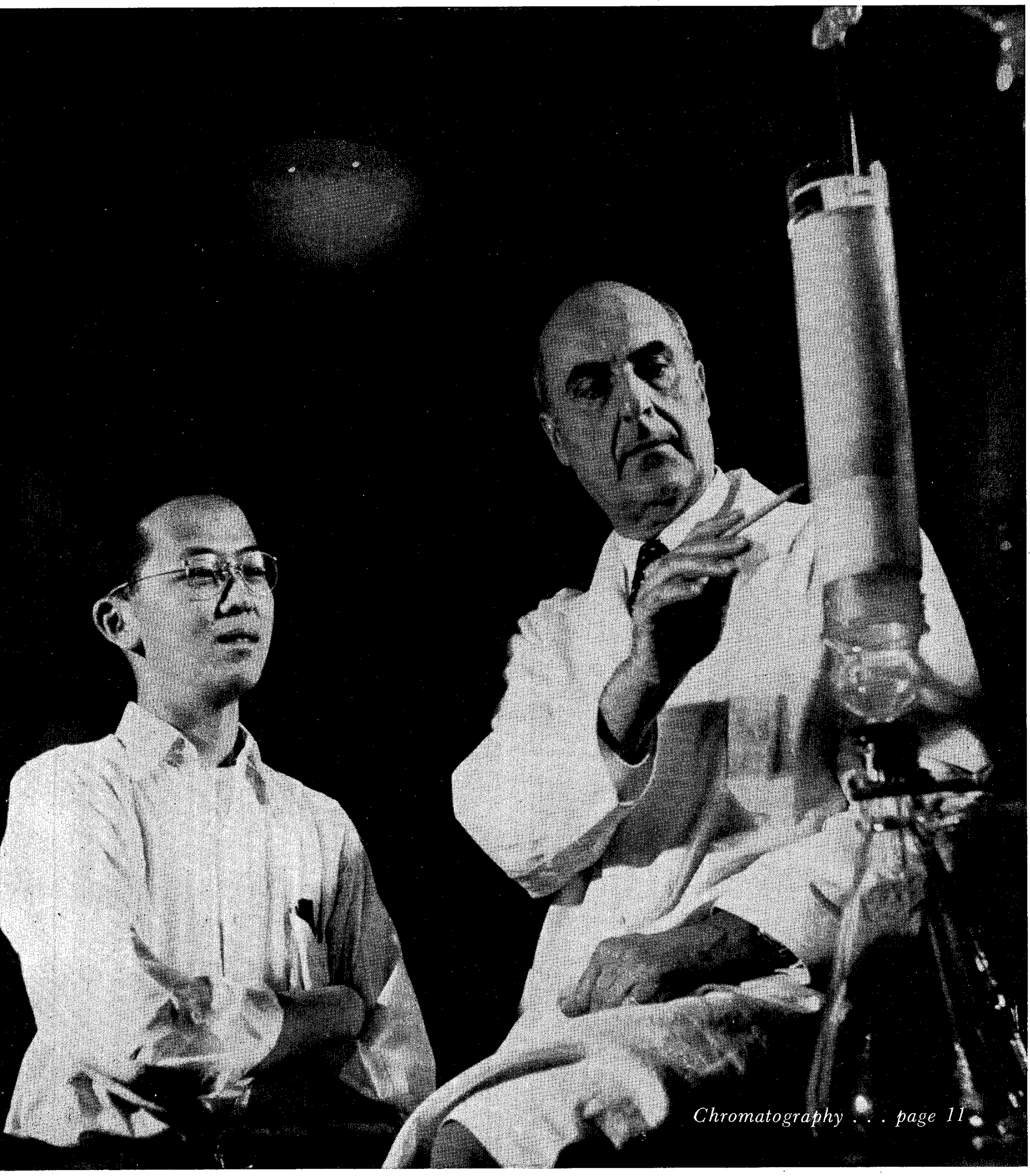
# ENGINEERING AND SCIENCE

March 1950



Chromatography . . . page 11

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

# How to make 31,000 people happy

One of the biggest single housing developments ever undertaken has taken its place in the panorama of New York City's lower East Side. It is the result of cooperation between private enterprise, the State, and the City.

The rise of Peter Cooper Village and adjacent Stuyvesant Town has changed the face of this 80-acre section of Manhattan . . . has transformed a slum area of tenements and factories into modern, roomy living quarters for 31,000 people.

Many similar projects . . . some perhaps not so large, some even larger . . . must take form before America licks its housing problem. And they'll all require vast quantities of steel, for steel is the backbone of modern construction.

Today the steel industry is looking ahead toward tomorrow's big projects. At United States Steel, a vast training program is going forward continually, preparing men to handle the many highly-technical jobs that modern steelmaking involves. Many of these jobs are far removed physically from the roaring blast furnaces and glowing open hearths —at the same time, they are absolutely essential to today's precision steelmaking.

Through its training program, United States Steel is laying the foundations for promising futures for young men who meet its qualifications.

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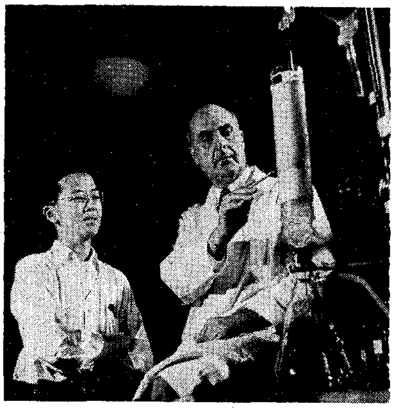

## In this issue

**On the cover** this month Dr. Laszlo Zechmeister, Professor of Organic Chemistry at the Institute, is performing a chromatographic experiment— to the edification and delight of Kenneth Koe, graduate student in chemistry. More specifically, Dr. Zechmeister is pointing out a colored zone on a column which looks like a *pousse café* but is actually composed of powdered lime. The story of chromatography, which is becoming an increasingly important technique for both chemists and biologists, is on page 11 of this issue.

### Profit Engineering

Robert J. Barry, author of "Profit Engineering," on page 8, received his B. S. in Mechanical Engineering from the Institute in 1938. After several years' experience in the fields of production and industrial engineering, Bob became a consulting industrial engineer in 1945. He specializes in the fields of variable budget control and the installation of incentive plans, and has recently established such plans at the Fluor Corporation, the Domestic Thermostat Co., and the Mission Appliance Corp. in Los Angeles—where he maintains his office.

**PICTURE CREDITS**

Cover—Ross Madden-Black Star

p. 11—Bill Wright '51

p. 13—Ross Madden-Black Star

p. 15—Bill Wright '51
C. M. Stearns
Pasadena Star-News

p. 16—C. M. Stearns

# ENGINEERING AND SCIENCE MONTHLY

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# BOOKS

**THE MEANING OF RELATIVITY (Third Edition)**

**by Albert Einstein**
**Princeton University Press, N.J., 150 pp. $2.50**

*Reviewed by H. P. Robertson*
*Professor of Mathematical Physics*

THIS THIRD EDITION of Einstein's 1921 Stafford Little Lectures at Princeton again makes available a concise treatment of his relativity theories—a treatment of the fundamental principles which has never been surpassed for brevity and clarity. The present edition retains the appendix on the cosmological problem, which was prepared for the 1945 edition, and adds a second appendix containing a brief fifteen page account of the author's current investigations on the generalized theory of gravitation.

The scope and content of the original lectures are adequately indicated by their titles and a brief mention of their subject matter:

"Space and Time in Pre-relativity Physics" reviews the basic concepts of the Newtonian theory of mechanics and the Maxwellian theory of electromagnetism, in a tensorial form appropriate for extension to the relativity theories.

"The Special Theory of Relativity" deals with the removal of the discrepancy between these two classical theories, in terms of the four dimensional space-time framework based upon the experimental work of Michelson and Morley and the theoretical investigations of Lorentz, Einstein and Minkowski.

The last two of the original lectures are devoted to "The General Theory of Relativity," a theory of gravitation which achieves the identification of gravitational and inertial mass. An account is given of the well-known observational tests of this theory, with their minute deviations from the Newtonian predictions, in the solar gravitational field.

The appendix for the second edition mentions briefly some of the advances made in the interim: the verification by Adams at Mount Wilson of the "mass red-shift" in light from the dwarf companion of Sirius; Einstein, Infeld and Hoffman's proof that the equations of motion of the field-producing matter are implied by the field equations; and finally, the derivation of a suitable space-time background for the universe as a whole, into which may be incorporated the observations by Hubble and others on the distribution and motions of extra-galactic nebulae.

Einstein elects to devote almost the whole of this appendix to an exposition of this cosmological problem, and to the at least partially satisfactory solution offered by the theory of the expanding universe. It is to be regretted that the author has not expanded his brief remarks on the derivation of the equations of motion from the non-linear field equations, for this extremely important but difficult advance in principle has received but little expository treatment since its inception more than a decade ago.

The general theory of relativity,

CONTINUED ON PAGE 4

# Electronics GLAMOUR GIRL—OR PRODUCTION WORKER?

*by* H. A. BARTLING
*Manager, Electronics Section*
*General Machinery Division*
ALLIS-CHALMERS MANUFACTURING COMPANY
(*Graduate Training Course 1927*)

SO MANY near-miracles, actual, experimental or imaginary, are being attributed to electronics that it's quite the glamour girl of the electrical industry. Working closely with this infant prodigy, we find it is indeed fascinating and astonishingly versatile. We find, too, that it is a terrific worker. Applying electronic principles to tough, matter-of-fact industrial jobs is the work of this section.

H. A. BARTLING

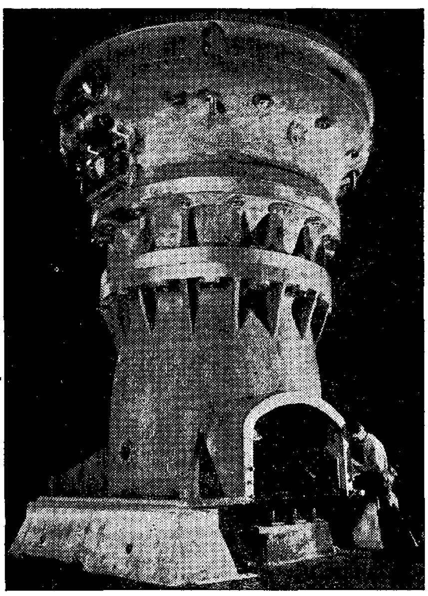
It rewards us with some really amazing success stories, and with abundant opportunity. The field has hardly been touched.

