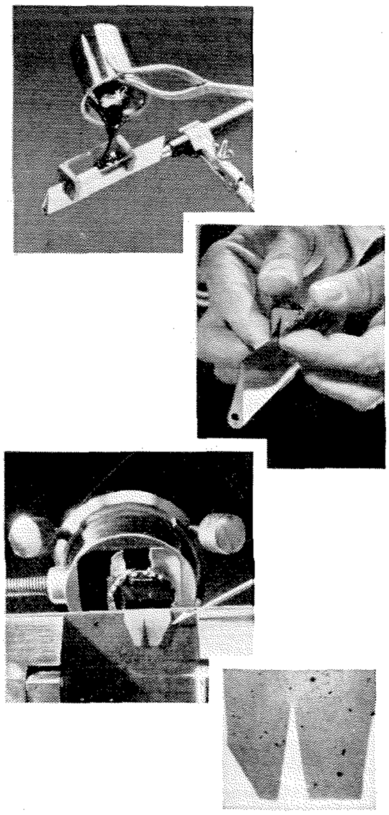
GOOD PACKING NEEDS GOOD RESEARCH

Faithful but flexible

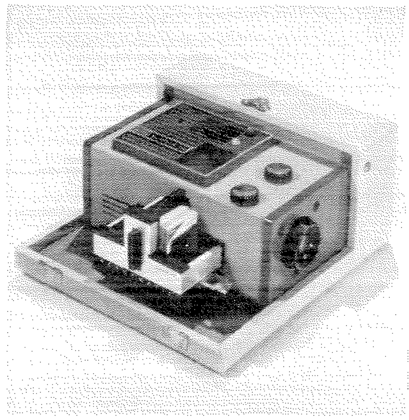
We find the trick shown below helpful in microscopic studies of profile sections along objects like knives. The casting material is our *Epolene C-10* Polyethylene Resin. You pour it at only 100°C. Yet at room temperature the little casting "remembers" its shape so accurately that despite the twist of unpeeling, profile details as small as 0.00009-in. radius are preserved in the sliced sections, and measurements are repeatable to ±0.00001". Then, if overheating is avoided, you can remelt and reuse the resin for more castings.

The man who came up with this trick is on our payroll to ward off trouble from micro-organisms in making film and paper. He is a microbiologist and has never been asked to contribute to machine shop practice in order to impress the plastics-molding trade.

Life can be devious instead of tedious.



It projects slides!



Learned and scientific as we are, we have not lost interest in simple consumer goods.

If you really want to know the truth, consumers are enjoying a simplicity kick at present. We even suspect you of being the type yourself. Otherwise we wouldn't be advertising the KODAK READYMATIC 500 Slide Projector to you.

It doesn't just scream "latest design!" but quietly is.

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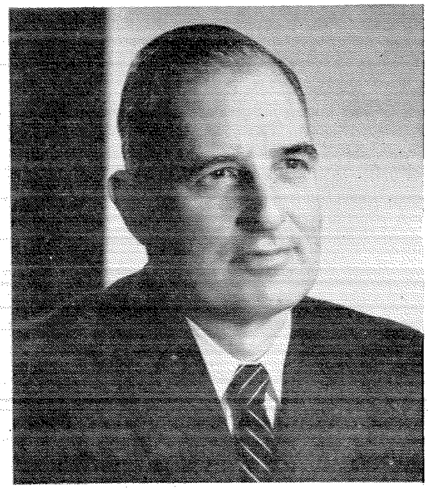
TRADEMARK

An interview with General Electric's W. Scott Hill

One of a series . . .



Manager—Engineering Recruiting

How to Make the Most of Your First Five Years

MR. HILL has managerial responsibility for General Electric's college recruiting activities for engineers, scientists, PhD's and technicians for the engineering function of the Company. Long active in technical personnel development within General Electric, he also serves as vice president of the Engineers' Council for Professional Development, board member of the Engineering Manpower Commission, director of the Engineering Societies Personnel Service and as an officer or member of a variety of technical societies.

