ENGINEERING | AND | SCIENCE

November 1963

Published at the California Institute of Technology

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Westinghouse

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ENGINEERING | AND | SCIENCE

NOVEMBER 1963 VOLUME XXVII NUMBER 2

On Our Cover

Richard P. Feynman, author of "The Problem of Teaching Physics in Latin America" on page 21. The article is a transcript of the keynote speech given by Dr. Feynman at the inaugural session of the First Inter-American Conference on Physics Education in Rio de Janeiro last summer.

In his article, Dr. Feynman considers the problem of teaching physics in Latin America as part of the wider problem of teaching physics anywhere —or of teaching *anything* anywhere, for that matter. These are problems that occupy a good deal of Dr. Feynman's time these days: He has played a prominent part in developing Caltech's radical new method of teaching undergraduate physics; and he is serving this year as a member of the State Curriculum Commission, which evaluates textbooks for elementary schools in California.

Dr. Feynman is Richard Chace Tolman Professor of Theoretical Physics at Caltech.

"Why Race for Space?"

is the third article we have had from Eberhardt Rechtin on this subject. It follows "Who Says There's a Space Race?" (December 1959) and "What Are We Racing For?" (October 1960). Dr. Rechtin keeps in close touch with the space race as assistant director for tracking and data acquisition at Caltech's Jet Propulsion Laboratory. His article on page 9 was first given as a talk before the American Gas Association in Los Angeles on October 15.

Illustrations:

Cover — Joe Munroe
16, 17, 18, 20 — James McClanahan, Graphic Arts Facilities

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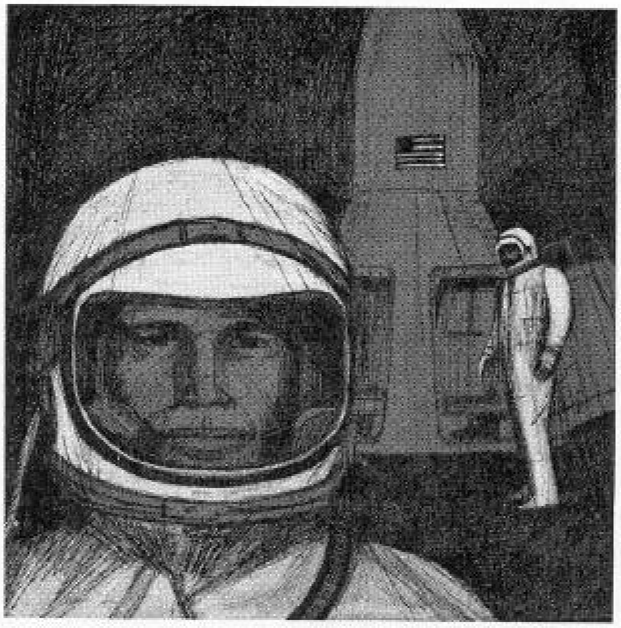
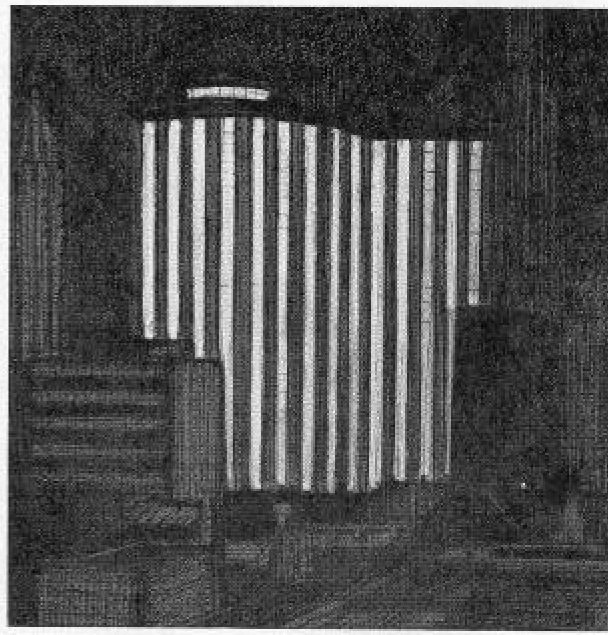
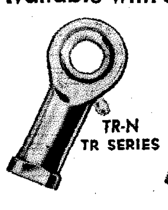
Published monthly, October through June, at the California Institute of Technology, 1201 East California St., Pasadena, Calif. Annual subscription $4.50 domestic, $5.50 foreign, single copies 50 cents. Second class postage paid at Pasadena, California, under the Act of August 24, 1912.

Manuscripts and all other editorial correspondence should be addressed to: The Editor, *Engineering and Science*, California Institute of Technology.





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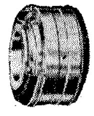

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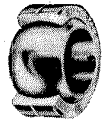

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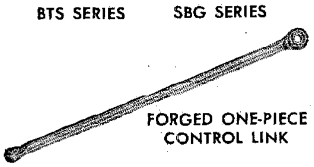

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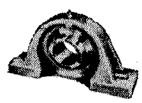

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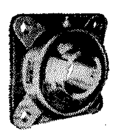

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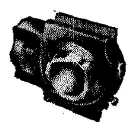

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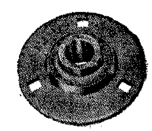

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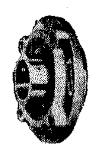

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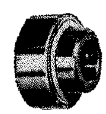

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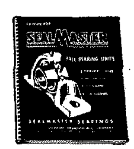

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Books

THE AMERICAN IMAGE OF THE OLD WORLD

by Cushing Strout
Harper & Row $4.75

Reviewed by Paul R. Baker, lecturer in history at UC-Riverside

In this richly rewarding critical narative, Cushing Strout, Caltech professor of history, deals with the American "idea" of Europe in its many varied manifestations throughout the course of American history. Just as the concept of America has long had profound meaning to Europeans, so also Americans themselves have looked at Europe in many ways and with mixed feelings.

Although articulate colonial Americans, whose cultural ties to Europe were usually strong, seldom had much sense of opposition to the Old World, by the time of the American Revolution the concept of America as an anti-Europe (already long a European idea) had begun to develop in the New World. Throughout the nineteenth century this idea of polar opposition formed the basis of the American image: the United States was constantly being represented as innocence, virtue, and purity, in contrast to the Old World – which invariably meant sophistication, vice, and corruption.

These valuations and attitudes, of course, were important foundations for the powerful tradition of isolationism. The image of Europe, nonetheless, was by no means a simple dichotomy for many Americans, who, though often smug and self-righteous in their opposition to the Old World, were still attracted to Europe and eager to learn from it. Thomas Jefferson displayed this double attitude, and it has subsequently been stressed time and again, especially among writers and artists, leading to both inner tensions and profound insights in their creative work. Professor Strout's discussion of the idea of the Old World held by American painters and sculptors is somewhat weaker.

The decades since the late nineteenth century have brought new meanings and further ambiguity to the image. With lively detail the author shows how the basic concept was altered and took on new dimensions at the end of the last century as huge numbers of immigrants poured into the country and as the United States emerged as a world power.

During and immediately following World War I, Wilsonian internationalism brought the question of the meaning of Europe close to all Americans, and once again the old antithesis was reaffirmed. In the 1920's, as American expatriates on a previously unequaled scale sought a new life abroad, another twist was given to the polar opposition, and the Old World took on new and positive attributes. The recent decades of depression, war, and cold war have led to further transmutations and a general weakening of the traditional image, especially as an Atlantic community has taken shape.

Professor Strout has based his stimulating discussion of this complex and ever-changing idea upon an impressive use of source materials, ranging in variety from close analysis of both major and little-known works of fiction to revealing probings into the significance of political and diplomatic events and of opinion poll compilations. The result is an important book, providing many fresh insights about the values and assumptions, the psychological needs, and the historical experience of the American people, and throwing light on some heretofore neglected patterns in the complex tapestry of American history.

Letters

Exploding Galaxy

Fort Huachuca, Arizona

DEAR SIR:

The October issue of *Engineering and Science* is one of the better issues that I have received in some time. Dr. Pickering's article, "Man at the Threshold of Space," is a most provocative dissertation on "whither are we drifting."

The article on "Exploding Galaxy" was also extremely interesting; however, in my ignorance of astronomy I was unable to reconcile the statements in the first and second paragraphs. The first paragraph states that "Galaxy M 82 is comparatively nearby (only 60 billion billion miles or 10 million light years away)." The second paragraph states: "It was calculated that the explosion started 1,500,000 years ago." It is my understanding that the definition of a light year is the distance traveled by light at 186,000 miles per second in one year. Since Galaxy M 82 is 10,000,000 light years away from the earth, then from the statement in the second paragraph that the explosion started 1,500,000 years ago, it would seem that the velocity of propagation outward from Galaxy M 82 must be 6.7 times the velocity of light if it is to be seen at the earth today.

I would appreciate you straightening me out on this little matter.

Yours truly,
WALTER L. BRYANT, '25

According to Dr. Allan Sandage, staff member at the Mt. Wilson and Palomar Observatories:

"The statement that the explosion took place 1,500,000 years ago refers to events as seen from the earth. If astronomers could have observed M 82 from earth 1,500,000 years ago, they would have seen the explosion in its initial phases. In cosmic time, of course, the explosion took place 1,500,000 years ago plus the time it took light to travel from the galaxy to us. It is always assumed in discussions of this type that the event took place a time ago as seen from the earth."

Suggestion

Hawthorne, Calif.

EDITOR:

I thought you might like to see this unsolicited compliment in the Letters column of the September-October issue of the *UCLA Alumni Magazine*:

> *"I am enclosing $7.50 for alumni dues, but I'm not sure why. It seems to have no worth at all. May I suggest . . . a magazine that has articles of new research by professors on campus. Each time it comes I do a slow burn, because the Caltech magazine also comes to our home. Take a look at one and see for yourself . . .*
> *Mrs. Barbara Doss McKinlay '41*

I concur completely.

GORDON S. REITER '56

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ENGINEERING AND SCIENCE
November 1963, Volume XXVII, No.2

WHY RACE FOR SPACE?

The controversy continues over sending men to explore the Moon. President Kennedy recently proposed cooperation in a heretofore competitive arena. Here is a recent talk by an Assistant Director of JPL, viewing the race from on the track.

by Eberhardt Rechtin

This country is now seriously embarked on a race for space. It was not always so. The start was certainly disorganized. For awhile there was only one racer, the Soviet Union, putting on a demonstration of unrivaled skill. When it showed up, the second racer—the United States—started off in a completely different direction from the first racer. And now we have still more contenders, including the French, the British, and possibly the Egyptians.

Surprisingly, for a while we did not even know why we were racing – we only knew that we were. Or maybe it was not so surprising after all: A truly dynamic society is usually brash and proceeds in directions which it feels intuitively are correct without working the reasons out ahead of time. Indeed, a society which plans every move in elaborate detail is usually on the road to extinction. But, once committed to the race, it is vital to study the field, to plan the pace, based on the rewards and the competition, and to understand how to take advantage of breaks or to recoup losses.

The present space race has many similarities with earlier international races. Parallels can be found throughout all recorded history. Using history as a guide, it is not difficult to work out general motivations for such races and even to learn a few lessons of success or failure from them.

Let us define a race as a fairly-well-coordinated *effort of a society, using at least one percent of its* gross productivity per year and aimed at providing prestige, influencing world politics and trade, providing work and wealth through productivity of the racing country, and unifying the country by providing one element of national purpose.

One kind of a race is war. Compared to other kinds of races, war is certainly more expensive and destructive. Particularly in modern wars, it is not clear that anyone wins. On the other hand, the motivations for war, the improvement or defense of one's position in the world relative to others by brutal means, are simple, primitive, and relatively easy to understand. Survival is so easily understood that even cold wars can call forth the willing expenditure of resources at a far higher level than is characteristic of other kinds of races. For example, our defense budget is ten times our civilian space budget, perhaps because the motivations are better understood and the potential consequences greater.

Peaceful races have much more complex motivations, are less easily understood, and are more subject to criticism by other competitors for the same resources. This is by no means bad. The peaceful races provide discussions of national purpose in areas which will make our country great, discussions which never even arise if our only national purpose is survival. In other words, we might very well view our defense budget as aimed at preventing war so that our country can debate and work toward peaceful goals. In our free and defended society, we can now debate the space race in terms of national purpose. The debate is healthy and necessary both for the space race and for all of our national purposes.

There have been many previous peaceful races. Free enterprise itself is based on the competition of racers. The world has been largely explored by different countries racing over the horizon into the unknown. Cathedrals, palaces, Parthenons, pyramids, roads, canals, seaways, and airways have been built as the result of races. Many of the motivations for these races are also characteristic of the space race. We are demonstrating that we are a highly successful society with sufficient skill, purpose, energy, stamina, organization, and national purpose to do a very large project.

It is considerably more difficult to do one large project than many small projects. We have now recognized that public relations, marketing, and sales are major ingredients in the space program. The space program certainly affects the world market. A quick calculation some years back showed that the Soviet Union probably acquired some five billion dollars worth of the world market just by the launching of Sputnik I. Traders on the world market were much impressed with Sputnik I and it seemed evident to these prospective customers that a society which could launch the first earth satellite could probably build reasonable dams and bridges and supply goods and services of high quality.

Whether this is actually true or not is immaterial. The customer thought it was. Khrushchev also maintained that the communist form of government, having been operative in the Soviet Union for more than 40 years, was a major factor in raising the country from a fairly backward nation to one which could be first in space.

A new contender in the race, the United Kingdom, is seriously considering launching and operating its own communications satellite system, not only for the commercial benefit of the United Kingdom but also to demonstrate that the sun has not yet set on the British Empire. The British are very concerned that participation in the space race has been equated in the world with advanced industrial technology, and that if the United Kingdom does not participate it will continue to see its scientists and technologists (and the industries which they create) leaving the British Empire.

The countries of Europe have established the European Space Research Organization and the European Launching Development Organization not really to explore space but to produce technological benefits for the community of European nations.