### New Field

This field of industrial electronics was completely unknown, of course, when I received my degree in Electrical Engineering from Illinois and entered the Graduate Training Course at Allis-Chalmers in 1925. During the 2-year course I stuck pretty close to electrical work—and at its completion, I was on the electrical test floor helping run tests on some of the first big blooming mill motors the company ever built.

Next, I worked in the Basic Industries Department on electric mine hoists. In 1931, I moved back to the Electrical Department, doing sales application work for the Motor and Generator Section. I worked, successively, on unit sub-stations, had charge of the Mixed Apparatus Section, was in Industrial Sales, handled contract negotiations and sales liaison work during the war, and in 1947 took charge of the company's growing Electronics Section.

**Hardening** 2200 trimmer blades per hour, this Allis-Chalmers Induction Heater is stepping up production for a Southern manufacturer of textile machinery.



**Massive castings** for a 60-inch Superior-McCully crusher being assembled in the A-C West Allis plant. Machine will reduce 5-foot boulders to crushed rock—handle 2500 tons of ore per hour!

Here we develop and apply four main classes of industrial electronic equipment: Rectifiers, Induction Heaters, Dielectric Heaters and Metal Detectors. With the exception of Rectifiers, this equipment is relatively new to industry. We're turning up new uses and applications every day. It's an absorbing line of work, and pioneers an entirely new frontier of industrial methods.

### Wide Choice of Interests

I've traced this brief personal history to illustrate the widely varied opportunities a young engineer finds at Allis-Chalmers even within a single field such as electricity. I never got far from the Electrical Department, because I found what I wanted right there. But I wouldn't be giving a true picture of Allis-Chalmers if I didn't touch on the other great departments, covering just about every major industry.

Many GTC students find their greatest interest and opportunity in the Basic Industries Department. There they design, build and install the machinery for mining, smelting, cement making, flour milling, oil extraction, food and chemical processing. Others become interested in hydraulic or steam turbines, the complexities of centrifugal pumps and the engineering problems of small motors or V-belt drives.

Some fit into engineering and design. Some find themselves most interested in manufacturing or in field work such as service and erection. Many like selling, and find their engineering training pays off best in a District Sales Office.

Whatever a man may eventually find most to his liking and advantage, the Allis-Chalmers Graduate Training Course is a wonderful vantage point from which to start. It offers contact with all major industries, and a chance at many types of work: design, manufacture, research, testing, installation, selling, advertising, export. There is no other organization that can offer a graduate engineer such a wide range of activities.

**ALLIS-CHALMERS**

*Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin*

# The Main Line

## MARCH, 1950

March, traditionally, comes in like a lion and goes out like a lamb.

Accordingly, this is one of the best months of the year to go places by train. (The other eleven are Jan., Feb., Apr., May etc.)


Southern Pacific has fine, fast trains going practically everywhere. Steel rails are the safest highway ever built. So when weather is uncertain, relax and let the engineer do the driving. Next time, try the train.

### What Else?

Every now and then we invite you to drop us a card in return for which we'll send you one of our folders to help you plan a trip. One of our friends has apparently been saving up these invitations, and recently decided to cash the whole kit and kaboodle in one fell swoop. Look!

"Dear Sir: Please send me free 3 new 1950 wall calendars, 200 pocket-size calendars, large & small memo pads, blotters, souvenirs, brochures, booklets, folders, menus, vacation suggestions, scenic picture wall posters & post cards, stationery, tiny gummed stickers, U. S. and world pictorial map, periodicals, list of publications, handbook, pencils, etc., also place me on your regular mailing list. Thank you!

Very respectfully yours,"

We are in some doubt as to the meaning of that "etc." About all we have left are the new, streamlined chair cars on the *Golden State.*

### Stick Around

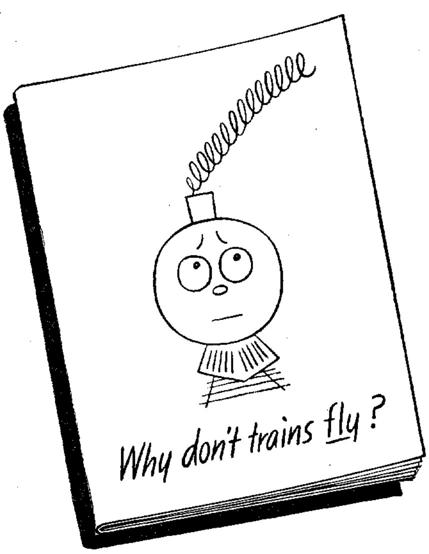
We've been meaning to tell you about a recent development in the round-trip ticket business. It used to be that you had to use up the return part of your ticket within 90 days. Now, however, on all tickets that formerly had a 90-day limit, you have six months in which to get back where you started.

This means you get six leisurely months for any train trip to the east, as well as on many local trips. Incidentally, it doesn't cost you a cent extra for this extension (unless, of course, your mother-in-law moves in for twice as long).

### Contact

Lately we railroads have been taking something of a lambasting from the advertising of another form of transportation. In fact, we feel that somebody has been getting away off base ethically and factually.

We don't want to get into a quarrel with anyone. But we do want the record straight. So to get it straight in our own minds, we prepared a little booklet on the subject entitled:




Originally we prepared the booklet for our own amusement as much as anything. But we ran off some extra copies too. If you'd like to have one, drop a card to Mr. F. Q. Tredway, Room 735, Southern Pacific, 65 Market St., San Francisco 5. He'll mail it right out to you.



## Books CONTINUED FROM PAGE 2

as accepted in the present body of science, truly incorporates the gravitational field into the metrical structure of space-time; matter and curvature are alternative aspects of the unified whole. But so far the electromagnetic field is merely tied formally into this structure from without—even as the gravitational field was tied into the Newtonian space and time or the Minkowski space-time in the older theories.

The problem of combining the metrical, gravitational and electromagnetic fields in a *unified field theory* is one which has challenged theoretical physicists for almost four decades. Noteworthy attempts to solve this problem have been made by Weyl, Eddington, O. Klein, Schrödinger and a host of others, in addition to Einstein himself; none of them, however, has proven ultimately satisfactory. That of Weyl has, on the other hand, found its expression in the concept of gauge invariance in quantum theory, and others of them have given a fruitful impetus to research in pure mathematics. But the challenge of incorporating both the gravitational and electromagnetic fields into a more universal structure, a more ultimate field of which both the former are but ideal limiting cases, is still a powerful incentive to research—and one which has again attracted the attention and the genius of Einstein.

**Progress Report**

The new appendix to the third edition, on "The Generalized Theory of Gravitation," is in the nature of a progress report by Einstein on his present search for a unified field theory—the background of which is admirably dealt with in his autobiographical sketch in the recent Einstein volume of *The Library of Living Philosophers.*

In this attack, which is in some respects similar to but more specific than the recent attempts of E. Schrödinger, Einstein proposes to broaden the metric field by adding an antisymmetric term $a_{ij}$ to the symmetric tensor $s_{ij}$, which in the older theory specifies the metrical-gravitational field. The sum $g_{ij}$ of these two parts is to encompass the metrical-gravitational-electromagnetic field in one entity, a structure which is to degenerate for weak electromagnetic fields into the case handled by the general theory of relativity, and to

CONTINUED ON PAGE 22

# Astromony In A Changing World

**A noted astronomer answers the question —**
**"What good does astronomy do the average man?"**

by IRA S. BOWEN
*Director, Mount Wilson and Palomar Observatories*

WHY INVESTIGATE and teach astronomy? How can we justify the very large expenditure of funds for great research telescopes, for laboratories and classrooms for instruction, and for salaries of large staffs of instruction and research?

When questions of this type are under discussion we have been asked many times, "What is the practical value of astronomy? Can any past or expected astronomical discoveries be used to make better radios, automobiles or atomic bombs?" To such questions we must answer that the direct application of recent astronomical observations to practieal affairs is very small. There are exceptions, such as the use of observations of sunspots and solar flares for the prediction of radio transmission, but these cases are rare.

But does this mean that astronomy is of little value to the average man, in comparison to some of the sciences that have found great direct application to technology? I would go even further and raise the question of whether we are as sure as we once were of the enormous human value of the great scientific and technological development of our present civilization. Thus present historians of civilization point with a certain amount of contempt at Greek and Roman philosophers and scientists because they attempted to reach an understanding of the world about them from reasoning alone and failed to develop the experimental method. We are told therefore that these early efforts led chiefly up a blind side road rather than along the great highway of scientific and technological advance of modern civilization.

But if our own civilization should follow these of the past, and be replaced by another a millenium or two hence, can we be certain as to how the historians of this new civilization will evaluate the scientific efforts of our own age? Will our efforts be considered a real advance along the road to a better world for mankind—or will they be listed as but another diversion up a blind alley? Obviously we are too close to our own period to have the necessary perspective for such an evaluation of our own science and technology. Lest we be too complacent about our present position, however, let us examine a very few effects of the impact of science and technology on our civilization.

A century or two ago most of the world had an agricultural economy. A large fraction of the people were small land-owners producing their own necessities of life. While many examples of tyranny and abuse of power could be found, various groups — notably in America, Switzerland, and to a large extent in England—had developed social and political institutions in which great individual freedom and security had been attained.

To this agricultural economy our great scientific and technological advances were added during the last century. To exploit these advances great industries were developed and an increasingly large fraction of the population left their farms and became factory workers. But as factory workers they no longer retained the security of being able to produce their own food and other necessities. The continuance of their livelihood depended on the goodwill of their employer and the stability of demand in their particular industry.

The insecurity and hardship that this situation can produce was acutely brought home to all of us during the depression of the 1930's. In an effort to counteract this insecurity the governments of most industrial nations have, by popular demand, moved rapidly toward job insurance, old age pensions, the detailed control of industry and many other steps toward state socialism. These steps, along with the attendant large increase in taxation, have already gone a long way toward eliminating individual freedom of action and incentive to individual effort.

Even more directly we have seen in the past decade

*This article is adapted from an address delivered by Dr. Bowen at the opening of the new Seaver Laboratory of the Frank P. Brackett Observatory, at Pomona College, Claremont, Calif., March, 1950.*

many of the beneficial effects of technological advance nullified by the application of these advances to the destructive purposes of warfare, often with truly appalling results.

Undoubtedly the early application of science to technology brought many physical comforts and freedom from drudgery and disease. On the other hand it is rapidly becoming evident that these technological advances are more and more being accompanied by the loss of security, freedom and incentive and are in many cases unleashing destructive forces which, unless controlled, may become a real menace to our civilization.

These questions are not raised in a spirit of pessimism and disillusionment. They are raised to emphasize that mankind may still have failed to find the one sure road to a better and happier world in the uncontrolled advance of science and technology. We still may profitably look for other criteria of value besides the applicability of a given discovery to technology.