Q. Mr. Hill, I've heard that my first five years in industry may be the most critical of my career. Do you agree?

A. Definitely. It is during this stage that you'll be sharpening your career objectives, broadening your knowledge and experience, finding your place in professional practice and developing work and study habits that you may follow throughout your career. It's a period fraught with challenge and opportunity—and possible pitfalls.

Recognizing the importance of this period, the Engineers' Council for Professional Development has published an excellent kit of material for young engineers. It is titled "Your First 5 Years." I would strongly recommend you obtain a copy.*

Q. What can I do to make best use of these important years?

A. First of all, be sure that the company you join provides ample opportunity for professional development during this critical phase of your career.

Then, develop a planned, organized personal development program—tailored to your own strengths, weaknesses and aspirations—to make the most of these opportunities. This, of course, calls for a critical self appraisal, and periodic reappraisals. You will find an extremely useful guide for this purpose in the "First 5 Years" kit I just mentioned.

Q. How does General Electric encourage self development during this period?

A. In many ways. Because we recognize professional self-development as a never-ending process, we encourage technical employees to continue their education not only during their early years but throughout their careers.

We do this through a variety of programs and incentives. General Electric's Tuition Refund Program, for example, provides up to 100% reimbursement for tuition and fees incurred for graduate study. Another enables the selected graduate with proper qualifications to obtain a master's degree, tuition free, while earning up to 75% of his full-time salary. These programs are supplemented by a wide range of technical and nontechnical in-plant courses conducted at the graduate level by recognized Company experts.

Frequent personal appraisals and encouragement for participation in professional societies are still other ways in which G.E. assists professional employees to develop their full potential.

Q. What about training programs? Just how valuable are they to the young engineer?

A. Quite valuable, generally. But there are exceptions. Many seniors and graduate students, for example, already have clearly defined career goals and professional interests and demonstrated abilities in a specific field. In such cases, direct placement in a specific position may be the better alternative.

Training programs, on the other hand, provide the opportunity to gain valuable on-the-job experience in several fields while broadening your base of knowledge through related course study. This kind of training enables you to bring your career objectives into sharp focus and provides a solid foundation for your development, whether your interests tend toward specialization or management. This is particularly true in a highly diversified company like General Electric where young technical graduates are exposed to many facets of engineering and to a variety of product areas.

Q. What types of training programs does your company offer, Mr. Hill?

A. General Electric conducts a number of them. Those attracting the majority of technical graduates are the Engineering and Science, Technical Marketing and Manufacturing Training Programs. Each includes on-the-job experience on full-time rotating assignments supplemented by a formal study curriculum.

Q. You mentioned professional societies. Do you feel there is any advantage in joining early in your career?

A. I do indeed. In fact, I would recommend you join a student chapter on your campus now if you haven't already done so.

Professional societies offer the young engineer many opportunities to expand his fund of knowledge through association with leaders in his profession, to gain recognition in his field, and to make a real contribution to his profession. Because General Electric benefits directly, the Company often helps defray expenses incurred by professional employees engaged in the activities of these organizations.

Q. Is there anything I can do now to better prepare myself for the transition from college campus to industry?

A. There are many things, naturally, most of which you are already doing in the course of your education.

But there is one important area you may be overlooking. I would suggest you recognize now that your job—whatever it is—is going to be made easier by the ability to communicate . . . effectively. Learn to sell yourself and your ideas. Our own experience at General Electric—and industry-wide surveys as well—indicates that the lack of this ability can be one of the major shortcomings of young technical graduates.

**The kit "Your First 5 Years," published by the Engineers' Council for Professional Development, normally sells for $2.00. While our limited supply lasts, however, you may obtain a copy by simply writing General Electric Company, Section 699-04, Schenectady, New York.*

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