The Egyptians maintain that they will launch earth satellites and, although this might seem strange to us, the Egyptians have not unreasonable motivations. The world that the Egyptians are interested in consists primarily of the Near East and that nearly-self-contained world has not yet launched its first satellite.

The history of the United States participation in the space race is well known. Our participation in space, except for the dreams and hopes of a limited number of us, began with the Eisenhower decision to support an earth satellite project as part of the International Geophysical Year. Participation was to be scientific and as non-competitive as most purely scientific endeavors can be expected to be. In other words, although one scientific group or another might discover some new and important scientific fact, the discovery was more nearly a credit to the individual than to nationalistic competition. In other words, it was decided that there was not going to be a race. The Russians obviously decided differently at that time.

The next major decision was that the space effort was going to be fairly significant in size, but that all of the effort should not be carried out in the Department of Defense. Furthermore, as much of our space exploration as possible was supposed to be civilian, unclassified, and open for the world to see.

The National Aeronautics and Space Administration was established under bipartisan sponsorship with the Space Act of 1958, one of the most forward-looking and statesmanlike accomplishments of the time. However, although the Act recognized that competition might be present, its stated purpose was to make the United States *a* leader in space, not *the* leader.

Dr. Keith Glennan, an eminent scientist and president of the Case Institute of Technology, was appointed as NASA's chief under the continuing policy that the United States was not in a race for space. The Russians again decided differently. Our space program continued to expand up to about one billion dollars per year, a level which in retrospect was non-controversial. But then, at this critical juncture, we had an election based to a remarkable degree on discussions of national purpose.

The position of *both* candidates, with respect to space exploration, was that there was a race whether we wanted it or not, and that we had better recognize it and do something about it. Senator Kennedy was emphatic about moving ahead with vigor. It is less well recognized that Vice President Nixon also supported the idea of a race, but was hampered by the need to defend the then-existing policy.

After the election, President Kennedy made the standard announcement that the previous policies on the space race would be retained for the time being, but there was clearly a major change in policy in the wind. Dr. Keith Glennan, an ideal administrator for the program of scientific exploration, was allowed to resign shortly after the election and was replaced with one of Washington's best politicians, "Jim" Webb, a man known for successes in Budget Bureau and Congressional circles.

Although it hadn't been announced yet, it was clear within NASA that a decision had been made that we were in a space race and that this race clearly had major impact on the international scene. Within both the NASA and the Department of Defense, debates which had been going on since about 1959 were accelerated, concerning the goal of the race, the permissible annual cost of the race, and so on. There were proponents of earth satellite stations, lunar landings, and planetary landings.

Most of us felt that the elections and Congressional opinions clearly indicated a mandate to engage in the space race, to *do* something, although the technical goal itself was not specified. Two months after Gagarin's flight and its world reaction, three weeks after Shepard's flight, six-and-a-half months after the election, and three-and-a-half years after Sputnik I, the decision was formally made that we were in a space race.

Contrary to some recent articles in the public press, I disagree that public policy in the space race was abruptly changed because of the Cuban Bay of Pigs. It certainly never occurred to any of *us* at the time that a change had not been in the wind for quite some time and none of us connected the two situations except in a very general way. As I remember it, we felt that the only reason the decision was not made sooner was that it was necessary to consider more urgent things first, and most of us were glad that the Cuban situation didn't delay the decision any more than it did. The decision had several parts:

1. The first good chance to beat the Russians was for a manned lunar landing.
2. Expenditure rates would have to be increased by about a factor of five over the then-present budgets to accomplish this.
3. To obtain required long-term funding, long-term support of Congress was essential and an increasing level of debate should be anticipated.
4. NASA would have to become a political as well as a technical agency if it was to compete for resources at the required scale.

Remember also that the world situation at the time was that the cold war would probably go on until it resulted in nuclear war, unless the Russian people revolted against their communist leaders. The probability of revolt was very dim and was growing dimmer as the Russians became increasingly proud of their technological achievements. If there was any tie between the Cuban situation and the space race, it was that in both cases the United States was tired of being pushed around. Indeed, President Kennedy said as much when he gave the reasons for the lunar expedition.

Consequences of the decision to race

The decision to race has had some remarkable consequences, not all of which were foreseen by any means. Most of the consequences have been on the positive and useful side, which is as good a criterion as any for judging the wisdom of a decision. One of the best consequences was that discussions of national purpose have continued unabated and much of the previous lethargy of the American people to this discussion has dissipated. The space budget annually brings up discussions of alternate projects, the purpose of the race, and the relationship of the race to almost every other national problem.

I can illustrate this in a personal way. The first time I ever gave a talk on "Why Race for Space" happened to be one week before the election of President Kennedy. Almost every year since, I have been requested, and found it worthwhile, to give a talk under much the same title. Mr. Webb, the Administrator of the NASA, would probably tell you that he has been giving a talk on the same subject continuously, ever since his appointment. Now, while there might be some consternation in the Space Agency over all the work that it takes to engage in a debate, no one questions the essential need for the debate as a way of determining the pace of the space race that is desired by the

American public and its representatives in Congress. And, as an American citizen, I have welcomed the interest of large audiences to discussions of national purpose.

A consequence of the need for general support on a large scale was the corollary decision that more parts of the country would have to participate in the space business than before. This did *not* mean that effort was to be taken from other parts of the country such as California, but rather that if the existing efforts were to expand, there must also be expansion elsewhere. Putting it in more blunt political terms, California has benefited handsomely from the decision that the Manned Spacecraft Center should be located in Houston, Texas.

Another consequence of the decision to race was a remarkable revamping of American industry. A recent poll by the Harvard Business School of businessmen across the country found them strongly in support of the space race because it was resulting in revamping old companies and starting new companies based on more advanced technologies, in a way which could only be compared with the American refurbishing of German and Japanese industry after the war. In other words, the space race had resulted in the rejuvenation of major parts of American industry which would put them in a much more competitive position with the rapidly rising German and Japanese industries.

Another rather curious consequence had to do with civil rights. Although it is doubtful that the decision was consciously made with this end in view, the decision to put a great deal of space industry into the South resulted in an influx of engineers and scientists and their social standards into the Deep South. Wherever these people went, they took with them a long background of civil equality and a reasonably objective view of life. This was best illustrated in the integration of the Alabama universities. In Huntsville, Alabama, the home of the Marshall Space Flight Center and its associated industry, the local majority was willing to do battle with the governor of the state to ensure that integration *would* occur and that the community would not be labeled as part of Deep South Alabama, The same reaction could be expected near Cape Canaveral; Michoud, Louisiana; the Mississippi Test Center; Houston, Texas; and so forth.

A consequence of the decision that the space race would be a matter of public debate was also the corollary that public support should determine the *kind* as well as the pace of the space program. For example, there are two self-consistent approaches toward exploring the Moon. The first approach is to use unmanned spacecraft and to take somewhat more time. This approach produces considerably less drama for the audience, less understanding and personal identification and satisfaction by the audience, and, consequently, less financial support. The reduced level of financial support is consistent with an unmanned, slower exploration of the Moon.

The second consistent approach is to use manned flight with a moderate degree of urgency. There is considerably more drama for the audience; there is more understanding, personal identification, and satisfaction by the audience; and, consequently, more financial support. The higher degree of financial support is consistent with a manned program of moderate urgency.

As far as the engineers and scientists are concerned, either approach is technically practical and, although the results will be different, there is no conclusive technical argument that one approach is better or worse than the other for exploring the Moon. As far as the engineers are concerned, the difference between the two approaches is not unlike the difference between building ferries or building bridges across the Golden Gate in San Francisco. It depends upon what the customer wants and is willing to pay for.

From my own point of view as one of several hundred million customers, I am glad that we are going to explore the Moon with men, even though my own business in the past has been that of unmanned exploration of space. I like the manned exploration because it is more dramatic and does result in much more challenging national discussions than simply a technological extension of the sounding rocket program. The only real technical mistake would be to attempt to do the manned exploration of the Moon at the funding level appropriate for the unmanned. The consequences to the Golden Gate Bridge of trying to build it with funds set aside for ferry operation would have been much the same.

The manned exploration obviously has a more profound influence on the country. Eric Sevareid expressed the thought particularly well way back on May 26th of this year: "After the first men walk upon the Moon, old Earth will never be the same and the change will be in the two societies, Russia and America, now competing for the cataclysmic honor of commencing the alteration." To paraphrase him slightly, Sevareid noted that the search transfigures the searcher and may well be more important than the marvels discovered.

The offer of cooperation in space research

President Kennedy, before the United Nations, recently made the offer that "surely we should explore whether the scientists and astronauts of our two countries – indeed, of all the world – cannot work together on the conquest of space, sending some day in this decade to the Moon, not the representatives of a single nation, but the representatives of all humanity." As with everything in the space business, this offer generated considerable discussion. I propose to continue the discussion here.

First of all, let us consider the *offer* and then discuss practical cooperation after that. The background of the offer has been well reported in the press. It was pretty obvious that the President did not discuss the offer ahead of time with NASA. We further know that the reaction of the White House press secretary to the implication that the offer meant a change in policy and an attempt to get out of the commitment of a race to the Moon was a rather angry retort that this was not the case. We have the President's letter to Representative Albert Thomas stating that, indeed, the offer did *not* represent a change in policy; on the other hand, the President has not yet revealed his reasons behind making the particular offer at the particular time. We also know that the Russians were caught flatfooted by the boldness and sincerity of the offer and have yet to make a well-thought-out reply. This, then, is the (incomplete) set of facts.

The critics of the space race have had a field day with this situation, calling the space race everything from a Moon-doggle to a forty-billion-dollar political shell game. They may be right. It would be presumptuous of me to claim that I have an inside track to the President's mind. But I would like to offer an alternate explanation which fits the same facts and which, if the explanation turns out to be true, permits a set of predictions as to what ought to happen next.

I will start out the alternate explanation with a set of assumptions. I will assume that the President knew what he was doing and had thought out the possible moves of both sides at least two steps in the future, much as in the Cuban missile-withdrawal situation. I will further assume that the President does not want out of the space race and regards the country as very much committed to winning it in front of an international audience. And finally I will assume that the reasons for the offer were for the benefit of the Department of State and the intelligence community and that it was believed that these benefits could be accrued without a damaging effect on the NASA.

If these assumptions are true, the first question to ask is what benefits might accrue to the Department of State and the intelligence community. If we assume that the Russians are out to bury us and are very much in the space race (as maintained by their cosmonauts but not by their academicians), then they are preparing secretly and it becomes important to try to find out their intentions. The intelligence effort necessary to find out the Russians' intentions is considerably simplified if we can get the Russians to make a public announcement on the world stage. If the Russians do intend to compete, they must be marshalling the technology to do so and must be developing large boost rockets to be able to undertake the job. (In the United States, we are developing the Saturn C-V class of vehicle for this purpose and have so announced.) Russian development of still larger boost rockets has obvious implications to national defense and their long-term intentions in the cold war. If the offer of a cooperative effort can smoke out the Russians on these points in this situation, this country will have gained a great deal.

On the other hand, let us again suppose that the Russians intend to bury us but have decided that the lunar expedition is too expensive, and the amount of information which they have on the dangers of space is too scant, for them to make the effort. If this is the case, then an offer of cooperation from a position of strength may force the competition to concede, and this country would have won the Moon race politically.

This does not mean that we can stop our efforts of a lunar expedition, because that would imply that we had insufficient stamina and national purpose to accomplish our self-set goal before our international audience, but it would say that we could proceed with a program designed for less risk and cost.

Therefore, if Russian long-term intentions still remain the conquest of the world, and whether or not they are in the race, an offer of cooperation at this particular time is to our advantage.

Suppose, on the other hand, that the Russian long-term policies are aimed at joining the West rather than conquering it. It really isn't necessary, you know, that the only resolution of international competition must be a full-scale war. I recognize that, although we have fought the Germans, Japanese, Chinese, British, Spanish, French (when we were a British colony), and a few others, it is not absolutely essential that we add the Russians to the list.

There is some indication that the Russians have decided that it might not be worthwhile to take on the United States after all and that a much more important problem is China. If this is the case, our efforts should be to try to change the cold war and to give the Russians every conceivable opportunity to move closer to the West. But obviously the Russians cannot move in this direction if we remain stubborn, aloof, or insulting. We must give the Russians reasons, sometimes face-saving reasons, for every step of the way until neither side continues to call the other side "the enemy."

One major step would be the opening up to world view of the Russian space-vehicle and tracking program. This Russian program has been completely closed to outside view until very recently. Suppose, then, that we assume for this part of the argument that the Russians are interested in moving westward. If they are, and if they have decided to engage in a competitive space race with us, just as the British, French, and Egyptians have, then this provides them a reason for being considerably more open in expressing their intentions.

On the other hand, again assuming that the Russians are interested in moving westward, but that they have found that the Moon expedition is too costly in available resources, then the offer of cooperation will permit them to join the West gracefully. They are not now in such a patently inferior position that by joining they have to acknowledge losing the race. Indeed, it is easier for them if they happen to be just slightly ahead at the moment. Therefore, an offer by us for cooperation is in our interest in this set of situations as well.

Now, in all of these cases it is important that the offer be made at a time when we can deal from a position of strength (or at the very least from a position of near-equality). Until 1960, the estimates of our lag in the space race typically varied from three to five years. The consensus these days would be from zero to two years. If this rate continues, we should be several years ahead by 1970. This year is therefore the first year when an offer of cooperation could be made from a position of reasonable strength. If we made the offer still later, at a time when we were clearly ahead, then we might be in the position of winning the race but losing the Russians.

Therefore, from both the intelligence community and Department of State points of view, the offer of cooperation was an excellent move. From the Russian point of view, the offer calls for a statement of national purpose from them—something which clearly presents them with problems as portentous as those they faced in having to answer the Cuban missile-withdrawal demand.