## The Value of Astronomy

What, then, may be some of the important values of astronomical discovery? Before attempting an answer let me review very briefly some of the concepts that have come from astronomy.

Until the time of Copernicus men thought of the universe as consisting of a stationary earth around which the sun, moon, planets and stars revolved in a complicated series of cycles. As the one intelligent inhabitant of the only tangible part of the universe, man and his doings were of very fundamental importance in this universe.

But Copernicus moved the center of the universe to the sun. His immediate successors found this newly-devised solar system to have dimensions measured in billions of miles. In 1838 refined instruments allowed Bessel to fix the distance of a nearby star. The next half century saw this and similar direct trigonometric measurements of the distances of the nearer stars push out the diameter of the measured universe to a few hundred light years. (It will be recalled that a light year is six million million miles.)

The measurement of still greater distances awaited the development of new methods in the present century. These methods depend on the comparison of the absolute and the apparent brightness of a given object, and were based on the discovery that the absolute brightness of a star can be determined from its spectra or, in the case of certain variable stars, from the period of its light variation. Using these methods the dimensions of our own Milky Way system were outlined during the first quarter of the present century. These investigations showed that the Milky Way contains some billions of stars, many of them larger than our own sun, arranged in a flat disklike structure some 100,000 light years in diameter.

Previous to this, astronomers had noticed a large number of faint nebulous objects often having a spiral structure. With the advent of the 100-inch telescope on Mount Wilson it was possible to resolve a few of the nearest of these into stars and apply these same methods for the determination of the distances and dimensions of these objects. These measurements showed that each of these spiral nebulae, or galaxies, is another system made up of many millions of stars, and is comparable in size and structure to our own Milky Way system. It is estimated that the 200-inch Hale telescope could photograph about 100,000,000 of these nebulae extending out to distances of one billion light years.

Further studies show that all of these galaxies are moving away from us at velocities which increase proportionally with their distances. The most distant objects thus far measured are receding at a velocity of 25,000 miles per second. If these measurements are correctly interpreted it means that all of these objects started from one place about two billion years ago. It is interesting to speculate that the universe, as we know it, may therefore have started off with a huge atomic explosion at that time which imparted to these objects their present velocity.

Other studies, particularly those using a spectrograph, have told us about the temperatures and the chemical compositions of the stars. Some of the surface temperatures are over one hundred thousand degrees, while in the interiors temperatures of several tens of millions of degrees are reached. At these interior temperatures nuclear reactions occur, similar to those that give the atomic bomb its tremendous power. This provides the sun and most of the stars with the enormous energy which they require to enable them to continue to shine with their great brilliance. From the determination of the chemical composition of the stars we can estimate the amount of fuel remaining to keep these nuclear fires burning. Again we arrive at stellar lifetimes measured in billions of years.

All of this has obviously had a very great and very humbling effect on our concepts of man's place in the universe. Thus, instead of man's home—the earth—being the center of the universe, we now find it to be a minor planet moving about one of the smaller of some billions of stars that make up our galaxy—which in turn is only one of many millions of such galaxies. Likewise, instead of man dominating the earth throughout its existence, we find that the history of civilized man has only extended for a few thousand years out of the billions of years that the universe has been developing.

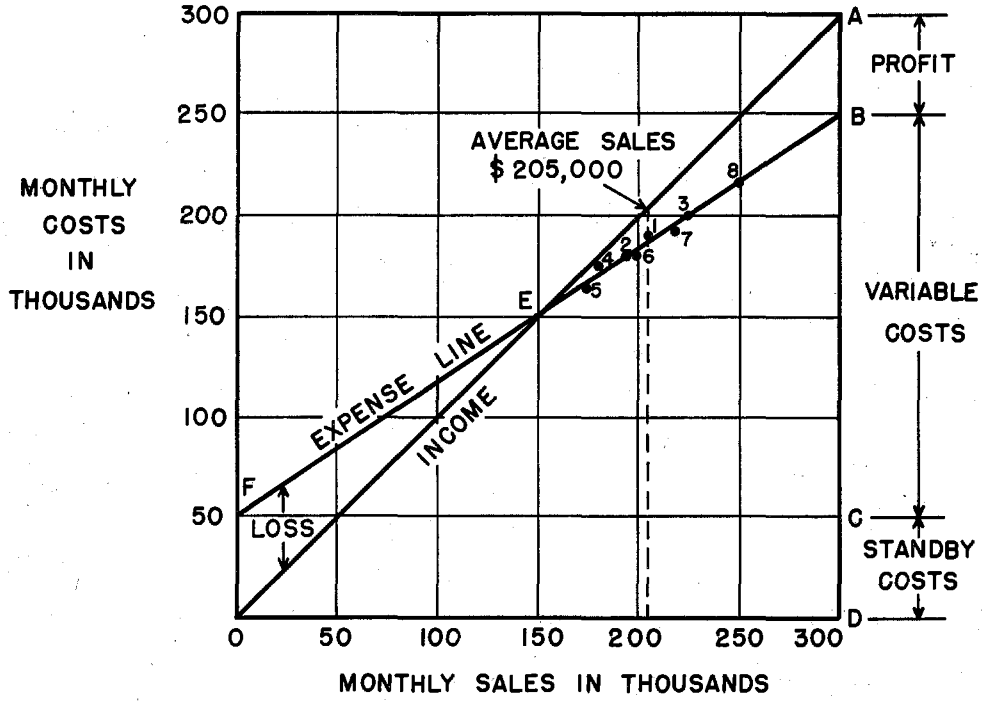
## A Matter of Perspective

This, I believe, is the great value of astronomy: More than any other science it has given us a true perspective of man's place in the universe. Possibly this is illustrated in a simple way by a request that came to the Mount Wilson Observatory shortly after the war. It came from a civilian high up in the War Department. He asked for one of our photographs of a spiral nebula. In explaining his request he said ,in effect, "These days of reconversion are very hectic, particularly here in the War Department. In a continually tense situation it is often very difficut not to take ourselves and our immediate problems very seriously. I would like to have this photograph of a nebula to frame and hang in my office opposite my desk so that, when the going gets tough and the immediate problem seems unusually important and urgent, I can just take a look."

I wonder whether we would not find some of our present problems and tensions somewhat relieved if a few more heads of states, and labor and industrial leaders were in a position to take an understanding look now and then.

Certainly, if our civilization is to continue to prosper and advance, it is evident that man must obtain a much broader understanding than he now has of the technological, social and political structures that are most conducive to his continued happiness and well being. Furthermore he must have not only the knowledge but the will to attain this goal. I cannot help but believe that the understanding of man's true place in the universe which we are slowly obtaining from astronomy is a significant step toward this end.

# PROFIT ENGINEERING




## The Break Even Chart: An Effective Management Tool for Improving Profits

by

ROBERT J. BARRY

HOW CAN THE PROFIT POTENTIAL of a business be given the same objective engineering study as the design of the product? The question constantly confronts business executives as they resolve business plans that are expected to influence profit.

There exists one remarkably effective method for showing management the summary effects on profit of changes in pricing, costs and sales volume. It is known as the break-even chart, or occasionally as the variable budget or profitgraph. Though it was first developed in 1910 by C. E. Knoeppel, it is being applied in very few organizations today—and in some it is scarcely known at all. But in recent years the break-even chart has been proving its effectiveness over and over again. More important, the application of this profit-planning analysis is helping to bridge the wide gap that has existed between the professions of finance and industrial engineering.

The first step in a profit-planning analysis is to determine the current relationship of profits, sales and costs for an enterprise. Typical sales and cost figures for one organization are shown below:

| | Month | Sales Dollars | Costs Dollars | Net Profit Dollars (Before Income Taxes) |
|---|---|---|---|---|
| 1 | Jan. | 205,000 | 190,000 | 15,000 |
| 2 | Feb. | 192,000 | 180,000 | 12,000 |
| 3 | Mar. | 225,000 | 200,000 | 25,000 |
| 4 | Apr. | 180,000 | 175,000 | 5,000 |
| 5 | May | 175,000 | 165,000 | 10,000 |
| 6 | June | 200,000 | 180,000 | 20,000 |
| 7 | July | 217,000 | 193,000 | 24,000 |
| 8 | Aug. | 250,000 | 215,000 | 35,000 |
| TOTAL | | 1,644,000 | 1,498,000 | 146,000 |
| AVERAGE | | 205,500 | 187,250 | 18,250 |

These figures—which show profits normally rising with increasing sales and dropping with decreasing sales—are then plotted on a break-even chart (above). Here, the horizontal scale represents sales volume, and the vertical scale represents costs. Both sales and costs are plotted to the same unit of measure.

Monthly cost figures follow a trend (line FB), intersecting the zero sales line (0) at \$50,000 (point F). Minor variations in expense charges from month to month cause the departures from a straight line, which is the usual case unless there have been significant changes in sales, prices or costs. A 45° line drawn upward from O represents income, since costs and sales are plotted to the same unit of measure (\$50,000 per inch in this case).

The normal profit or loss can now be determined by subtracting the expense intercept from the revenue intercept at the particular sales volume. For example, at sales of \$300,000, normal expenses would be \$250,000, and the profit \$50,000.

The intersection of the revenue line with the expense line (point E, or \$150,000) locates the sales volume point at which expenses equal sales. This is the break-even point. When sales exceed this point, there will be a profit; when sales fall below it, there will be a loss.

When the horizontal line FC is drawn, it is evident that there are two classes or basic types of costs making up the expense total—standby expenses and variable expenses. The standby costs (FO, or \$50,000) are of the nature of real estate taxes, depreciation, rental costs, etc. They vary with time, but are not affected by the volume of sales. Variable costs include direct material, direct labor, sales commissions, etc., and vary directly with the sales volume. Variable costs at sales of \$300,000 are \$200,000 (BC).

Although many costs such as indirect labor and supervision increase with sales, but not in direct relationship, they can be broken down into variable and standby elements. These costs are called semi-variable. An example is shown at the bottom of this page.

The break-even chart summarizes all standby, variable and semivariable costs on one picture.

In our typical example fixed costs were identified as \$50,000 per month. The relationship of variable costs to sales is $\frac{BC}{FC} = \frac{200}{300}$ or 66 2/3%. We now have the basic information to determine the algebraic relationship between profit, sales volume and costs.