But what about from the point of view of NASA? Some of the first reactions were that cooperation was technically impossible and that the offer was impractical. With all due respect to those who voiced these views, I think that the questions were asked too soon for a thoughtful answer. The natural defensive reaction toward preserving the space program when the questioner implies that cooperation will sharply reduce one's own program, is allayed considerably by the fact that the offer can only be made from a position of strength and that this position of strength must be maintained throughout all of the negotiations. Indeed, the best thing at the moment for the United States, awaiting the concrete expression of intentions from the Russians, is to sprint and not stop to look around. After all, the consensus is that the Russians are slightly ahead of us at the moment.

If, on the other hand, true and detailed cooperation does come about, the relaxation in cold war tensions resulting from much increased openness between the U.S. and the U.S.S.R. will have solved so many more important problems that the purely technical ones of matching spacecraft and vehicles can certainly not loom very large in contrast. Indeed, I would welcome the chance to help solve the purely engineering problems of matching pieces of hardware in a spirit of friendly cooperation in contrast to wondering how to solve the political science problems of a cold war. As any engineer can tell you, technical compatibility is made either very easy or very difficult by the attitudes of the participants and has little to do with the hardware itself. If everyone wants to cooperate, the hardware will fit all right. If no one wishes to cooperate, pieces of hardware from the same company won't even fit each other.

The offer of cooperation should therefore not result in a slackening of NASA's efforts and, if actual cooperation is negotiated, the NASA would be serving our country by solving technical compatibility questions in preference to our State and Defense Departments solving more difficult cold war problems.

Following this line of reasoning, I then conclude that the offer was a brilliant one but that the President must wait for an expression of Russian intentions before officially announcing the particular set of reasons which led him to the offer. For example, it would be a very poor idea to announce before the Russian response that the purpose of the offer was "to smoke out the enemy," because it might well turn out that the Russians were trying hard not to be the enemy and we had simply pushed them back again.

It would be equally foolish to say that our offer was based on the assumption that the Russians wished to come westward because, whether true or not, only the Russians can legitimately state their own intentions on the world stage. The President is therefore not able to state at this time the detailed reasons for the offer or for its timing. In the present blast of press criticism, this must take remarkable patience. Furthermore, consultation with NASA is not a prerequisite to the offer, providing the President can satisfactorily explain to Congress enough of the situation so that the NASA budget is not slashed (or at least is not slashed for the wrong reason!).

In any case, the offer has clarified some questions of why we race for space. First, there *is* such a thing as a space race. Second, some of the main reasons for the race are international in character. Third, our government has officially recognized not only that the space race affects the cold war but that the status of the cold war should affect the space race.

Some predictions

It is always risky to make predictions, but without predictions it is difficult to make decisions or to consider the desirability of the predicted course. Needless to say, my personal predictions are not necessarily those of the management. I will start with the easy ones and will first assume that detailed U.S.-Russian cooperation is limited to data exchange between racers.

I believe, then, that the U.S. will be on Mars before anyone else and probably before 1980. I believe that the U.S. and the U.S.S.R. will both be on the Moon within a year of each other, that doing so before 1970 is still a good bet, and that it is also a good bet that the U.S. will be first. In this respect, the choice of a lunar orbit rendezvous technique was significant and helpful. This decision gives us the best chance of accomplishing the mission with the minimum vehicle and yet a vehicle that neither racer presently has. In other words, in the race to the Moon, the U.S. and the U.S.S.R. are starting out much closer to even than in the case of the first satellite.

It is quite possible, however, that the U.S.S.R. might send a man around the Moon first. We might just as well be prepared for that one. We should also expect the U.S.S.R. to demonstrate earth orbit rendezvous first. In other words, it is a foolish man who counts out the Russians at this stage of the game.

If the lunar expedition turns out to be a cooperative one between the U.S. and the U.S.S.R., we might expect significant cooperation in exchange of data within a year, opening up of the resources and facilities of both sides to world view within two years, and joint use of facilities in four years. The launch vehicles, the launching points, the tracking facilities, and the recovery systems might very well be mixed, depending upon demonstrations of engineering superiority in each of the areas. The arrival at the Moon, however, would probably be delayed a year or two and might cost a bit more, but I haven't heard of anyone yet who would mind paying for the overall result.

I also believe that the military will have a role in space, but I do not think that it will be via the so-called "useful manned weapon" route. Physics, logistics, and vulnerability of the man are all arguments against this route. Success will come, I think, via the more classical approach used by the Navy to explore Antarctica and the Army to explore the Far West. In other words, the exploration of space by the military is necessary to understand the new environment in *military* terms, possibly to discover it a poor arena of conflict, possibly even to deny it as an arena. No civilian has ever been able to do this task well.

The military, of course, already has an extensive reconnaissance and defense penetration space program, as demonstrated by the fact that there were more secret satellites put into orbit last year than all of the non-military satellites combined. The military program *should* continue even if the cold war cools off still more. The reconnaissance satellites are still the auditors or referees insuring that the new game is being played properly, and no one has yet declared that the *Chinese* are interested in moving West!

And, as a final prediction: A major war would unquestionably end the space race to the tragedy of mankind. We could all have a fantastic adventure if we can keep the peace. Fortunately, I believe that the space race may well help.

The Month at Caltech

Leader of America

Ralph Helstein, International President of the United Packinghouse Workers of America, AFL-CIO, will be on campus December 4-6 as the first YMCA Leader of America for 1963-4.

Mr. Helstein, who has been prominent on the national labor scene since 1934, became president in 1946 of the UPWA, which has been an acknowledged leader in the integration movement since the 30's. Helstein is one of the outstanding authorities on the subject of automation and its impact on the labor force and the national economy. Under his leadership, the UPWA devised Technological Adjustment Pay, a pioneering attempt to meet problems caused by automation.

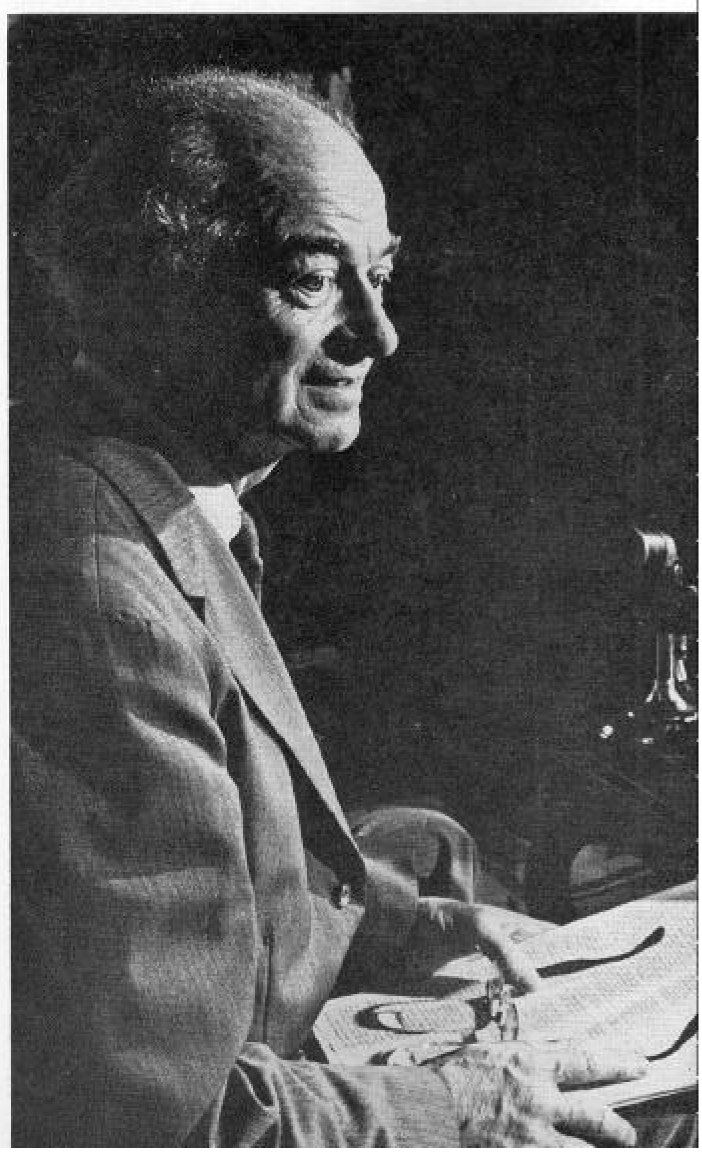
The second Leader of America will be Lukas Foss, composer, and conductor of the Buffalo Symphony, who will be on campus January 22 to 24.

New Appointment for Pauling

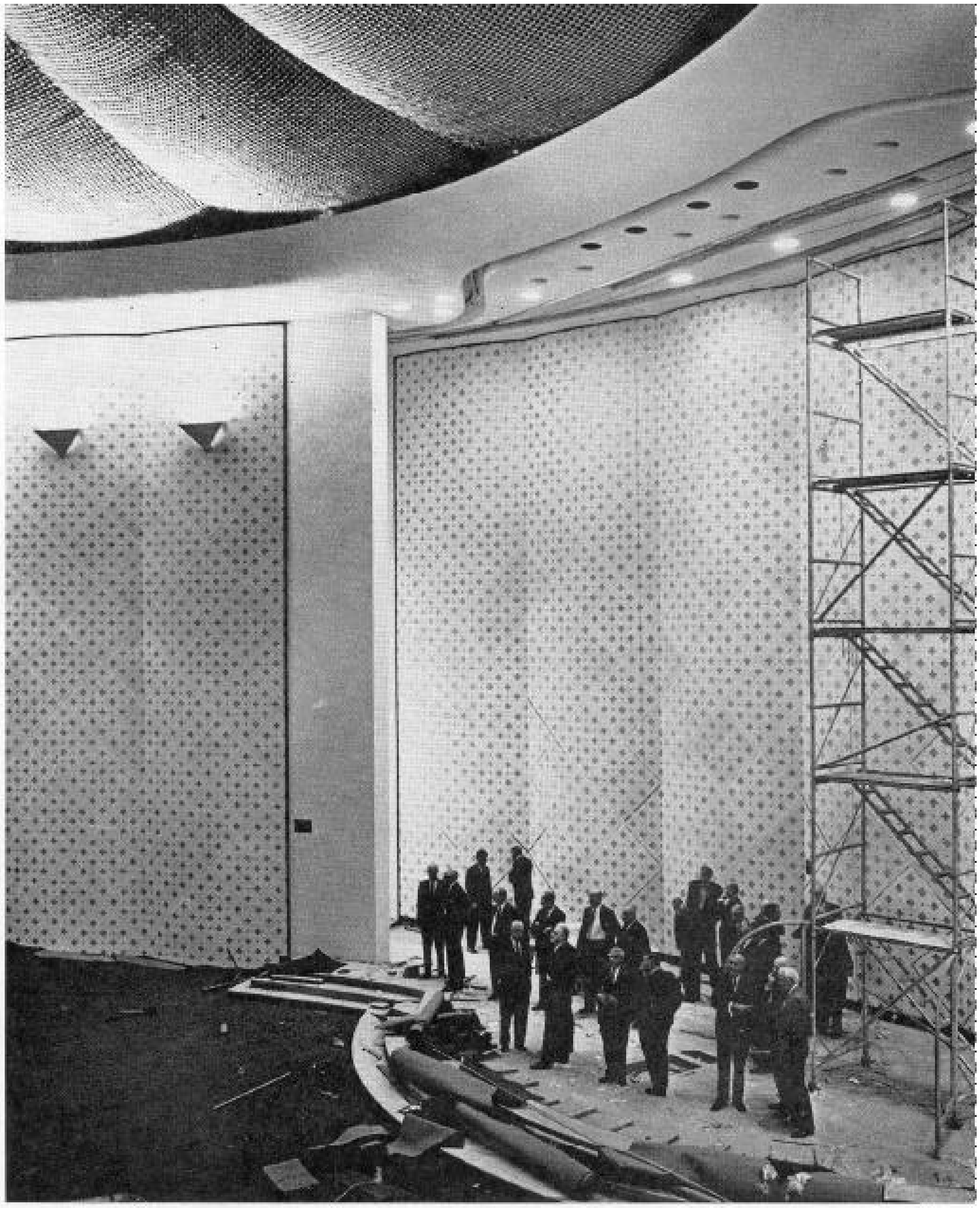
Linus Pauling, Caltech professor of chemistry, and winner on October 10 of the 1962 Nobel Peace Prize, held a press conference at his home in Pasadena on October 18 to announce that he had accepted appointment, effective November 1, as a member of the staff of the Center for Democratic Institutions, in Santa Barbara, "under conditions favorable to the continued prosecution of my work in science, medicine, and world affairs."

Dr. Pauling will be on leave of absence from Caltech during the remainder of the academic year, but will continue to supervise the program of experimental and theoretical research in the fields of chemistry in relation to mental disease and the mechanism of action of anesthetic agents, now being carried out under his direction.

"It is not without regret," Dr. Pauling wrote in a letter to John D. Roberts, chairman of Caltech's division of chemistry and chemical engineering,



Linus Pauling, professor of chemistry, announces his appointment as a member of the Center for the Study of Democratic Institutions in Santa Barbara.



TOUR OF INSPECTION

Caltech's National Board of Trustees, meeting on the campus on November 4, checks progress of construction on the new Beckman Auditorium. Tentative plans now call for dedication of the Auditorium late in January.

"that I view the ending of my association with the California Institute of Technology, after the more than forty-one years that I have spent as a staff member. I have felt that over much of this period the California Institute of Technology provided the most favorable environment for the prosecution of scientific work that could be found in the world.