Let S = Sales volume
V = Ratio of variable costs to sales
F = Standby costs
P = Profit (or loss)

$$S = P + F + VS$$
$$P = S - VS - F = S(1-V)-F$$
$$P = S(1-V)-F$$

For a sales volume of \$200,000, the Profit (P) would be:

$$P = \$200{,}000\ (1-.66\ 2/3) - \$50{,}000$$
$$= \$\ 16{,}667$$

We can also determine the break-even point by the fact that P = O and solve for Sales (S)

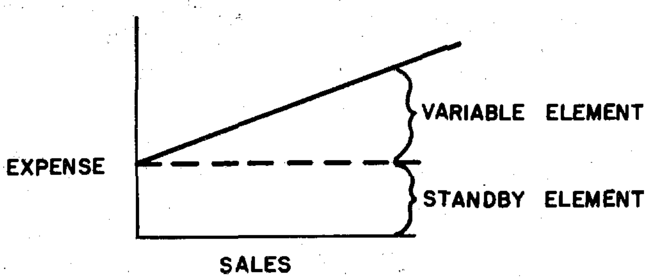
$$O = S(1-V)-F$$
$$S = \frac{F}{1-V} = \frac{50{,}000}{(1-.66\ 2/3)} = \$150{,}000$$

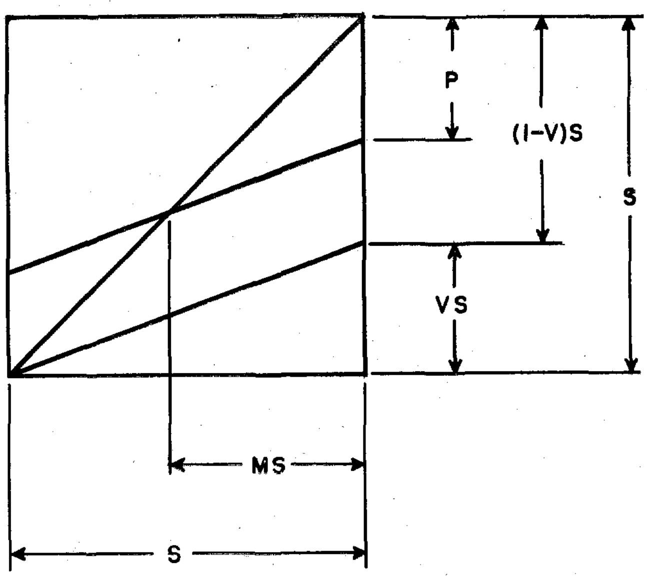
The sales required to obtain a profit of \$40,000 can also be determined:

$$40{,}000 = S(1-.66\ 2/3) - 50{,}000$$
$$S = \frac{90{,}000}{.333} = \$270{,}000$$

## Margin of Safety

In our typical case, the average sales were \$205,000 per month, which is only \$55,000 above the break-even point. It is obvious that a company that has a high break-even point in relation to sales will quickly turn from profit to loss when sales drop off. The profit strength of a company is directly proportional to the distance between present sales and the break-even point. This distance, expressed as a percentage of sales, is called the Margin of Safety. In our example the margin of safety is $\frac{55}{205} = 26.8\%$. Two companies may have the same percentage of net profit to sales at present volume but one company may withstand a much more severe drop in sales without loss because of its higher margin of safety.




The margin of safety directly influences the net profit, as shown at the top of this page.

Let M = Margin of safety as % of sales.

Then $\frac{P}{MS} = \frac{(1-V)S}{S}$ (from the break-even chart on page 7)

(Net Profit) $\frac{P}{S} = M(1-V)$

or

The Net Profit percent $\frac{P}{S}$ is equal to the Margin of Safety times the Complement of the variable costs factor.

## FACTORS THAT INFLUENCE PROFITS

There are five basic steps that can be taken to improve net profits:

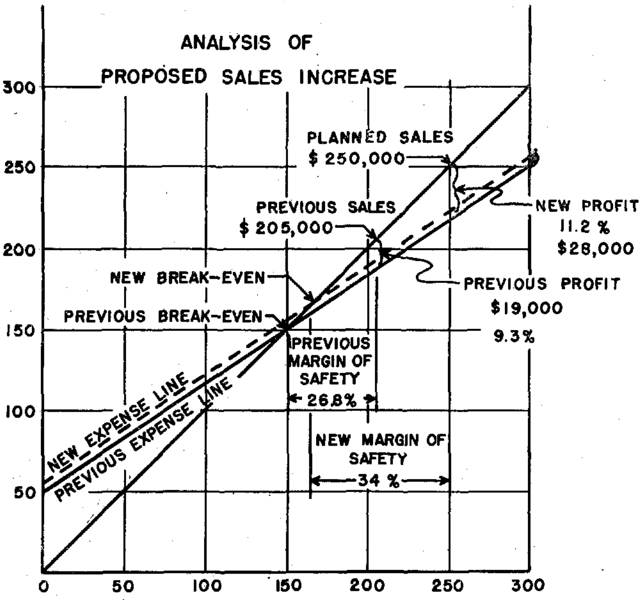
1. Increase sales
2. Reduce standby costs
3. Reduce variable costs
4. Raise prices
5. Change the sales mix

In our example, it was assumed that factors 2, 3, 4, and 5 did not change during the period covered by the study.

## Increasing Sales

1. Obviously sales should be increased as a first step if the organization has the facilities and market to absorb the additional volume. Management may feel that the company is already getting its economical limit of sales in the industry or that its plant capacity has already been reached. However each possibility should be objectively appraised for its summary contribution to profits.

For example, the sales manager advises management to increase sales \$45,000, but this would call for an




additional $5,000 per month for sales promotion, trucks, warehouses, etc.—which we will assume are all standby charges over and above the normal expenses expected at that sales volume. The problem is to evaluate this proposal on its profitability. The analysis, projected on the break-even chart (see chart above), shows that the proposal would be profitable, increasing the net profit from $19,000 (9.3%) to $28,000 (11.2%) and increasing the safety factor from 26.8% to 34.0%. However, since the break-even point is increased from $150,000 to $165,000, the company will need a definite assurance that the sales volume can be held in the range of $250,000 per month for an extended period.

## Reducing Standard Costs

2. Each reduction of standby costs adds an equal amount to profit when other factors, including sales, are constant. Therefore the profit picture could be considerably improved in our example by reducing the standby costs 15% ($7,500) as shown in the chart at the right.

This step would not only increase the net profit to $26,500 (12.9%) but increase the margin of safety from 26.8% to 36.6% and lower the break-even point from $150,000 per month to $130,000. It is therefore evident that reduction of standby costs is an effective and direct method of improving the profit potential.

## Reducing Variable Costs

3. Any decrease in the variable cost ratio to sales will of course reduce and improve the break-even point and increase the net profit where sales are above this break-even point. Some of the more significant methods of reducing this variable cost:

a. Redesign of the product to reduce material and labor costs.
b. Substitution of less expensive materials, and the appraisal of purchasing costs, discount rates and freight rates.
c. Methods improvements in shop and office to reduce the direct and indirect labor required.
d. Standardization of methods and procedures.
e. Use of wage incentives and/or profit-sharing to improve productivity and reduce labor costs.

The chart on p. 10 shows how the profit potential would be improved by a reduction of 10% in variable costs. The profit would increase to $32,000 from its former $19,000 and the margin of safety would become 39%, indicating that the reduction of variable costs is another way to strengthen the profit picture.

## Raising Prices

4. Naturally it is a sound move to increase prices if the number of units sold remains constant, because this would have an effect similar to that of reducing variable costs with respect to sales. However, increasing prices usually reduces the number of units sold and the problem is to determine the most profitable price-volume relationship. As an example, suppose sales management has made a thorough study of the market and advises management that it can sell the following units at different price levels:

| Selling price/unit | Number of units that can be sold | Total Sales |
|---|---|---|
| $20.50 (present price) | 10,000 | $205,000 |
| 22.50 | 8,500 | 192,000 |
| 25.00 | 6,000 | 150,000 |
| 30.00 | 4,000 | 120,000 |

In the analysis of the present cost structure it is already known that the standby costs are $50,000 and the variable costs are 66 2/3% or $13.70 per unit. (We will assume that variable costs remain at this figure.)

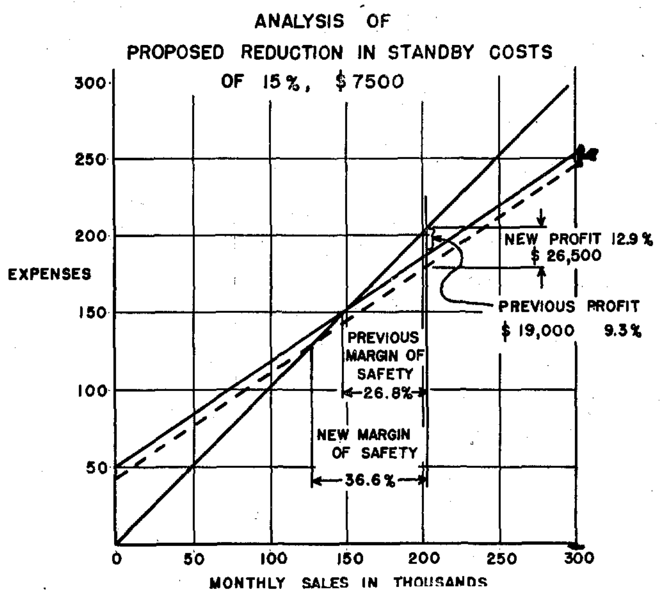
$$\text{Since } P = S(1-V)-F$$

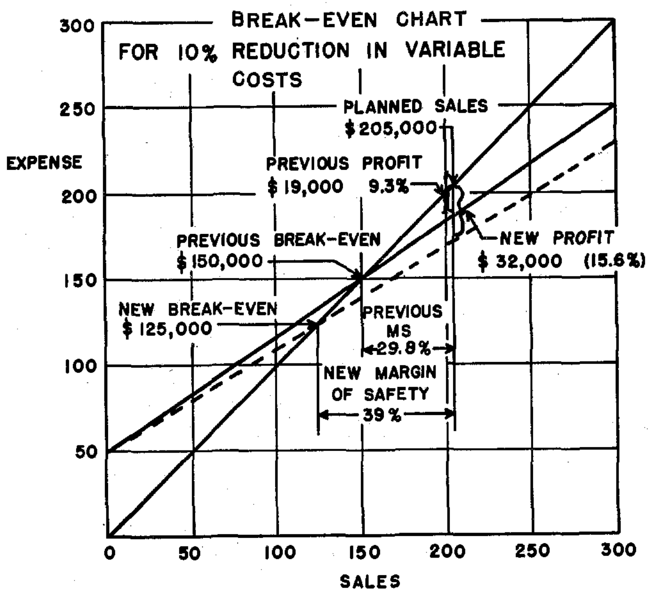
$$P20.50 = \$\ 19{,}000 \text{ from previous example}$$

$$P(22.50) = (192{,}000)\left(1-\frac{13.70}{22.50}\right) - 50{,}000 = \$24{,}500$$

$$P25.00 = (150{,}000)\left(1-\frac{13.70}{25.00}\right) - 50{,}000 = \$17{,}500$$

$$P30.00 = (120{,}000)\left(1-\frac{13.70}{30.00}\right) - 50{,}000 = \$14{,}400$$






It is therefore recommended that the price be increased to $22.50 per unit, reducing total sales to $192,000 per month but increasing the profit to $24,500 or 12.8%, since this price-volume relation gives the best net profit.

## Changing the Sales Mix

5. In many organizations the problem is complicated by the number of different products that are sold. In this case the solution is to break down the costs to products and determine the most profitable mix or percentage sales of each product. If the products are too numerous, they may be grouped in classes or divisions for study and analysis.

For example, the $205,000 sales program may consist of three products, A, B, and C.

| | Sales Dollars | Standby Cost Dollars | Variable Cost Dollars | Variable Percent | Net Profit Dollars | Net Profit % |
|---|---|---|---|---|---|---|
| A | $100,000 | $20,000 | $ 72,000 | 72 % | $ 8,000 | 8 % |
| B | 75,000 | 20,000 | 49,000 | 65.5 | 6,000 | 8 |
| C | 30,000 | 10,000 | 15,000 | 50 | 5,000 | 16.7 |
| TOTAL | $205,000 | $50,000 | $136,000 | 66⅔ % | $19,000 | 9.3% |

We will assume in this case that total sales cannot be increased, that all possible cost reductions in both variable and standby costs have been made, and that prices cannot be changed.

Since Product C has the least (50%) variable cost per sales dollar, compared to A (72%) and B (65.5%) it is evident that any shift of sales from A or B to C will add to net profit. For example, by holding total sales constant but changing the sales mix, as below, an increase of $5,800 is obtained.

| | Sales | Standby Dollars | Variable Dollars | Variable Percent | Net Profit | Net Profit % |
|---|---|---|---|---|---|---|
| A | $ 80,000 | $20,000 | $ 57,600 | 72 % | $ 2,400 | 3 % |
| B | 65,000 | 20,000 | 42,600 | 65.5 | 2,400 | 3.7 |
| C | 60,000 | 10,000 | 30,000 | 50 | 20,000 | 33 |
| TOTAL | $205,000 | $50,000 | $130,200 | 63.3% | $24,800 | 12.1% |

The adjustment of the sales mix as shown here is one of the least used yet most profitable steps a company can take in order to increase profits. In some cases, the total profit can be increased by dropping a product or replacing it with a product having a lower variable cost factor.

In practice, the steps taken to improve the profits and break-even point are usually a combination of two or more of these five basic steps. For example, labor-saving machinery may be added that increases standby costs but reduces variable costs. The sales mix may be changed and some selected products repriced in order to attain the best profit structure. A production method may be improved, making it possible to decrease labor cost and also dispose of expensive equipment, which would effect a reduction of both standby costs and variable costs.

## Conclusion

The profit planning and break-even analysis of a company—whether manufacturer, wholesaler, or institution—can be an invaluable method of analyzing and presenting the facts about cost, volume and pricing—all of which affect profits. These facts are not only more readily recognizable in a simple chart; it is easier to make an objective decision on the basis of a chart than to mentally appraise and evaluate a bulky sheaf of financial figures. In fact, this combination of finance and industrial engineering is another step forward in the field of scientific management.

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*This article has focused on the planning of profits. The factors necessary to control and measure profits, expenses and sales—such as budgets and sales forecasts—are subjects beyond the scope of this discussion.*

## *Further references*

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# CHROMATOGRAPHY

## It helps scientists tell one thing from another

by

C. M. STEARNS

To study the substances that make up a living system, and that are responsible for its birth, growth, and disease, a biochemist has to be able to separate one chemical compound from the next. That has been one of the big problems of biochemistry from its very beginning. Unfortunately, the chemistry on which life processes are based is so complex, and so sensitive to seemingly insignificant changes, that the separation of pure compounds is often a first-class headache. It is not at all unusual to find two drugs, for instance, whose biological effects are very different—but whose chemical and physical difference is insufficient to allow the chemist to separate one from the other, using only classical methods.

That is where chromatography comes in.

The reason that chromatography is being widely and rapidly adopted by scientists in a whole range of fields is that it *can* often resolve a complicated mixture, even when none of the other chemical and physical levers—the still, the centrifuge, the solvents, the precipitators, and so on—can pry the mixture apart.

Caltech's leading expert on chromatography is Professor L. Zechmeister, who is internationally known for his work in this field. Dr. Zechmeister and his collaborators, as well as the many other scientists at the Institute who are using the chromatographic technique to an ever-increasing extent, are quick to point out that chromatography is not a new idea. It was largely the brainchild of Michael Tswett, a Russian botanist and microbiologist who in 1906 published a pioneer paper on the subject; and the cylinder of adsorbent material that is the hallmark of chromatography is still known as the Tswett column. But Tswett's brainchild lay unnoticed for many years, and only comparatively recently have chemists and biologists begun to develop the seemingly unlimited possibilities of the method.

The method, in all its variations, relies on one physicochemical attribute of all chemical compounds; the capacity for being adsorbed on the surface of solid substances. Inside a small particle (*e.g.*, a gram of powder) the electrical charges are compensated from all directions; but on the surface of the particle there remain unoccupied forces which, under suitable conditions, are able to remove molecules from a solution and hold them firmly. The way adsorption works in a Tswett column is this:

A large glass cylinder is tightly packed with some powder such as calcium carbonate, alumina, or sugar. The solution containing the substance to be separated into its components is poured onto the top of the column. The component with the greatest affinity for the column material (with the greatest "adsorbability") moves down into the column, and soon occupies a top zone on the column; the other compounds migrate further down the column and occupy individual zones there. This resolution process is assisted and made more efficient by washing the column with a suitably selected solvent, which increases the distances between the zones. At the end of this process there is, near the top of the column, a zone of the component with the greatest adsorbability; below this is a second zone, of the component with the second-strongest adsorbability; and so on.

After the separation into zones in the column is completed, the glass tube containing the "chromatogram" is taken from the apparatus and laid on a table; and the

*The work of (left to right) Dr. Malcolm Gordon, Francis Haskins, and Dr. Herschel K. Mitchell, of the Biology Division is a good example of the fine distinctions that chromatography makes possible. Using a chromatopile (right foreground), they have been able to break down a mixture of enzymes into several zones, each containing enzymes with slightly different capabilities—an achievement that may add importantly to the understanding of how an enzyme goes about its business of converting raw materials to forms suitable for use by living cells.*

column is then forced out of the tube, like a sausage, with a wooden pestle. It is now a simple matter to cut the column into sections, each containing a single component of the original mixture.

Often the separate zones are colored; there may be, for example, a red zone, an orange zone, and so on. In this case one look serves to indicate where to cut the column. When color fails, fluorescence often succeeds; ultraviolet light in a dark room may indicate the location of the zones. Sometimes streaking of the extruded column along its length with a brush will locate invisible and non-fluorescing zones if the brush carries a reagent which develops color with the zone material.

## Variations on a theme

That is chromatography in its simplest, and original, form. Two of the modern variations on the original theme increase the versatility of the method markedly. The first of these is the so-called "paper-chromatography," recently introduced mainly by British investigators. A drop of the substance to be analyzed is placed near the corner of a piece of paper and spread out, with the chromatographic technique, first along one side of the sheet. Then the process is repeated in a direction perpendicular to the first. Characteristic spots on the paper result, each spot being formed by a different component of the original substance.

One of the latest developments in chromatography is a cross between the original Tswett column and the paper technique. It was Dr. Herschel K. Mitchell, of Caltech's Biology Division, who invented the "chromatopile."

The chromatopile is a large stack, or pile, of regular, round filter papers (like those used in some kinds of coffee-maker) compressed between metal plates until it is about a foot high. For a typical separation problem, the top few papers are impregnated with the solution of the substance to be resolved, and the solvent is poured down onto the stack of paper through a hole in the top metal plate. As the solvent works down the pile of papers, carrying the unknown material with it, the zones analogous to those of the Tswett column again appear. In many instances it is easy to separate the zones containing different components; in the simplest case, the experimenter can tell the zones apart simply by inspection and then, using only his fingers, can separate the filter-paper discs.

So much for the methods of chromatography. What good have they done?

## What chromatography has accomplished

They have made possible a progress in almost all branches of chemistry. At the Institute, for example, much of the work based on chromatography has centered around the carotenoids, an interesting set of colored compounds responsible for such varied effects as the orange of carrots and the red of tomatoes. Some carotenoids are important to human beings because they are converted, in the body, to vitamin A.

More recently, chromatography has been turned to that troublesome class of compounds known, to chemists and biologists, by the name of "cis-trans isomers." It happens that, among the millions of variations on the carbon-hydrogen theme that make up organic chemistry, there are many compounds that have the same number of each kind of atom in their makeup *and* have these atoms hooked together in the same order—and yet are different compounds. The molecules of a compound belonging to this type are able to assume various geometrical forms; they may be straight (rod-like), or bent in the middle (V-form), and so on.

By ordinary chemical standards this is one of the smallest possible differences between two compounds, and two such compounds are accordingly very difficult to tell apart. However, because adsorbability depends on the general shape of a molecule as well as its chemical makeup, chromatography is quite adept at separating the various molecular forms of one and the same compound.

Another class of bothersome compounds to which chromatography is now being applied is that comprising proteins. Proteins, besides being the substances that make up (and hide most of the secrets of) living organisms, are composed of very large molecules, containing many thousands of atoms. There is reason to believe that the very largest protein molecules may even be visible under an electron microscope. But their very size and complexity has made them difficult to handle, from the chemist's standpoint; and he has been particularly handicapped by the fact that many proteins are over-sensitive to his rough handling. In other words, quite often the chemist trying to separate one protein from others damages it hopelessly. It may very well prove possible to devise chromatographic methods which, applied to proteins, will not do such extensive damage to the materials under study, and a good start has already been made in this direction.

## The chromatography of amino acids

Much success has already been achieved in the chromatography of the building stones of the proteins, the amino acids. It is now possible to do an amino acid survey of, say, a virus, much more quickly and reliably than by earlier methods. And, using chromatography, a chemist can tell how much of each amino acid occurs in that particular virus, even in cases where the older approach would have led only to rough proportions. That the exact determination of the amino-acid makeup of proteins, whether in germs or in parts of healthy cells, will have extensive effects on the knowledge of life in general and of how to protect it hardly needs to be pointed out.