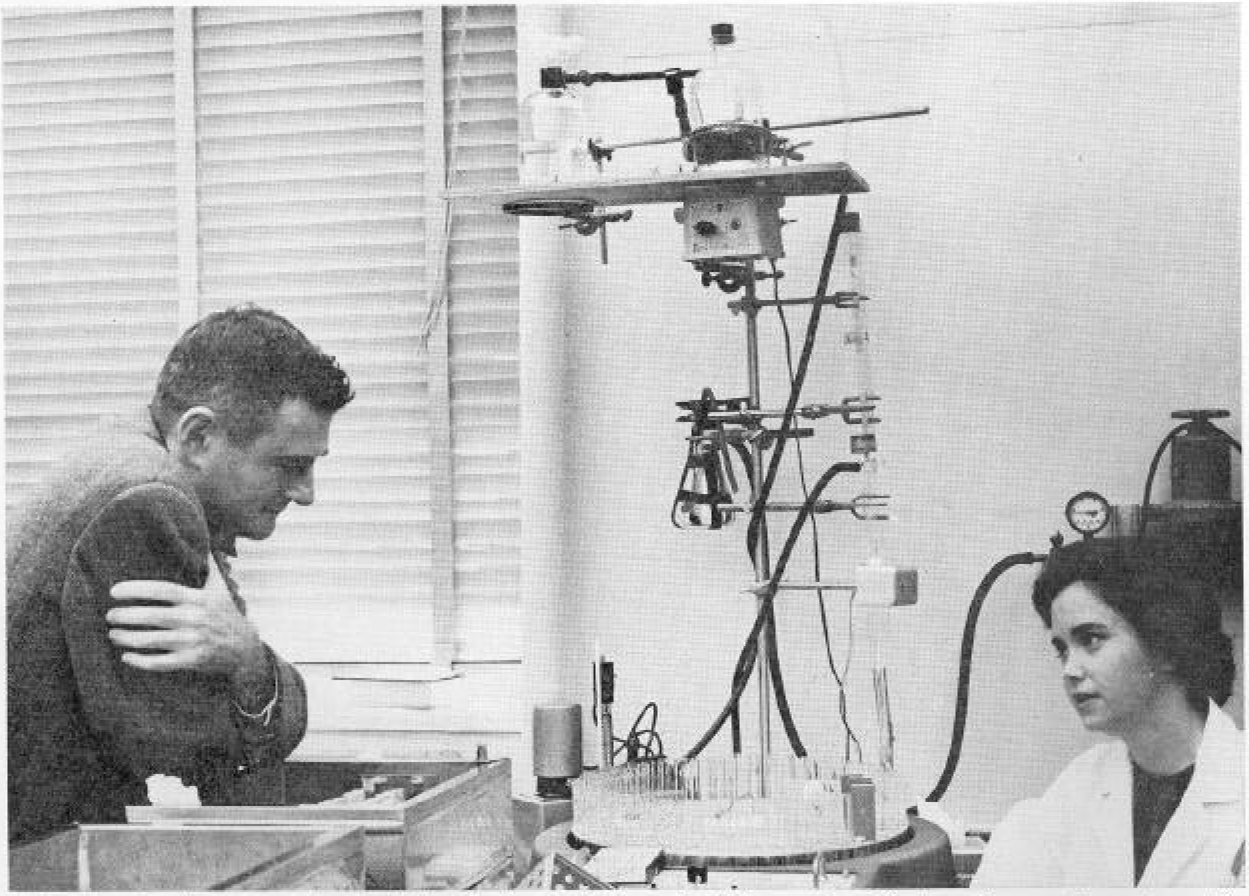
"I now look forward to an increased opportunity to carry out further work, during the coming years, in the fields of science, medicine and peace."

American Mathematical Society

The 606th meeting of the American Mathematical Society will be held on the campus from November 21 to 23. Some 200 members from the U.S., Canada, and England are expected to attend. In conjunction with the meeting, a symposium on recent developments in the theory of numbers will be held on November 21 and 22. There will be a special memorial service in honor of Dr. Morgan Ward, professor of mathematics at Caltech, who died on June 26. Dr. Ward was known for his extensive work on algebra and number theory, with particular emphasis on arithmetical sequences.

Frontiers in Science

Frontiers in Science, the book made up of articles from *Engineering and Science*, has sold over 25,000 copies since it was published in 1958 by Basic Books, Inc. Royalties received to date amount to $13,982.58, which has been turned over to Caltech's Faculty Salary Fund as a gift from the Caltech Alumni Fund.



Robert L. Sinsheimer, professor of biophysics, and Research Fellow Alice Burton discuss chromatographic experiments in the laboratory where DNA is fractionated before ultracentrifugal analysis.

RINGS OF LIFE — AND DEATH

by Robert L. Sinsheimer

Recent discoveries about DNA structures could lead to further insight into reproduction of viruses.

In the past two decades biologists and biochemists have convincingly demonstrated that the genetic substance of all living creatures, from viruses to man, is nucleic acid—most usually deoxyribonucleic acid, or DNA. Molecules of DNA are long chains of thousands—or tens, or hundreds of thousands—of subunits called nucleotides. There are four principal types of nucleotides, and the sequence in which they occur in the chain is the basis of the genetic inheritance.

"Take a circle, caress it, and it will turn vicious."
—IONESCO, *The Bald Soprano*

Until very recently the attention of biochemists has been focused upon the interactions and sequences of these chains. Little attention has been given to their termini – to their beginnings and endings. While obviously of relative infrequence, these are unique points in each chain and it would seem plausible that Nature may have introduced some special features at such sites.

Within the last two years it has been shown, in considerable part at Caltech, that in several instances, and particularly in certain virus particles, DNA chains have no ends; they are rings.

The relatively short and defined lengths of the nucleic acids of virus particles afford a particular advantage to an investigator interested in the nature of nucleic acid endings. Hence it is not surprising that the first demonstration of a ring structure for a DNA was achieved with the smallest viral DNA known, that of the bacteriophage Phi X 174. This result was obtained at Caltech by Dr. Walter Fiers, a Rockefeller Fellow, and myself.

The DNA of this virus is a single chain of 5500 nucleotides with a molecular weight of 1.7×10^6. The proof that this chain is a closed ring rests upon the observation that the introduction of any single break into the chain does not change the molecular weight of the chain (while it does alter its configuration, as indicated by its properties when observed in the ultracentrifuge), whereas the introduction of any second break invariably produces a decrease in molecular weight.

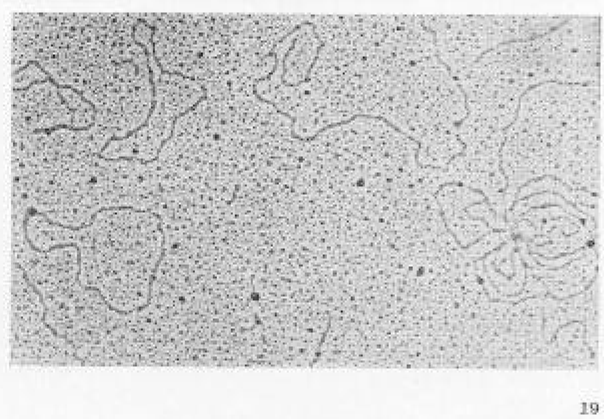
During the process of infection of bacterial cells by this virus, the single-stranded viral DNA is converted to the more familiar double-stranded DNA form. This was named a "replicative form" to indicate that this is the form the viral DNA assumes while it is replicating in a host cell.

This replicative form has very recently been isolated by Dr. Alice Burton, a research fellow in my laboratory. As a double-stranded molecule it is much stiffer and has a more extended configuration than does the viral DNA and it is much more suitable for direct observation in the electron microscope.

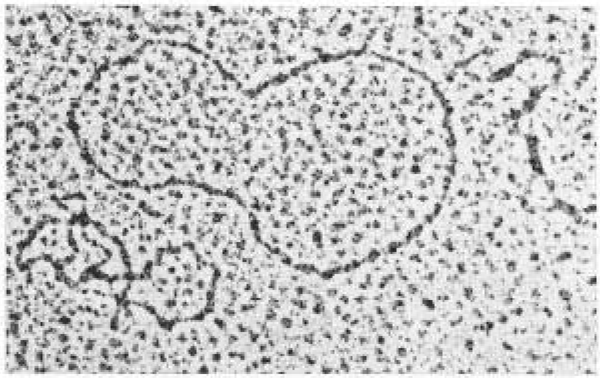
Electron micrographs of this replicative form of Phi X DNA have been taken in collaboration with Dr. A. Kleinschmidt, in the virus laboratory of the University of California at Berkeley, and one is shown below. Ring molecules, in single loops or frequently twisted into several loops, can be clearly seen, and contour lengths of these rings are readily measured. The mean contour length of 200 rings was 1.64 microns.

The detailed structure of double-stranded DNA has been deduced from X-ray diffraction analysis. In this instance, the structure leads to a calculated mass per unit length of 1.96×10^6 atomic weight units per micron. The mean molecular weight of these rings will then be 3.22×10^6, or 1.6×10^6 per strand. This conclusion is in splendid agreement with the much earlier measurement of the molecular weight of the single-strand DNA of the virus as 1.7×10^6. The visualization of these rings, of course, confirms the earlier analytical deduction of their form.

During the last year similar lines of evidence have led two groups at Caltech – Professor Renato Dulbecco and Senior Research Fellow Marguerite Vogt, in the biology division; and Research Associate Jerome Vinograd and Research Fellow Roger Weil, in chemistry – to the conclusion that the DNA of the tumorigenic virus, polyoma, is



Electron micrograph of the replicative form of Phi X DNA shows ring molecules in single loops, or frequently twisted into several loops.



Electron micrograph of the polyoma virus DNA clearly shows ring structure. The mean contour length of this ring DNA is almost identical to that of the replicative form of Phi X DNA.

also a double-stranded ring structure. An important facet of this proof was the analysis by Drs. Vinograd and Weil of the behavior of the polyoma DNA upon centrifugation in alkali. Under such conditions the hydrogen bonds linking the two strands into a stiff structure are destroyed. However, being entwined several hundred times, and lacking ends, the two strands cannot untwine and cannot separate. This situation results in a previously undescribed structure composed of two multiply-intertwined, but unlinked, polynucleotide strands with unusual centrifugal properties.

An electron micrograph of the polyoma virus DNA is shown above. By an extraordinary coincidence, the mean contour length of this ring DNA is 1.56 microns, almost identical to that of the Phi X replicative form DNA. It is remarkable that these two very distinct types of virus carry essentially identical amounts of genetic information.

It thus appears that, in these instances, the ends of the DNA chain are joined. In each case, however, there is more than a suggestion that there may be a special junction or coupling between the ends which differs from the usual internucleotide linkage along the chain. In Phi X DNA, one special enzyme-resistant linkage has been described in the ring. Polyoma DNA is found to be present to a small extent in an open-chain form.

Such a coupling may play a special role in the replication of these ring molecules. Ordinarily, during the duplication of DNA, the two chains of the double-strand molecule are untwisted and separated, one going to each daughter molecule. However, the two entwined chains of a ring DNA cannot be separated unless at least one is opened. The couplings may play an important part in such a step.

This recent work, then, has shown that DNA rings can and do exist and multiply. The detailed structure of these rings and the manner of their function and reproduction, remain to be elucidated. Such studies on the DNA from Phi X 174, and from polyoma virus, are continuing at Caltech.

Research Associate Jerome Vinograd uses the analytical ultracentrifuge to study buoyant density and sedimentation velocity of the polyoma DNA.

THE PROBLEM OF TEACHING PHYSICS IN LATIN AMERICA

by Richard P. Feynman

The problem of teaching physics in Latin America is only part of the wider problem of teaching physics anywhere. In fact, it is part of the problem of teaching anything anywhere – a problem for which there is no known satisfactory solution.

There are many new plans in many countries for trying to teach physics, which shows that nobody is satisfied with any method. It is likely that many of the new plans look good, for nobody has tried them long enough to find out what is the matter with them; whereas all the old methods have been with us long enough to show their faults clearly.

The fact is that nobody knows very well how to tell anybody else how to teach. So when we try to figure out how to teach physics we must be somewhat modest, because nobody really knows how. It is at the same time a serious problem and an opportunity for new discoveries.

The problem of teaching physics in Latin America can also be generalized in another way, to remind us of the problem of doing *anything* in Latin America. We must get at least partly involved in the special social, political, and economic problems that exist here.

All the problems come into sharper focus if there is before us a clear picture of the reasons for teaching physics in the first place. So I will try to give some reasons why I believe we should teach physics. We can then ask whether any particular educational plan is in fact satisfying any of the reasons.

The first reason is, of course, that physics is a basic science, and as such is used in engineering, chemistry, and biology, and has all kinds of applications in technology. Physics is the science, or knowledge of nature, that tells us how things work. In particular, I am stressing here how devices of various kinds–invented by men in present and forthcoming technology – work. Therefore, those who know physics will be much more useful in coping with the technical problems arising in local industry.

It might be argued, and in practice it is argued, that in the earlier stages of industrial development that we have in Latin America, such talent is completely superfluous because it is so easy to import good technically-trained personnel from more advanced countries outside. Therefore, is it really necessary to develop highly-technically-trained people locally?