One final virtue of chromatography deserves a word. It provides an almost ideal purity test. If a solution of a truly pure substance is tested on the Tswett column, only a single zone should appear; on the other hand, contaminants would show up by forming additional (minor) zones.

Because it may appear, from what has been said, that chromatography will solve all the problems of biology and chemistry combined, a few dashes of cold water may be in order. First of all, in any work dealing with huge organic molecules, no method (chromatography included) is going to explain their make-up unless it can work on a pure sample—which is still, more often than not, unavailable. You cannot, in other words, analyze a virus until you have isolated (entirely purified) it; if you have not isolated it, you may be analyzing ten other things at the same time.

## How to tell things apart

And finally, chromatography is just one more method of telling things apart. However, it is, as we have seen, extraordinarily selective and efficient. Having a chromatogram to go by is much like having a fingerprint to go by in searching for a criminal, instead of just a description of his overcoat.

# THE MONTH AT CALTECH

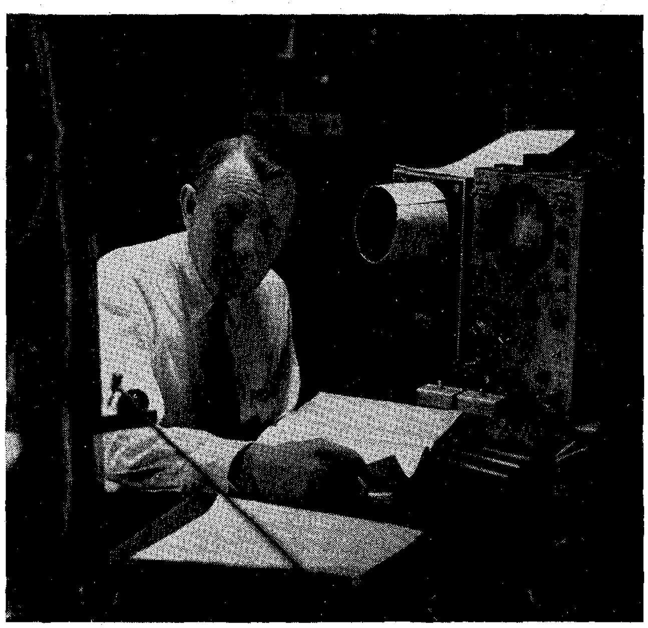
## Physicists and the Hydrogen Bomb

■ CHARLES C. LAURITSEN, Professor of Physics and Director of the Kellogg Radiation Laboratory, was one of 12 prominent American atomic scientists to sign a joint statement last month urging the United States to make a solemn declaration that it would not use the hydrogen bomb in warfare unless an enemy used it first against us or our allies.

The physicists, who were attending the annual New York meeting of the American Physical Society at Columbia University, released their statement just four days after President Truman ordered construction of the hydrogen bomb.

The statement follows, in full:

> A few days ago, President Truman decided that this country should go ahead with the construction of a hydrogen bomb.
>
> This decision was one of the utmost gravity. Few of the men who publicly urged the President to make this decision can have realized its full import. Among the reports in the press was a great deal of misinformation. However, it was stated correctly that a hydrogen bomb, if it can be made, would be capable of developing a power 1,000 times greater than the present atomic bomb. New York, or any other of the greatest cities of the world, could be destroyed by a single hydrogen bomb.
>
> We believe that no nation has the right to use such a bomb, no matter how righteous its cause. This bomb is no longer a weapon of war but a means of extermination of whole populations. Its use would be betrayal of all standards of morality and of Christian civilization itself.
>
> Senator McMahon has pointed out to the American people that the possession of the hydrogen bomb will not give positive security to this country. We shall not have a monopoly of this bomb, but it is certain that the Russians will be able to make one too. In the case of the fission bomb the Russians required four years to parallel our development. In the case of the hydrogen bomb they will probably need a shorter time. We must remember that we do not possess the bomb but are only developing it, and Russia has received through indiscretion, the most valuable hint that our experts believe the development possible. Perhaps the development of the hydrogen bomb has already been under way in Russia for some time. But if it was not, our decision to develop it must have started the Russians on the same program. If they had already a going program, they will redouble their efforts.
>
> Statements in the press have given the power of the H bomb as between 2 and 1,000 times that of the present fission bomb. Actually the thermonuclear reaction on which the H bomb is based is limited in its power only by the amount of hydrogen which can be carried in the bomb. Even if the power were limited to 1,000 times that of a present atomic bomb, the step from an A-bomb to an H-bomb would be as great as that from an ordinary TNT bomb to the atom bomb.
>
> To create such an ever-present peril for all the nations in the world is against the vital interest of both Russia and the United States. Three prominent senators have called for renewed efforts to eliminate this weapon, and other weapons of mass destruction from the arsenals of all nations. Such efforts should be made, and made in all sincerity from both sides.
>
> In the meantime, we urge that the United States, through its elected government, make a solemn declaration that we shall never use this bomb first. The only circumstance which might force us to use it would be if we or our allies were attacked by *this* bomb. There can be only one justification for our development of the hydrogen bomb, and that is to prevent its use.



*Lauritsen*

Besides C. C. Lauritsen, the signers—all professors of physics at their respective universities with the exception of Dr. Tuve—were: S. K. Allison, Director of Institute for Nuclear Studies, University of Chicago; K. T. Bainbridge, Harvard University; H. A. Bethe, Cornell University; R. B. Brode, University of California; F. W. Loomis, Chairman of Physics Department, University of Illinois; G. B. Pegram, Dean of Graduate Faculties, Columbia University; B. Rossi, Massachusetts Institute of Technology; F. Seitz, University of Illinois; M. A. Tuve, Director, Department of Terrestrial Magnetism, Carnegie Institution, Washington, D.C.; V.F. Weisskopf, Massachusetts Institute of Technology; M. G. White, Princeton University.

## Not Talking

■ DR. R. A. MILLIKAN has made some great speeches in his time, and he is justly famous for his speechmaking. So famous, in fact, that he added to that fame last month by *not* making a speech.

Dr. Millikan was guest of honor at a Chamber of Commerce banquet in Van Nuys. He was scheduled to deliver an address on "The Road to Peace."

The dinner began at 6:30 p.m. Afterwards, new officers were installed. Then assorted distinguished guests were introduced. The treasurer gave his report. Several committee chairmen gave theirs. The new president made a speech. Some service awards were presented. Andy Devine and Monty Montana, a couple of western movie actors, were sworn in as honorary mayor and sheriff of Van Nuys. At 10:15 Dr. Millikan was introduced.

Dr. Millikan began by giving his definition of an educated person ("an individual who can apply constant attention to one subject for two minutes"). He went on to say that he didn't think that any of the people present could—at that hour of the night, and after all they had been through—give the attention they otherwise might have devoted to the subject he was prepared to speak on. So, he explained, he didn't believe he'd speak at all. That effectively ended the meeting.

Dr. Millikan gave his speech on "The Road to Peace" at a Los Angeles Bar Association luncheon the next day.

## Honors and Awards

■ PRESIDENT L. A. DUBRIDGE: named by President Truman to a five-man temporary Communications Policy Board, to study present and potential use of radio and wire communications facilities.

DR. H. S. TSIEN, Robert H. Goddard Professor of Jet Propulsion: elected a fellow of the Institute of Aeronautical Sciences.

ROYAL W. SORENSEN, Professor of Electrical Engineering: reappointed by Governor Warren as a member of the State Board of Registration for civil and professional engineers.

ROBERT D. GRAY, Director of the Industrial Relations Section: elected a director of the Pasadena Chamber of Commerce.

## King Kong is Dead

■ DAVID P. WILLOUGHBY, scientific illustrator in Vertebrate Paleontology at the Institute, shattered the King Kong myth in a recent report to the American Association for the Advancement of Science. After measuring hundreds of gorilla bones and checking photographs and reports of countless scientific expeditions Willoughby came to the disappointing conclusion that gorillas don't grow much taller than people. In fact the tallest reliably reported height he could find for a gorilla was 6 ft. 2 in.—which almost any basketball center could look down on.

Willoughby had to admit, though, that gorillas still run to considerable more heft than most humans—some of them weigh in at more than 500 pounds.

## Visiting Lecturers

■ DR. RICHARD P. FEYNMAN, Professor of Theoretical Physics at Cornell University, delivered a series of twelve seminar lectures at the Institute last month on "Quantum Electrodynamics and Meson Theories." Dr. Feynman was the third in a series of eminent physicists to lecture at the Institute this year, following Drs. Rabi and Oppenheimer.

DR. JOSEPH SLEPIAN, Associate Director of the Westinghouse Research Laboratories at Pittsburgh, Pa., and an internationally known electrical engineering authority, also came to the Institute last month to deliver three lectures.