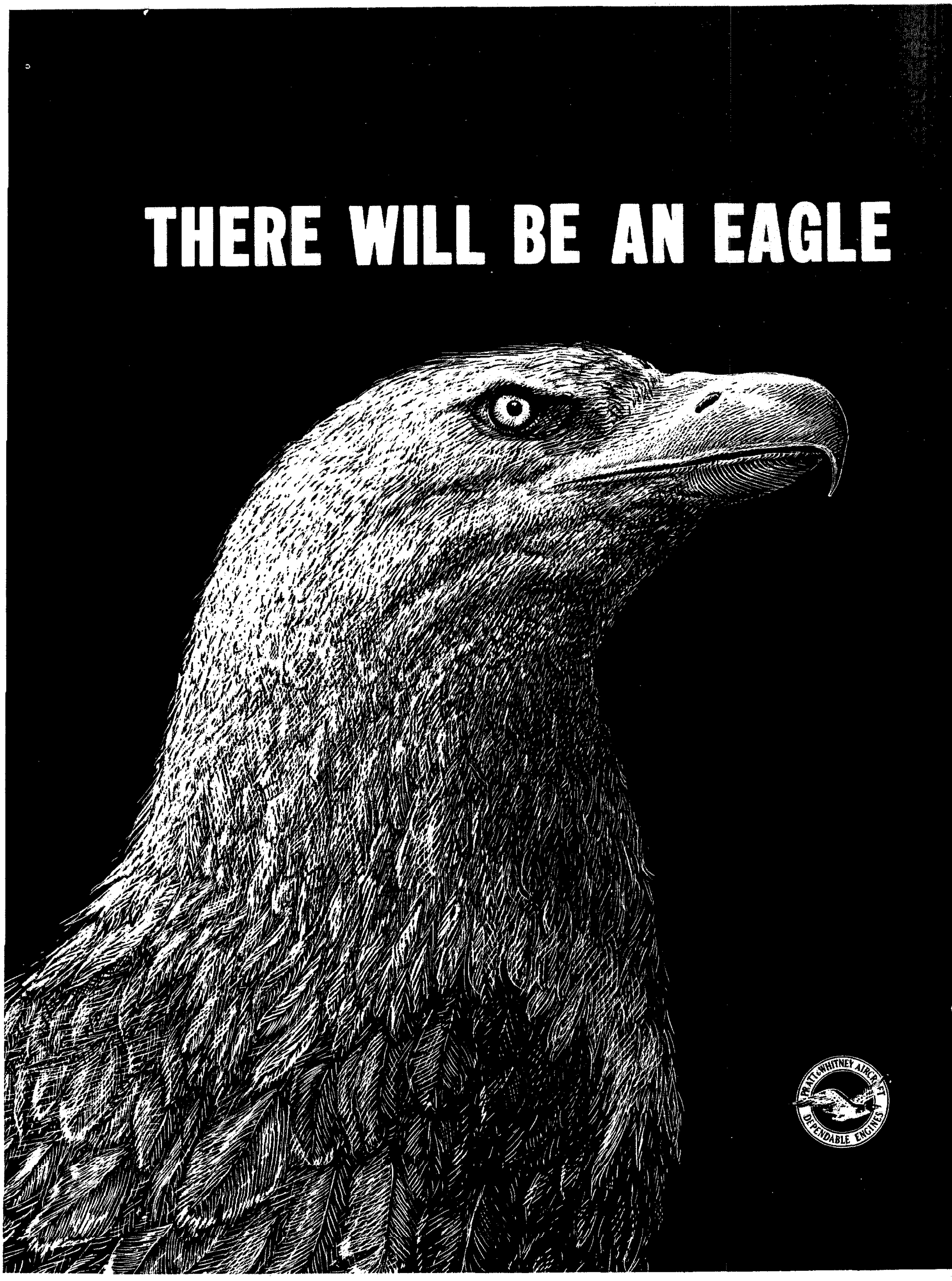
I probably do not know enough economics to answer correctly, but I will try to give an opinion anyway. I think it is vitally important to improve the technical ability of the peoples of Latin America. By education, the man with higher technical ability is able to produce more, and I believe that in the improvement of the technical ability, and thus the productivity, of the people of Latin America lies the source of real economic advancement.

It is not economically sound to continuously import technically-skilled people. If Latin American people were educated technically they would find positions in the developing industries here; it would soon be realized by the people who now import such workers that there is a supply of really able men in this country, and that this local supply has many advantages. The local people would not demand such high wages, would know the customs and ways of the country, and would be glad to take more permanent positions.

It is true that Latin Americans with the same degrees in science or engineering as their foreign counterparts seem to be very much less able. This (as I shall explain) is because they have not really been taught any science. This experience has probably conditioned industrialists to pay very little attention to the local universities and scientists. If they were wise the industrialists would see the problem quite the other way around and would be the first to clamor for a meeting of the kind we are

continued on Page 24

"The Problem of Teaching Physics in Latin America" is a transcript of the keynote speech given by Richard Feynman at the First Inter-American Conference on Physics Education in Rio de Janeiro in June 1963. Dr. Feynman is Richard Chace Tolman Professor of Theoretical Physics at Caltech.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having today, to find out what is the matter with the local product and how to teach physics in a really satisfactory manner in their countries. Yet none of them are here.

A secondary reason for teaching physics, or any experimental science, is that it incidentally teaches how to do things with your hands. It teaches many techniques for manipulating things – as well as techniques of measurement and calculation, for example – which have very much wider applications than the particular field of study.

Another major reason for teaching physics is for the science itself. Science is an activity of men; to many men it is a great pleasure and it should not be denied to the people of a large part of the world simply because of a fault or lack in the educational system. In other words, one of the reasons for teaching science is to make scientists who will not just contribute to the development of industry but also contribute to the development of knowledge, joining others in this great adventure of our times, and, of course, obtaining enormous pleasure in doing so.

Thirdly, there is good reason to study nature to appreciate its wonder and its beauty, even though one may not become an actively-working professional scientist. This knowledge of nature also gives a feeling of stability and reality about the world and drives out many fears and superstitions.

A fourth value in teaching science is to teach how things are found out. The value of questioning, the value of free ideas – not only for the development of science, but the value of free ideas in every field – becomes apparent. Science is a way to teach how something gets to be known, what is not known, to what extent things *are* known (for nothing is known absolutely), how to handle doubt and uncertainty, what the rules of evidence are, how to think about things so that judgments can be made, how to distinguish truth from fraud, and from show. These are certainly important secondary yields of teaching science, and physics in particular.

Finally, in learning science you learn to handle trial and error, to develop a spirit of invention and of free inquiry which is of tremendous value far beyond science. One learns to ask oneself: "Is there a better way to do it?" (And the answer to this is *not* the conditioned reflex: "Let's see how they do it in the United States," because there must certainly be a better way than that!) We must try to think of some new gimmick or idea, to find some improvement in the technique. This question is the source of a great deal of free independent thought, of invention, and of human progress of all kinds.

This ends my list of reasons for the teaching of physics as a science. Let me turn now to a description of some of the major characteristics of science education in Latin America which appear to me to be of special concern for us.

First, and most serious, I believe, is the almost exclusive teaching and learning by means of pure abject memory. This in no way teaches physics as a science. Nothing is understood; it is only remembered. This in no way satisfies the reasons I outlined for teaching science. Memorization of laws does not permit one to make applications of these laws to new situations; it does not permit one the pleasure of ultimately making scientific contributions; it cannot teach any techniques with the hands. From memorizing, knowledge is not understood, and the beauty of nature is not appreciated. It does not tell how things were found out, or reveal the value of an inventive free mind.

For example, the telescope is an interesting device to make, understand, look through, and play with. It turned men's ideas and minds in new directions. It gave a great impetus to the modern revolution of thought. For a long while it was the sole revealer of the vastness of the heavens and man's modest place in it. But, in Latin America one learns that there are four kinds of telescopes: the Newtonian, the Cassigranian, etc., etc. In the first, the image is virtual and inverted, etc. (I put in all this "etc." because I really don't know how many kinds of telescopes there are, or what their names are, or which way the image is in each kind. But don't underestimate me; I know a very great deal about telescopes – how they work, how to make and use one, their powers and limitations, etc.) The result is that the telescope is lost. There is no more telescope, no lenses, no stars, no eyes, no light – just words memorized without requiring understanding. The examination is passed, for the question was "What are the four types of telescopes?"

I must say immediately that I am not against memorizing. Some things, even many (though nothing special) may be learned by heart; for example, it is good, but not essential, to know by heart 7 x 8 = 56. What I oppose in any teaching philosophy is that the philosophy is used exclu-

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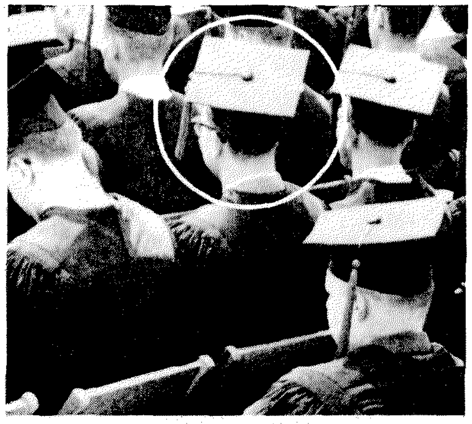

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Principal manufacturing locations in 13 cities • Operating centers in many of these same cities plus 36 others throughout the U. S. • Engineering Research Center, Princeton, New Jersey • Teletype Corporation, Skokie, Illinois, Little Rock, Arkansas • General headquarters, 195 Broadway, New York 7, New York sively; but in this case it is especially serious because so little is left of the subject.

It was incomprehensible to the people of my country when I reported how material is memorized in Latin America completely without understanding. Lectures are dictated so slowly that students can copy them word for word into their notebooks – and sentences are even repeated so they can check them back.

When asked what Brewster's Law is, advanced students answer in a flash: "Light impinging on a material of index n is 100 percent polarized with the electric field perpendicular to the plane of incidence if the tangent of the angle of incidence equals the index of refraction."

To these same students I then say, "Look out at the bay from which the sunlight is being reflected. If I look at that reflection through this piece of polaroid and turn it, what will happen?" All I receive are blank stares. No one knows. But I get cries of surprise and delight when they try it and see the reflections getting brighter and dimmer.

This shows something is completely wrong. There is no knowledge whatsoever of nature. With the wrong entrance clue the memorization is useless. These students are like books, no more. I can look in the index of a book under "Brewster's Law" and find a reference equivalent to the students' reply. But in the index I cannot find "sun reflecting on bay."

What do the students know that is not easily and directly available in a book? The things that can be looked up in a book are only a part of knowledge. Who wants such a student to work in a plant when a book requiring no food or maintenance stands day after day always ready to give just as adequate answers? Who wants to *be* such a student, to have worked so hard, to have missed so much of interest and pleasure, and to be outdone by an inanimate printed list of "laws"?

What experience I have makes me think that this is one of the main failures in the education of students in Latin America.

A second problem in Latin America is that the students are all alone. They cannot converse with other students; they cannot see how stupid some fellow students are. This is mainly for some psychological reason. They do not wish to be found unsure, for they will be ridiculed. They cannot ask questions in class because the others later say, "Why do you waste the time of all of us? Everyone knows that." So, to save face, they all put on a show of knowledge, thereby frustrating free discussion and the exchange of ideas—one of the pleasantest and easiest ways of learning things. There is too much show, and too much formality in the classroom for any exercise of free thought and discussion.

A third problem is the lack of freedom in the university structure. You cannot move around from one subject to another or from one lab to another. Those who go abroad to learn find it difficult to communicate their new knowledge easily and directly to the university students when they return—for they cannot find a place in, and are not welcomed into, the university structure. For some reason or other, it becomes necessary for such people to create new and separate research institutes. The spirit of excitement in these institutions as their research progresses is not found in the universities, and this is quite unfortunate.

Another problem in Latin America is that there is very little outlet for the students who do not want to become complete scientists. It is not easy for them to obtain jobs in the developing industries here. Perhaps if these students were really adequately trained, the companies would gradually realize their value and this problem would disappear. But some of the enthusiastic students are not geniuses, and there must be some place for them to go—even though they are not going to make any scientific contribution, or become second Einsteins.

When I began studying at MIT I started in mathematics, and probably I thought I would be a mathematician. Then I discovered that the only use of higher mathematics is to teach more higher mathematics and I turned to something more practical—electrical engineering. Finally I realized I had gone too far in the other direction and chose something in between—physics.

This was all very easy because, for such closely related subjects, the courses taken by students in each discipline were almost exactly the same and were taught by the same professors. The engineers studied physics taught by the physicists, for instance, and the physicists learned some of their electricity in a course taught by the professors of electrical engineering. It is easy for students to move back and forth among related disciplines. If physics is too difficult for them, or mathematics too abstract, they can turn to engineering and can later expect to find a position somewhere. Such

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changes are much more difficult in Latin American universities.

Another characteristic of the situation in Latin America is the small number of people involved: the result is a rapid fluctuation and irregularity in the character of organizations and institutions. How something goes depends very much on particular individuals.

Finally, we must mention the problem of the best students leaving to go to other countries. This is because of the lack of opportunities in Latin America, the climate of rigidity that exists in the universities, and the vagaries of fortune of the research institutions as their budgets find uneven support from year to year, from the government and private sources of funds.

I should now like to give some of the questions for which I think we must seek answers here.

First, how can we free the lower levels of secondary education from the drudge memorization that exists at the present time? It is well known that you can get children quite interested in science in a true, live, and active way while they are young. It is sometimes said you cannot get them interested by the time they are in the university, but this is not true—provided they have not been destroyed as thinking humans at the earlier levels.

Gibbon said: "The power of instruction is of little efficacy, except in those happy dispositions where it is nearly superfluous." This is not really true. It is true of good instruction, but bad instruction can be very efficacious indeed in impressing on one how impossibly dull some subject is. It is possible to destroy the excitement and interest that students may have gained by discovering a small book in the library, by buying a toy, a chemistry set, or a little electric motor—by playing around. In fact, one of the most important sources of motivation of interest in science is in a toy, or in a special book, and from those few teachers who are free enough from the bonds of an educational system to be able to keep children excited and inspired by supplying them with suggestions, demonstrations, and games.

It is a well known experience in education that, in spite of all plans and programs, ultimately almost everything depends on teachers—on individual teachers. You can have poor teachers and, no matter what you try to do with them, the students learn very little. Or you can have good teachers and it doesn't make much difference what you do, *provided* you leave the teacher free. So I think we must find how to free those few teachers who can be inspiring to children. It is important that those inspiring teachers work along with children, suggesting experiments and trying them freely.

The second question we shall have to try to answer is how to bring engineers and other applied scientists closer to their real world of application. It is not enough for them to remember exactly how to use the formula, providing that the situation is exactly the same as the situation was in the engineering school when the professor dictated the lecture. We must do something to make the applied engineer more flexible, so that he is effective in a wide range of applications.

One way may be to have true scientists — and especially active research experimental physicists —teaching physics to some engineering students. Experimental physics generates technical problems. To succeed, you have to work with your hands; you have to meet reality; pure memory won't do. So, people who are good at experimental physics know what engineering problems are.

The development of industrial technology is in a great measure simply the wider application of techniques which in most cases were developed by scientists trying to do experiments. This is because, in trying to do some experiment in science, you have to push some technique to the extreme. In doing so, you learn how things can be done. Experimental physicists first pursued the problems of how to make a higher vacuum or a lower temperature than ever before, and now high vacuum and low temperatures are tools of industrial technology.

Therefore, experimental science is a source of engineering and experimental science should be taught to engineers in school to keep them aware of the wide range of techniques available and the open possibilities of the future. Perhaps, then, after we have created enough real engineers with real value to industry in Latin America, industry will see that there is no advantage to hiring engineers from overseas and will want more of the locally-trained men and will support the schools with methods of teaching which produce such engineers. Then we will have the ball rolling.

I understand that the number of engineering schools in Latin America is growing rapidly. For example, in Brazil there are twice as many en-

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gineering schools as there were ten years ago. If this is the case, then maybe the problem can solve itself. If these schools are not all organized under the same system, if there is a variety in the schools, then one or another school may develop a way to produce excellent students—if the secondary school preparation has not first ruined them. Then this school will acquire a reputation, children will try to go there, other schools will try to compete and copy the better methods—and so on until the problem solves itself.

The third problem that we have here is how to encourage the true research workers and keep them from leaving home permanently. We have to supply them with books, with experimental equipment, with money for visits abroad, and with a coterie of active interested students. No, excuse me—the coterie will form automatically if the researcher is good and can get to students in any way at all.

It is imperative to encourage the true research worker who is making contributions to science to make his home base in his own country. This should not be hard because there are strong feelings of patriotism in these men; they know they have a great deal to give their country and *want* to give it. The difficulty is the terrible problems they have at home. For example, the physics research center in Rio, which is one of the leading ones in Latin America, has become isolated from the rest of the world because of a very simple thing: Nobody wants to pay for the *Physical Review* or *Nuovo Cimento.* Nobody wants to pay for the journals that can keep people informed of what happens somewhere else.

This, along with the fact that salaries are absurdly low, shows a lack of interest by the Brazilian government, people, and industry, in the development of science in this country. It is an attitude that does not respect or understand the value of these men. These creating scientists should have a dignity and a power to control their own destiny, and that of science and of science education in their countries. It will be in safe, loving hands.

It is from the fountain of research workers who understand what science is really about that the true spirit of inquiry rains onto their students, and their students' students, and ultimately, if things are organized right, permeates the entire educational system and speeds the technical development of the country.

The fourth problem, then, is how to get these research workers back into the universities where they belong. Then the "rain" will have a far easier and direct passage to the students, the new scientists of the country.

I should like to emphasize, by addressing my fifth and final question to the problem, the importance of doing any of these things in a steady, consistent, continuous, and modest way. It should not be done with a big show, the big money, with much advertising, unsupported in the future by any effective maintenance. Maintenance is lacking in many of these projects, for these things have happened before. Pulses of energy have been liberated, forward steps have been taken, only to slip back for lack of continued support. It is necessary to keep up anything that works out. It is necessary to provide a continuous, consistent, perpetual support and to make things more modest so that continuity of support can be maintained. A research group becomes world famous only after years of fruitful research. One year of no support and people drift away and there is nothing left.

I appreciate that this is a problem of great difficulty and seriousness because it involves so closely all of the social and economic circumstances in the country, and the difficulties are often (but not always) merely the reflection of the vastly more serious problems of the varying fortune of the country as a whole. Yet we ought to discuss it further here. We might try to see if there are ways to work out a scheme so that the educational system, or at least such critical parts of it as research scientists or especially good teachers, is partially independent of the variations in success of the government.

Perhaps it should not be completely supported by government. Perhaps greater efforts to obtain private funds might work. Possibly more reliance on, and contact with, more permanent institutions like religious schools might sustain the continuity of these efforts.

I have discussed the problems as directly and frankly as possible, as I see them. I don't mean to make any criticism, except in the same spirit as any discussion we shall have later will represent a criticism. For surely we shall not all find everything well with the present situation in physics education in Latin America. If so, we would not have had such a meeting. I have tried to avoid making too many specific active suggestions on how to proceed, because this is our job for the rest of this meeting.

Alumni Speak Out... II

Some random comments from the Alumni Survey questionnaire

In the 5,000 Alumni Survey questionnatres that have been returned to the Institute to date, responses to the back-page invitation for "comments" have been gratifyingly numerous. Although there is no such thing as a typical comment, some representative ones appear on these pages. Remember, however, that for every comment below, there is at least one other stating an opposite point of view.

All fancy pedagogic philosophy aside, if every professor or teacher was required to attend one speech clinic per month, 9 months a year, I feel the academic accomplishments of this nation would become historically notable.

Have always felt Tech was remiss in not offering extension type courses to keep graduates updated in general science and engineering advances through the years in more condensed form than commonly available via technical journals and periodicals covering specific areas.

I am and was too sensitive for the competitive rigors of Caltech. I needed more time to talk to women, explore educational areas, reflect on philosophy, needed more exposure to good Ivy League culture. Keen competition impaired drive to explore scientific areas on my own. Caltech o.k. for geniuses and non-sensitive types. However sensitive types are usually more creative. Caltech impairs creativity in bottom 90%.

Physics should be deleted from the underclass curricula, being replaced by humanities and an applied mathematics course, which should emphasize problem-solving and applications to all branches of engineering and science. The physics courses were awkward and inefficient because the student had not received sufficient mathematical training.

I often felt that Caltech was not the place I should be since I wasn't particularly interested in becoming an intellectual scientist. I wanted to know the things a scientist knows so I would then know how things should be done, but the working out of problems with no immediate use for the answer was not of much interest. With the stress that Caltech placed on the intellectual rather than the pragmatic pursuit of knowledge I often felt that I was not really the type of student desired there. It gave me a feeling of insecurity which affected my studies. Though I have already noted that if I had it to do all over again I would attend Caltech, I would like to qualify that by saying that if Caltech were interested in training me to become an *engineer* I again would like to attend, but if Caltech continues to stress training for theoretical scientists with the expectation that most will go on to obtain PhD degrees I would rather go to another college.

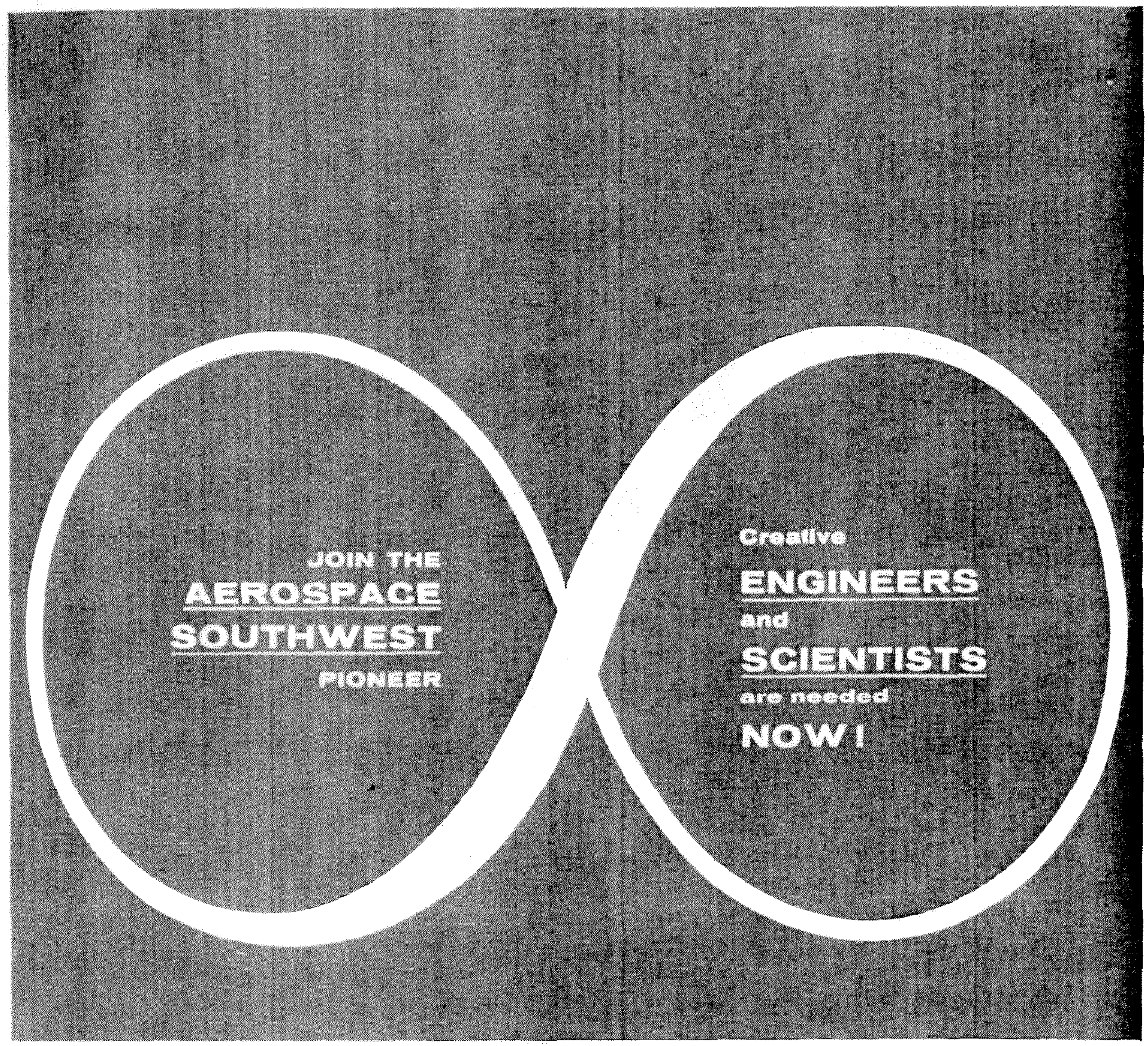
How long has it been since an outstanding scientist or engineer spoke at the graduation banquet, rather than a corporate or military big shot?

It was my strong feeling while I was at Caltech – and it still is – that the use of graduate students and/or researchers for teaching *undergraduate* courses should be eliminated.

The normal shock of transition between high school and college, plus the abnormally difficult load imposed on the undergraduate by the Caltech curriculum entitle the student, I think, to the most competent and most experienced teachers available at Caltech – namely bona fide professors.

The present practice vis-a-vis graduate student teachers may be good experience for them but is certainly hard on many undergraduates!

I was not an undergraduate at Caltech. The undergraduates there seemed characterized by a vast technical egotism – a belief that they had all the answers, which they would deliver to an eager world as soon as they were graduated. This lack of technical humility must give them (and their employers) some nasty shocks when they start trying to cause real hardware to obey in the desired fashion.



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GENERAL DYNAMICS | FORT WORTH

Personals

1931

CAPTAIN PERRY M. BOOTHE, MS'32, has been stationed for the past three years in the Navy's Bureau of Yards and Docks in Washington, D.C. He has now been appointed director of the Bureau's European-Mid East Division and is in charge of maintenance and construction at Navy installations throughout the European and Mediterranean areas.

The Boothes have a son, Thomas, 13, in high school in London, and a daughter, Lorraine, who graduated from Western Washington College in Bellingham last June. She now plans to get an MS from the Royal Academy of Dramatic Arts in London. Allen, their oldest son, is married and has a son, 2. Allen is a lieutenant in the Civil Engineer Corps, U.S.N., and is assistant resident officer-in-charge of construction for a NASA project at Seal Beach, Calif.

GEORGE LANGSNER, assistant state highway engineer in administration for the State of California in Sacramento, has been promoted to deputy state highway engineer. He has been with the Division of Highways since 1931.

1933

JOHN R. PIERCE, MS '34, PhD '36, executive director of research in the communications principles and communications systems divisions of the Bell Telephone Laboratories, is co-recipient of the Arnold Air Society's General Hoyt S. Vandenberg Award for 1963. This is the first time the award has been given. Pierce was cited for his "contributions to space age research and development in the field of communications"—including Telstar.

1934

WILLIAM BOLLAY, MS, PhD'36, construction engineer and founder of the Aerophysics Development Corporation in Santa Barbara, is back in Santa Barbara after a year as visiting professor of astronautics at MIT. Under his guidance, 60 graduate students carried out the preliminary design of a new equatorial weather satellite system. Because of the novel features of the system, the U.S. Weather Bureau requested Bill and five of his students to make a special presentation of the idea to the chief of the Weather Bureau and the weather satellite leaders of NASA, in July.

1941

Robert E. Rundle, PhD, professor of chemistry at Iowa State University, died on October 9 at Iowa Methodist Hospital in Des Moines, after suffering a stroke.

He had been at Iowa State since 1941 and was a senior chemist in the Atomic Energy Commission's Ames Laboratory. He was known for his work on the structure of starches, uranium, and other heavy elements.

CAPTAIN DONALD C. CAMPBELL, USN, is the new commanding officer and director of the US Naval Radiological Defense Laboratory in San Francisco. He has been in the Navy since 1941, and was director of the Laboratory Management Division of the Bureau of Ships prior to the new appointment. The Campbells have four children: Laure, 17; Bruce, 14; John, 6½; and Wayne, 4.

EBERHARDT RECHTIN, PhD '50, assistant director of the Deep Space Instrumentation facility at JPL, was co-recipient of a $5,000 NASA award last summer for his work in space communications systems. Walter K. Victor, chief of the JPL Telecommunications Division, shared the award with Rechtin for a series of electronic devices which has revolutionized the field of deep space communications. Starting in 1953, when JPL was working on the Corporal and Sergeant missiles for the U.S. Army, the two men developed a radio guidance system that was immune to enemy interference.

1947

COL. CHARLES M. DUKE, MS, chief of supply and logistics for the Army's First Corps Group in Korea, has been named District Engineer Commissioner in Washington, D.C., by President Kennedy. The Dukes have one son, Charles, 18, who attends the Valley Forge Military Academy, and a daughter, Allyson, 13, in high school.