# THE BEAVER

## Some Notes on Student Life

### The Bleacher Beaver

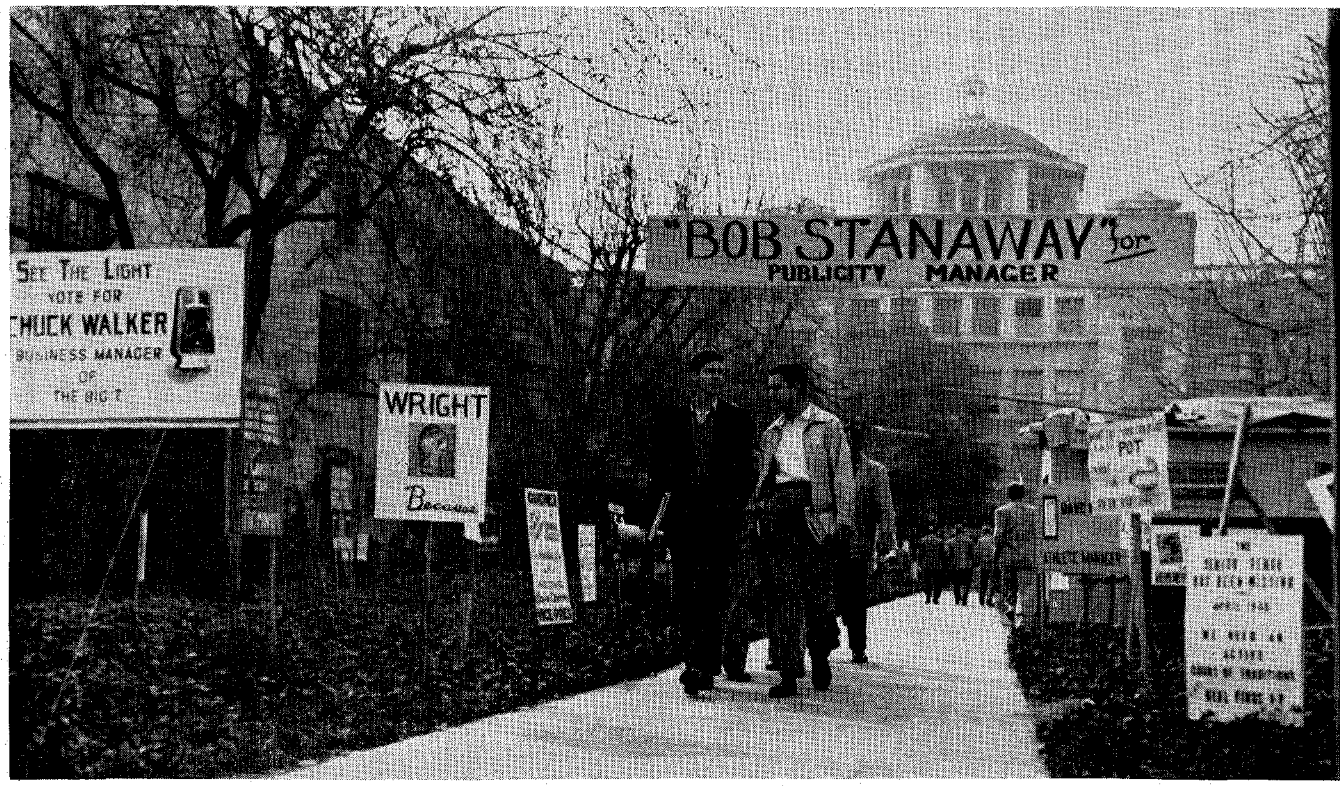
ALMOST EVERY WEEKEND during the past term the Beaver had tossed his slide rule down and trudged up to the PCC gym to yell at the basketball games. There was something thrilling about the hot, brightlight tension of the gym and the Beaver felt the stirrings of a budding school spirit in his liver as he perched on the bleacher seats and chanted "ex, ex, ex, dx."

School spirit was a commodity that was largely lacking and cynically viewed among his Tech acquaintances. This was in some contrast to most colleges, the Beaver realized, as he watched the competing schools in the grandstands. The Tech cheering section was usually small and vocally inhibited, and, although he liked Merten and the other cheerleaders, the Beaver saw that their agility never approached the bouncing histrionic talents of the ones from Oxy and the other schools.

He saw it as a lamentable thing and wondered if, after he graduated, he would not look back on his four years here and feel that something had been missing in his experience. So he sat in the bleachers and let himself be carried away by the cheering and the band and the excitement. Every time Tech lost, he was black with despair; Cox, Montgomery, Butler, and the rest always seemed to play a fine game, but there were moments when the Beaver noticed a glint of professional brilliance in the opposition and wondered how many of them depended on their performances that night to continue to keep their scholarships.

### The Voter

■ ELECTION EXCITEMENT was not confined to England this month, the Beaver noted as he wandered into kitchenettes and rooms where sheaves of cardboard and pots of poster paint overflowed into the superlatives of campaign signs. At the traditional Sunday midnight, campaign week began with an eager throng of carpenters swarming over the east campus, hammering and yelling in the dim glow of the spotlight on top of Throop.



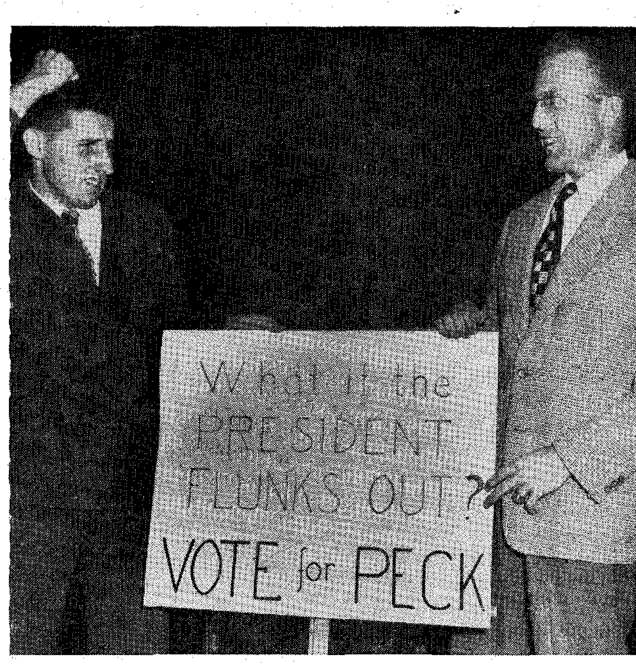

*Monday morning Techmen were met by a frontal attack of campaign posters, which sprouted from the ivy overnight.*

Monday morning sleepy Techmen were met by a frontal attack of posters in all directions. Floating over Throop was a large balloon dedicated to Norm Gray; over the sidewalk a succession of arches proclaimed Neal Pings, Doug Inglis, and Bob Stanaway; and all through the despised iceplant sprouted the colorful posters. Even the most apathetic snakes paused in their scuttling to classes to read.

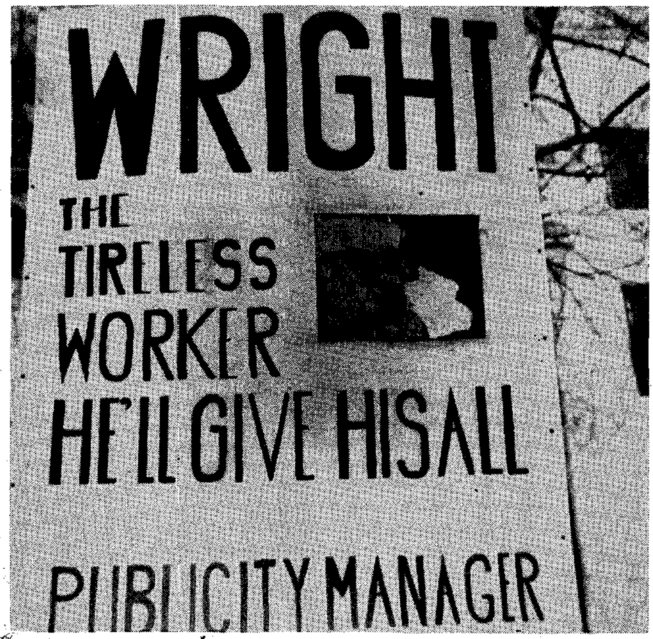
The campaign was much more spirited and clever than last year; off-campus men were deluged with 19 personal postcards apiece; matchbooks and leaflets appeared beside the plates at lunch; eager candidates sprawled in their rooms and chewed pencils worriedly over campaign ideas and didn't go to classes all week.

Novelty was the keynote: one poster, headed "Mason Gets Around," showed a photomontage of Mason in uniform talking to Mason in tracksuit talking to Mason in street clothes. Another (below) showed Bill Wright holding a Man-of-Distinction glass in one hand, a cigar in another, and sticking the thumb of his third hand sportily into his suspenders. A mirror was framed inside an open box with the inscription, "Look Who's Voting For Groner." The ultimate blow was a brown envelope in the Beaver's mailbox one noon that con-

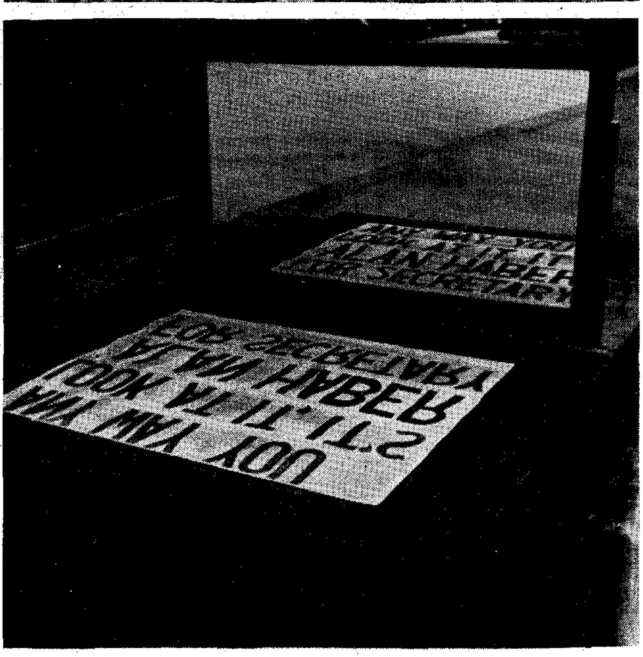

*Nature was a little over-generous to Candidate Wright.*




*Presidential Candidates Merten and Fee check on Peck.*







←*The campaign was spirited enough for everybody*

tained a blue-slip in "Civics la" for all who didn't vote for Haber; its authentic appearance had made the Beaver gasp for breath for a moment—and he suspected Haber might have lost some votes by this terrorizing method of winning attention.

Consternation was abroad in faculty circles; the students had proposed serving beer at the election rally Tuesday night in Culbertson. The students had already consented to remove the annual surreptitious election stag from the dusty catacombs to a position of recognition above ground, but had suggested that the ancient tradition of malt brew be maintained. An emergency Student-Faculty Committee meeting was called on Monday. It was packed with grim, beer-determined students. And when the smoke had cleared, there was only one dissenting vote and the triumphant rumble of kegs being moved into Culbertson was heard offstage.

The candidates were nervous; the night before election they sat for hours smoke-filling their rooms, discussing pro and con the effects they had had on the troops; they sat at meals on Thursday twitching their knives and forks with perceptible palsy. The Beaver sat across the table and watched them, wondered how Techmen would vote. He didn't know how many would honestly review the candidates' campaigns with unjaundiced eye, but he remembered that at most of the elections he had seen, experienced candidates with solid ideas had almost always won over less qualified opponents. With a sadistic leer at one candidate standing by the polls he took his ballot and secretively but with satisfaction marked in X's beside all the right names. When the suspense was over at 11:00 that night everyone journeyed up to the Skip Inn to drown or celebrate in beer. At least the final move could be made by all, victor and loser alike, although probably the biggest celebrators were the old Board members who were going out of office next week.

## The Theater-Goer

■ NORMALLY THE BEAVER was an exceptionally casual dresser, his constant weekday habiliments consisting of Levis and a rumpled shirt, each probably bearing acid-hole reminders of Frosh chem lab. However, several times during the winter term he had felt obliged to don formal attire and one of these times had been the gala premiere in Culbertson of EE Instructor Campbell's comic opera, "Spooks in the Basement."