1948

GEORGE L. HUMPHREY, MS, is now acting chairman of the department of chemistry at West Virginia University in Morgantown. The Humphreys have three children: Denton, 13; Lynn, 9; and Alita, 7.

KEITH W. HENDERSON, member of the research laboratory of Lockheed Missiles and Space Company in Palo Alto, is now chapter president of the Peninsula Chapter of the California Society of Professional Engineers. He has served for the past four years successively as secretary, second vice president, and for two terms, first vice president.

1951

FREDERICK T. RALL, JR., MS, is at MIT for a year, studying management on an Alfred P. Sloan Fellowship. He is chief of the aerodynamics branch of the B-70 engineering office of the Aeronautical Systems Division of the Air Force Systems Command at Wright-Patterson Air Force Base in Ohio.

ARTHUR B. LEAK, MS, research project supervisor of the Applied Physics Laboratory of Johns Hopkins University, died on May 24 at the National Institutes of Health Cancer Clinic. He was 34.

Leak had been an aeronautical engineer and staff member of the laboratory at Silver Spring since 1957 and was credited with several significant contributions to the dynamics analysis and missile systems development effort for the Navy. His early research at the laboratory helped unravel some of the problems of missile launching aerodynamics. His theoretical research and analysis pointed the way to more effective use of warheads destined for a submarine air defense.

Leak was working toward his PhD at the University of Maryland when he became ill. He is survived by his wife.

GEORGE C. DACEY, PhD, has been named executive director of the telephone and power division of Bell Telephone Laboratories in Holmdel, N.J. He has been on leave from the Laboratories since 1961 to serve as vice president of research at the Sandia Corporation. The Daceys have three children – Donna, John, and Sarah.

1952

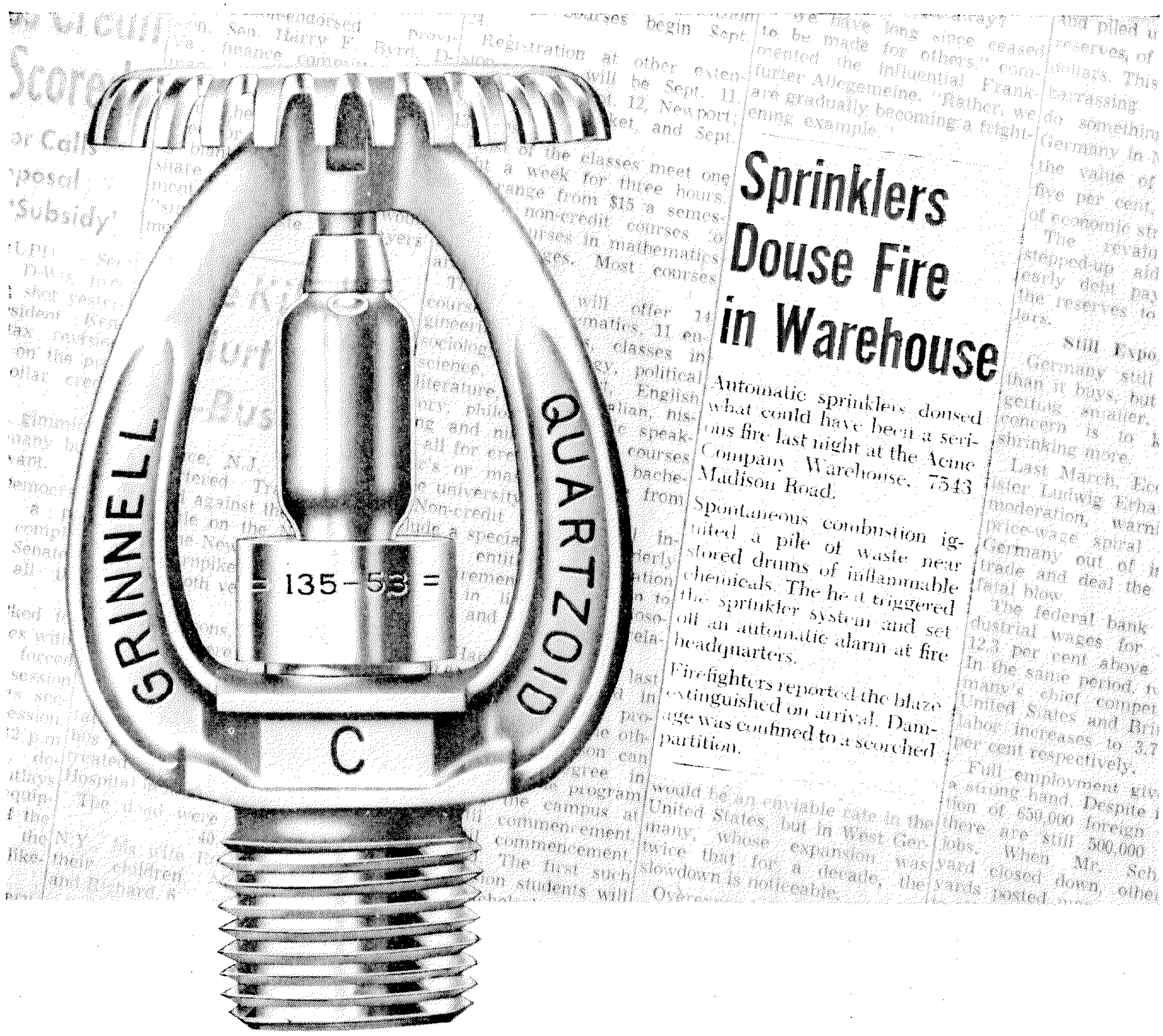
MARTIN GOLDSMITH, MS, PhD '55, currently on loan to the Air Force's Project Forecast, has been appointed staff engineer in the engineering division of Aerospace Corporation's El Segundo technical operations. He has been with the corporation since 1961. Before joining Aerospace, he spent six years as a specialist in propulsion applications in the RAND Corporation's aeroastronautics department. Prior to this, he was associated with JPL. The Goldsmiths and their son live in Malibu.

1954

HOWARD L. CROSWHITE is now section supervisor for the engineering and research staff of the Ford Motor Company's transmission and chassis division in Dearborn, Mich. He has been with the company since 1954. The Croswhites have two children, Linda, 7 and Steven, 4.

1962

JOHN E. FISCHER, MS, graduate student at Rensselaer Polytechnic Institute, was married to Linda Mammano on June 15 in Beacon, N.Y.



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Lost Alumni

The Institute has no record of the present addresses of these alumni. If you know the current address of any of these men, please contact the Alumni Office, Caltech.

1906
Norton, Frank E.

1907
Miller, James C., Jr.

1911
Lewis, Stanley M.

1918
Lavagnino, John F.

1921
Arnold, Jesse
Seaver, Edward D.

1922
Bruce, Robert M.
Cox, Edwin P.
Cronin, John A.
Rose, Edwin L.

1923
Hickey, George I.
Skinner, Richmond H.

1924
Henderson, William G.
Tracy, Willard H.
Young, David R.

1925
Waller, Conrad J.
Winckel, Edmond E.

1926
Chang, Hung-Yuan
Yang, Kai Jin

1927
Evjen, Haakon M.
Marsland, John E.
Moore, Bernard N.
Peterson, Frank F.
Riggs, Eugene H.

1928
Chou, P'ei-Yuan
Martin, Francis C.
Morgan, Stanley C.
Wingfield, Baker

1929
Briggs, Thomas H., Jr.
Burns, Martin C.
Lynn, Laurence E.
Nelson, Julius N.
Robinson, True W.
Wolfe, Karl M.

1930
Allison, Donald K.
Chao, Chung-Yao
Forney, Morgan T.
Moyers, Frank N.
Shields, John C.
White, Dudley

1931
Hall, Marvin W.
Ho, Tseng-Loh
West, William T.
Yoshioka, Carl K.

1932
Patterson, J. W.
Schroder, L. D.

1933
Applegate, Lindsay M.
Downie, Arthur J.
Koch, A. Arthur
Larsen, William A.
Leeds, William L.
Michal, Edwin B.
Murdock, Keith A.
Rice, Winston R.
Shappell, Maple D.
Smith, Warren H.

1934
Core, Edwin J.
Harshberger, John D.
Liu, Yun Pu
Moore, Morton E.
Rassieur, William T.

1935
Bertram, Edward A.
Huang, Fun-Chang
McCoy, Howard M.
McNeal, Don
Ricketts, Donald H.

1936
Chu, Djen Yuen
Kelch, Maxwell
Ohashi, George Y.
Van Riper, Dale H.
Young, Larry L.

1937
Burnight, Thomas R.
Cheng, Ju-Yung
Easton, Anthony
Fan, Hsu Tsi
Jones, Paul F.
Lotzkar, Harry
Maginnis, Jack
Munier, Alfred E.
Nojima, Noble
Odell, Raymond
Penn, William Lee
Servet, Abdunrahim
Shaw, Thomas N.
Wylie, Jean

1938
Gershzohn, Morris
Goodman, Hyman D.
Gross, Arthur G.
Gutierrez, Arnulfo G.
Kanemitsu, Sunao
Li, Yuan Chuen
Lowe, Frank Clare
Rhett, William
Rynearson, Garn A.
Tilker, Paul O.
Tsao, Chi-Cheng
Wang, Tsun-Kuei
Watson, James W.
Woodbury, William W.

1939
Aime, Edgar A.
Brown, William L.
Gombotz, Joseph J.
Green, William J.
Hsueh, Chao-Wang
Jackson, Andrew M., Jr.
Kazan, Benjamin
Liang, Carr Chia-Chang
Tsien, Hsue-shen
Weinstein, Joseph
Wilson, Harry D.

1940
Abraham, Lewis
Batu, Buhtar
Compton, Arthur W.
Gentner, William E.
Gibson, Arville C.
Hsu, Chang-Pen
Karubian, Ruhollah Y.
King, James L.
Lovoff, Adolph
Menis, Luigi
Paul, Ralph G.
Tao, Shih Chen
Torrey, Preston C.
Wang, Tsung-Su

1941
Clark, Morris R.
Dieter, Darrell W.
Easley, Samuel J.
Geitz, Robert C.
Gould, Martin
Green, Jerome M.
Hardenbergh, George A.
Harvey, Donald L.
Helmick, Benjamin W.
Hubbard, Jack M.
Kuo, I. Cheng
Nicholson, George H.
Noland, Robert L.
Robinson, Frederick G.
Standridge, Clyde T.
Taylor, D. Francis
Vaughan, Richard
Wolfe, Samuel
Yui, En-Ying

1942
Bebe, Mehmet F.
Callaway, William F.
Devault, Robert T.
Drake, John A.
Emre, Orhan M.
Go, Chong-Hu
Hughes, Vernon W.
Johnston, William C.
Levin, Daniel
MacKenzie, Robert E.
Martinez, Victor H.
Proctor, Warren G.
Widenmann, John A.

1943
Angel, Edgar P.
Bridgland, Edgar P.
Brown, Glenn H., Jr.
Brown, James M.
Bryant, Eschol A.
Burlington, William I.
Carlson, Arthur V.
Colvin, James H.
Eaton, Warren V., Jr.
Gaffney, Thomas A.
Gould, Jack E.
Hamilton, William M.
Hillyard, Roy L.
Hilsenrod, Arthur
Johnsen, Edwin G.
King, Edward G.
Koch, Robert H.
Kong, Robert W.
LaForge, Gene R.
Lee, Edwin S., Jr.
Ling, Shih-Sang
Lobban, William A.
Lundquist, Roland E.
McNeil, Raymond F.
Mampell, Klaus
Mixsell, Joseph W.
Mowery, Irl H., Jr.
Nesley, William L.
Neuschwander, Leo Z.
O'Brien, Robert E.
Patterson, Charles M.
Pearson, John E.
Rivers, Nairn E.
Roberts, Fred B.
Rupert, James W., Jr.
Scholz, Dan R.
Shannon, Leslie A.
Smitherman, Thomas B.
Tindle, Albert W., Jr.
Vicente, Ernesto
Waldrop, Nathan S.
Walsh, Joseph R.
Washburn, Courtland L.
Weis, William T.
Wheeler, Rodney S.
Wood, Stanley G.

1944
Alpan, Rasit H.
Baranowski, John J.
Barriga, Francisco D.
Bell, William E.
Benjamin, Donald G.
Berkant, Mehmet N.
Birlik, Ertugrul
Burch, Joseph E.
Burke, William G.
Cebeci, Ahmed
Clendenen, Frank B.
Cooke, Charles M.
DeMedeiros, Carlos A.
Fu, Ch'eng Yi
Harrison, Charles P.
Hu, Ning
Johnson, William M.
Labanauskas, Paul J.
Leenerts, Lester O.
Lin, Chia-Chiao
Mapel, Robert W.
Mattinson, Carl O.
Onstad, Merrill E.
Pi, Te-Hsien
Pischel, Eugene F.
Ridlehuber, Jim M.
Rutland, David F.
Shults, Mayo G.
Stanford, Harry W.
Stein, Roberto L.
Sullivan, Richard B.
Sunalp, Halit
Trimble, Wm. M.
Unayral, Nostafa A.
Wadsworth, Joseph F., Jr.
Wight, D. Roger
Williams, Robert S.
Wolf, Paul L.
Writt, John J.
Yik, George

1945
Ari, Victor A.
Bryner, Dean L.
Budney, George S.
Bunze, Harry F.
Clementson, Gerhardt C.
Dixon, Thomas F.
Fanz, Martin C.
Fox, Harrison W.
Gibson, Charles E.
Grossling, Bernardo F.
Jenkins, Robert P.
Knapp, Norman E.
Kuo, Yung Huai
Levy, Charles N.
Rice, Jonathan F.
Tseu, Payson S.
Turkbas, Necat
Yank, Frank A.

1946
Allison, Charles W., Jr.
Barber, John H.
Behroon, Khosrow
Bowen, Mark E.
Burger, Glenn W.
Chen, Ke-Yuan
Dethier, Bernard
Dougherty, Chas. B.
Dyson, Jerome P.
Esner, David R.
Foster, R. Bruce
Gould, Edwin S.
Halvorson, George G.
Hoffman, Charles C.
Huestis, Gerald S.
Ingham, John S.
Ingram, Wilbur A.
Jacobsen, John R.
KeYuan, Chen
Lewis, Frederick J.
Lowery, Robert H.
Maxwell, Frederick W.
McConnaughhay, James W.
Miller, Jack N.
Olsen, Leslie, R.
Parker, James F.
Prasad, K. V. Krishna
Rice, Jerry H.
Salbach, Carl K.
Shepard, Elmer R.
Sledge, Edward C.
Smith, Harvey F.
Stephenson, Robert E.
Tung, Yu-Sin
Webb, Milton G.
Winson, Jonathan

1947
Asher, Rolland S.
Atencio, Adolfo J.
Atkinson, Paul G., Jr.
Brown, Raymond A.
Clarke, Frederic B.
Clements, Robert E.
Collins, Hugh H.
Dagnall, Brian D.
Darling, Donald A.
Darling, Rodney O.
Hammerle, William G.
Heppe, Ralph R.
Hsu, Chi-Nan
Huang, Ea-Qua,
Lane, James F.
Leo, Fiorello R.
Lim, Vicente H., Jr.
MacAlister, Robert S.
McClellan, Thomas R.
Manoukian, John
Molloy, Michael K.
Moorehead, Basil E. A.
Olson, Raymond L.
Orr, John L.
Ray, Kamalesh
Rust, Clayton A.
Sanders, Lewis B.
Sappington, Merrill H.
Schroeder, Henry W.
Thompson, Russell A.

Lost Alumni . . . *continued*

Torgerson, Warren S.
Wan, Pao Kang
Wellman, Alonzo H., Jr.
Wimberly, Clifford M.
Winters, Edward B., Jr.
Ying, Lai-Chao

1948

Agnew, Haddon W.
Bunce, James A.
Clark, Albert R.
Collins, Burgess F.
Cotton, Mitchell L.
Crawford, William D.
Herold, Henry L.
Holm, John D.
Hsiao, Chien
Hsieh, Chia Lin
Lambert, Peter C.
Latson, Harvey H., Jr.
Lawton, G.
Leavenworth, Cameron D.
Mason, Herman A.
Mooney, Harold M.
Oliver, Edward D.
Rhynard, Wayne E.
Stein, Paul G.
Swain, John S.
Voelker, William H.
Winniford, Robert S.
Woods, Marion C.
Wray, Robert M.
Yanak, Joseph D.

1949

Abramovitz, Marvin
Barker, Edwin F., Jr.
Bauman, John L., Jr.
Baumann, Laurence I.
Bottenberg, William R.
Brown, John R.
Bryan, Wharton W.
Cheng, Che-Min
Clancy, Albert H.
Clendening, Herbert C.
Cooper, Harold D.
Dodge, John A.
Felt, Gaelen L.
Foster, Francis C.
Galstan, Robert H.
Hardy, Donald J.
Heiman, Jarvin R.
Krasin, Fred E.
Krauss, Max
Leroux, Pierre J.
Lowrey, Richard O.
MacKinnon, Neil A.
McElligott, Richard H.
Merrell, Richard L.
Parker, Dan M.
Petty, Charles C.
Rinehart, Marion C.
Ringness, William M.
Saari, Albert E.
Sinker, Robert A.
Stappler, Robert F.
Weiss, Mitchell
Wilkening, John W.
Yu, Sien-Chiue

1950

Bryan, William C.
Edelstein, Leonard
Forrester, Herbert A.
Gimpel, Donald J.
Li, Chung Hsien
McDaniel, Edward F.
McMillan, Robert
Mesara, R. Reha
Montemezzi, Marco A.
Pao, Wen Kwe
Paulson, Robert W.
Petzold, Robert F.
Scherer, Lee R., Jr.
Schmidt, Howard R.
Soldate, Albert M.
Whitehill, Norris D.

1951

Arosemena, Ricardo M.
Cheng, Kwok Ying
Davison, Walter F.
Denton, James Q.
Goodell, Howard C.
Hawk, Riddell L.
Lafdjian, Jacob Parseh
Li, Cheng-Wu
Merkel, George
Padgett, Joseph E., Jr.
Palmer, John M., Jr.
Sjodin, Raymond A.
Sunderlin, Joseph E.
Summers, Allan J.

1952

Abbott, John R.
Arcoulis, Elias G.
Bucy, Smith V.
Harrison, Marvin E.
Helmer, John C.
Helmuth, James G.
Kitching, Gilbert E.
Krause, Dale C.
Loftus, Joseph F.
Long, Ralph F.
Lunday, Adrian C.
Meyer, Robert F.
Primbs, Charles L.
Robieux, Jean
Robison, William C.
Schaufele, Roger D.
Shelly, Thomas L.
Sutton, Donald E.
Wiberg, Edgar
Wilson, Howard E.
Woods, Joseph F.
Zacha, Richard B.

1953

Crespo, Manuel J.
Elliott, David D.
Lennox, Stuart G.
Robkin, Morris A.
Schroeder, Norman M.
Wilburn, Norman P.

1954

Billings, John T.
Coughlin, John T., II
Feuchtwang, Thomas E.
Graves, Jack C.
Guebert, Wesley R.
Heiser, David A.
Mertz, Charles, III
Rogers, Berdine H.
Seele, Gordon D.
Sergeyevsky, Andrew
Von Gerichten, Robert L.

1955

Campbell, Douglas D.
Crowe, Thomas H.
Engels, Eugene
Lim, Macrobio
Moore, William T.
Roman, Basil P.

1956

Edwards, Robert W.
Frignac, Jean-Paul
Garnault, Andre F.
Goldenberg, H. Mark
Kelly, James L.
McAllister, Don F.
Spence, William N.
Sugai, Iwao
Tang, Chung-Liang

1957

Bloomberg, Howard W.
Brust, David
Furumoto, Warren A.
Goebel, Charles V.
Howie, Archibald
Schwartz, Lowell M.
Stuteville, Joseph E.
Wong, Chi-hsiang

1958

Ackley, David A.
Chang, Berken
Donoho, Paul L.
Dundzila, Antanas V.
Jones, Laurence G.
Kern, William M.
Knight, Harold G.
Saffouri, Mohammad H.
Wille, Milton G.

1959

Bailey, John S.
Byuan, Chai B.
Guillemet, Michel P.
Gustafson, Harold R.
Idriss, Izzat M.
Irons, Edgar T.
Lallemet, Robert G.
Lange, Gordon D.
Monroe, Louis L.
Muraoka, Kenneth A.
Weber, Walter V., Jr.

1960

Dym, Harry
Lindquist, David M.
Mauger, Richard L.
Farha, Norman S.

1961

Dombey, Norman
Hemphill, Lewis W.
Richter, Rolf
Steinberg, Charles M.

1962

Dorlhac, Jean-Pierre

1963

Luttermoser, Robert L.

EN GARDE!

Last month we announced our intention to describe in Engineering and Science *a variety of important Institute needs. This month's article is the first of a series.*

Recently we talked with Hal Musselman about current athletic facility requirements. Hal, you know, is Director of Physical Education and Athletics at Caltech. He told us, "We're very proud of our athletic plant. Our gymnasium is the newest and finest in the Conference. However, there are two recent developments which have shown us that we're reaching a saturation point in our ability to meet all the demands imposed on us. First, there has been an increase in the number of students and faculty and, secondly, more and more different activities are being undertaken.

"Last year we entered the intercollegiate wrestling field, and this year we are holding fencing classes for the first time. In addition, sports such as tennis, volleyball, golf, karate, and handball are showing an upsurge of interest."

In essence, Hal was telling us that the Athletic Department could very easily use another building, practically as large as the present gymnasium. The increase of participation in so-called "minor" sports has presented this pleasant dilemma. Right now, the fencing class must meet in Culbertson Hall, the karate group (in fair weather) on the Tournament Park field, and the wrestling team is forced to practice during the normal *dinner hour!*

We're aware, of course, that individual Alumni Fund contributions won't cover the cost of another building (first estimates are in the $800,000 range). But we feel that the total of funds earmarked for athletic facilities can aid in some other important ways. Let's look at a few items:

- The wrestling team does not have a regulation mat for practice or matches. For $1800, the Athletic Department could purchase a mat.

- Coach Lee Andrews' soccer team practices in the late afternoon. In October and November, this means that they practice *in the dark.* Lighting the soccer field for practice would cost $5000.

- The tennis courts are heavily used the year round. Each year two of the courts must be re-stained, at a cost of $1000. This is a continuing item, and must be budgeted each year. Incidentally, many alumni get a lot of enjoyment from the use of the courts.

- We could also mention such items as filling and crowning the football field, periodic refinishing of the basketball floor, or improving the public address system in the swimming pool area. These are things which should be done, and which should be included in the Institute's operating budget.

The demands on Caltech's athletic facilities are many and varied, as is the case at any great university. Perhaps only an alumnus can look back and recognize the full value received from the use of those facilities. Alumni, students, and faculty all recognize that athletics and physical education are a vital and integral part of the Institute's program and, as such, merit our consideration and support. If your interests lie in this area, a gift directed toward athletic facilities will be greatly appreciated.

– *G. Russell Nance '36 and David L. Hanna '52*
Directors of the Caltech Alumni Fund

CALTECH CALENDAR

ALUMNI EVENTS

November 16 Alumni Dinner and Interhouse Dance

ATHLETIC SCHEDULE

Football

November 15
Caltech at Occidental

November 22
Claremont-Harvey Mudd at Rose Bowl

CALTECH YMCA ATHENAEUM LUNCHEON FORUM

Reservations by Tuesday noon

November 27
America and Europe: The End of the Affair
—Cushing Strout

December 4
Are Unions Becoming Too Powerful?
—Ralph Helstein

FRIDAY EVENING DEMONSTRATION LECTURES

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

November 15
Radio Astronomy
—Richard B. Read

November 22
Activity of the Chromosomes
—Ru-Chih Huang

December 6
How Atoms Arrange Themselves in Beautiful Patterns in Complex Metal Crystals
—Sten O. Samson

December 13
Scanning Patterns of the Eye
—Derek Fender

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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:

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☐ 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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Luncheon first Friday of each month at noon.
Visiting alumni cordially invited—no reservation.

Dr. E. W. Hughes
131 Crellin

FV

COULD YOU OUT-THINK A COMPETITOR?

Consider a Career in Technical Marketing

An Interview with G.E.'s J. S. Smith, Vice President, Marketing and Public Relations

Mr. Smith is a member of General Electric's Executive Office and is in charge of Marketing and Public Relations Services. Activities reporting to Mr. Smith include marketing consultation, sales and distribution, marketing research, marketing personnel development, and public relations as well as General Electric's participation in the forthcoming New York World's Fair. In his career with the Company, he has had a wide variety of assignments in finance, relations, and marketing, and was General Manager of the Company's Outdoor Lighting Department prior to his present appointment in 1961.

For more information on a career in Technical Marketing, write General Electric Company, Section 699-08, Schenectady, New York 12305.

Q. Mr. Smith, I know engineering plays a role in the design and manufacture of General Electric products, but what place is there for an engineer in marketing?

A. For certain exceptionally talented individuals, a career in technical marketing offers extraordinary opportunity. You learn fast what the real needs of customers are, under actual industrial conditions. You are brought face-to-face with the economic realities of business. You participate in some of the most exciting strategic work in the world: planning how to out-engineer and out-sell competitors for a major installation.

Q. Sounds exciting. But I've worked hard for my technical degree. I'm worried that if I go into marketing, I won't use it.

A. Don't worry—you'll use all the engineering you've learned, and you'll go on learning for the rest of your life. In fact, you'll have to. You see, the basic purpose of business is to sense changing customer needs, and then marshal resources to meet them profitably. That means that you must learn to know each customer's operations and needs almost as well as he understands them himself. And with competitors trying their best to outdo you, believe me—every bit of knowledge and skill you've got will be called into play.

Q. Is that why you said you wanted "exceptionally talented people"?

A. Technical marketing is not everybody's dish of tea. It takes great personal drive and energy, and a talent for managing the work of others in concert with your own. It takes flexibility . . . imagination . . . ingenuity . . . quick reflexes . . . leadership qualities. If you're nervous with people or upset by quick-changing situations, I don't think technical marketing's for you. But if you are excited by competition, like to help others solve technical problems, and enjoy seeing your technical work put to the test of real operation—then you may be one of the ambitious men we're looking for.

Q. Now what, actually, does a man do in technical marketing?

A. Let me describe a typical situation in General Electric. A field sales engineer is in regular contact with his customers. Let's say one of them makes an inquiry, or the sales engineer senses that the time is right for a proposition. With his field application engineer, he determines the basic equipment needed. Then he contacts the marketing sales specialist in the G-E department that manufactures that equipment. The sales specialist, working closely with his department's product engineers, specifies an exact design—realistic in function and cost. Then the sales engineer and his supporting team try to make the sale, changing and improving the proposition as they get cues from the competitive situation. If the sale is made—a very satisfying moment—then the installation and service engineers install the equipment and are responsible for its operation and repair. With the exception of the product design engineers, all these people are in technical marketing. Exciting work, all of it.

Q. In college we learn engineering theory. How do we get the sales and business knowledge you mentioned?

A. At General Electric, a solid, well tested program of educational courses will quickly advance both your engineering knowledge and your sales capacities. But perhaps even more important, you'll be assigned to work with some of the crack sales engineers and application and installation men in the world, and that's no exaggeration. A man grows fast when he's on the sales firing line. As a FORTUNE writer once put it, the industrial sales engineer needs "that prime combination of technical savvy, tactical agility, and unruffled persuasiveness." Have you got what it takes?

699-08

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