As he tied his tie before the mirror the Beaver realized that this was the winter theater season and even Caltech was not entirely immune to its influence. The opera concerned itself with the love of a feminine math instructor for a superstitious but ambitious janitor who believed that the basement of the physics building was haunted. It struck a note of accord with the Beaver, who had long felt that the subterranean depths of Bridge contained many dark secrets rattling about among the old oil drops and bones of deceased researchers who had forgotten to eat in the absorbing quest for knowledge.

The theater season wasn't over with this, either, for the first week in March heralded the opening of the Drama Club's annual theatrics in a melodrama of considerable vintage and humor. It wasn't enough to necessitate buying a top hat, but Caltech's miniature Broadway was definitely a going institution, sliderules and thermodynamics notwithstanding.

—*Jim Hendrickson '50*

# ALUMNI NEWS

## New Board Members

■ In accordance with Section 3.04 of the By-Laws of the Association, the Directors met as a nominating committee on February 9, 1950. Five vacancies will occur on the Board at the end of the current fiscal year, one vacancy to be filled from the present Board and four members to be elected by the Association. The present members of the Board and the years in which their terms of office expire, follow:

| | | | |
|---|---|---|---|
| R. C. Armstrong '28 | 1951 | J. W. Lewis, Jr. '41 | 1950 |
| N. A. D'Arcy '28 | 1950 | R. F. Mettler '44 | 1950 |
| R. J. Hare '21 | 1951 | R. P. Sharp '34 | 1951 |
| R. M. Lehman '31 | 1950 | A. C. Tutschulte '31 | 1951 |
| G. K. Whitworth '20 | 1950 | | |

The four members of the Association nominated by the Directors are:

| | |
|---|---|
| T. C. Coleman '26 | D. C. Tillman '45 |
| J. E. Sherborne '34 | W. O. Wetmore '37 |

In accordance with Section 3.04 of the By-Laws of the Association: ". . . Additional nominations may be made by petitions signed by at least ten (10) regular members in good standing, provided that the petitions are received by the Secretary not later than April fifteenth."

Statements about the nominees of the Directors are presented below.

—*D. S. Clark, Secretary*

**SAVE THE DAY**

**THE ANNUAL MEETING**

**of the**

**ALUMNI ASSOCIATION**

**will be held on**

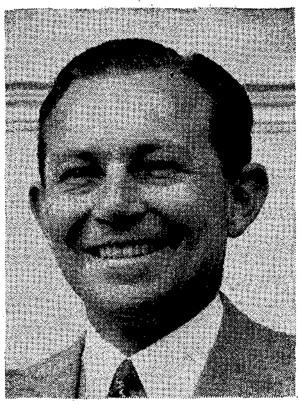
**June 7**

**COMMENCEMENT WEEK REUNIONS**

**JUNE 7**

**for the classes of 1915, 1920, 1925, 1930**

**1935, 1940, and 1945**



■ Theodore C. Coleman received his B.S. in Engineering and Economics in 1926. He participated in various student activities, and received an Honor Key during his junior and senior years. After three years with the Los Angeles County Road Department as a Junior Civil Engineer he entered the investment banking business as a salesman for Blyth & Co. in Pasadena. In 1930 he became manager in the Pasadena office of Banks, Huntley & Co., and was made a partner and sales manager for this firm in 1936.

Prior to the outbreak of World War II he was one of the organizers of Northrop Aircraft, Inc., joining that company as Secretary in 1940. He was made Vice-President and director in 1941, serving in this capacity until the end of the war.

At the end of 1945 he took his family to Sao Paulo, Brazil, where he engaged in his own business as distributor for a number of U. S. airplane and other manufacturers. At the end of 1947 he returned to California and served for a brief time as Assistant Treasurer of the Standard Oil Company of California in San Francisco.

He has now returned to Southern California and re-entered the investment securities business as manager of the Pasadena office for Hill Richards & Co. He is a member of Pi Kappa Delta, the Gnome Club, Stock Exchange Club, and Valley Hunt Club in Pasadena. He served as a director of the Alumni Association in the early 1930's.

■ John E. Sherborne received his B.S. in Science in 1934. He was President of the Chem Club, member of the Drama and Press Clubs and Associate Editor of the *California Tech*. From graduation until 1936 he worked at Tech as API research fellow with Sage and Lacey. In July, 1936, he joined the staff of the Union Oil Company of California as apprentice engineer. He continued to serve this company in various production engineering capacities until 1940. From 1940 until 1944 he was employed by the same company as a process engineer in charge of those phases of process engineering having to do with oil and water gathering, handling, dehydration, water disposal and water treatment. In 1945 he was made Division Production Engineer; in January of 1948 he was promoted to Chief Production Research Engineer, and in August of 1948 he was made Chief Production Engineer. In October of 1949 he was transferred to the Research Department as Assistant to the Vice President.

From 1940 until 1947 he also served as a member of the staff of the Department of Petroleum Engineering of the University of Southern California, during which

# ALUMNI SEMINAR DAY
# APRIL 15th

●

## THE PROGRAM

**MEAD**
The Psychology of Leadership

**GREENSTEIN**
Physical Properties of Interstellar Space

**SWEEZY**
Is the Cold War Ruining Us?

**ENGEL**
A Story from the Oldest Rocks in the World

**WENT**
The Earhart Plant Research Laboratory

**PANEL DISCUSSION**
Who Should Go to Caltech?

●

■ Prof. Hallett Smith will lead a discussion of the Humanities at Tech. An opportunity to meet the new Chairman of Humanities.

■ To acquaint the Alumni with the "Post-War" Campus, all the new labs and facilities will be open.

●

## EVENING BANQUET

**UNTEREINER**
What's Around the Corner

●

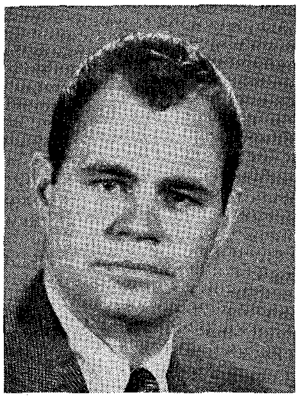
**DON'T FORGET . . . APRIL 15TH**

Registration 8:30 A.M.

time he conducted evening classes in various phases of petroleum production and reservoir engineering.

He has taken an active part in A.I.M.E. activities since 1938, and has served on both the Membership and Engineering Research committees—as chairman of the latter committee from 1946 through 1948. From 1947 to the present time he has been a member of the Executive Committee of the Petroleum Branch and, in 1948, he was Vice-Chairman of the Petroleum Branch. In 1949 he was also chairman of the Production Technology Committee. He is currently chairman of the Petroleum Branch.

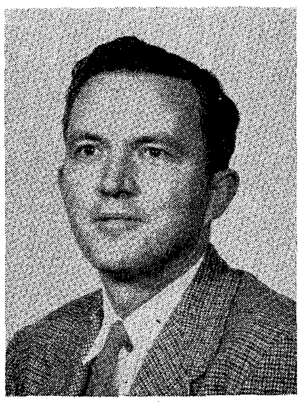
He has been active in A.P.I. affairs for a number of years, during which time he has served as chairman of numerous district and national committees. He is also a member of Sigma Xi, A.A.P.G. and A.I.Ch.E.



■ DONALD C. TILLMAN received his B.S. in 1945 and his M.S. in 1947 in Civil Engineering. He was a three-year letterman. He was a co-captain of the track team and a center on the football team (his name was placed on the Wheaton Football Trophy in 1944). He served on the Student Body Board of Directors as Second Representative-at-Large, Athletic Manager, and President. He was also Junior Class President, a member of the Board of Control, the Beavers, Tau Beta Pi, and holder of the Honor Key.

As an Ensign in the United States Navy, following graduation, he served as an instructor in the Civil Engineering Corps Officers' School at Davisville, Rhode Island. After discharge and working for private engineers in the east, he returned to a teaching assistantship and graduate year at Caltech.

In 1947 he worked for a contractor as Job Engineer on the Pacific Coast Highway realignment and construction at Malibu. He next went to work for the Street and Parkway Design Division of the City of Los Angeles and he has been engaged for the past two years in the design of freeways.



■ WILLIAM O. WETMORE received his B.S. in Engineering in 1937, his M.S. in Mechanical Engineering in 1939, and his Ph.D. in 1941. As an undergraduate he was Treasurer and Vice-President of Dabney House, Vice-President of the Varsity Club, athletic manager of the student body, captain of the football team, a member of the Beavers, and holder of the Honor Key. For two years, in 1938 and 1939, he was Resident Associate of Ricketts House.

From 1941 to 1945 he served as Chief Metallurgist for the Permanente Metal Corp., near San Jose, Calif. During this time he also taught war training courses in

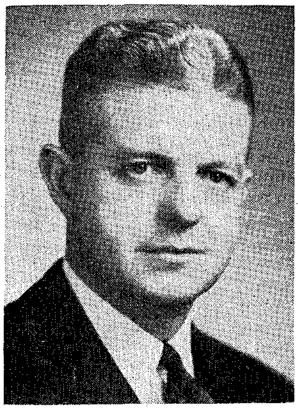
Metallurgy at Stanford University and the University of Santa Clara.

From 1945 to 1947 he worked on production problems related to the fabrication of metal parts for the Kinney Aluminum Co. in Los Angeles, and the General Tire and Rubber Co. of California in Pasadena.

Since 1947 he has headed the Metallurgy Branch of the U. S. Naval Ordnance Test Station in Pasadena.

He is a member of Sigma Xi and various metallurgical societies, and during the current (1949-1950) year he is serving as Chairman of the Social Committee for the Alumni Association.

## Vesper Trophy



■ THE INSTITUTE'S Athletic Department was happily surprised recently to receive a new perpetual trophy from Howard Vesper '22, to be awarded at the close of each basketball season to that member of the squad most qualified from the standpoint of sportsmanship, improvement, moral influence and scholarship. The first winner will be announced this month, and his name is to be engraved on the trophy, which is designed to accommodate such listings for a number of years.

In making the award, Howard Vesper, who played basketball on Tech teams from 1918 to 1922, says, "It is my sincere hope that the establishment of this award will in some measure be effective in stimulating greater interest and enthusiasm in the sport at the Institute."

## Chapter Notes

■ THE ALUMNI CLUB of Chicago held its winter meeting on January 26 at the Chicago Engineers Club. Special guest and speaker of the evening was Prof. Gilbert D. McCann, who gave an illustrated talk on the Analog Computer. The club was also happy to see Prof. F. C. Lindvall, who was in Chicago at the time.

■ ALUMNI OF the San Francisco Chapter, their wives and friends, gathered for a social evening at the Twentieth Century Club in Berkeley on Friday, January 20. After a pot luck dinner, new members were introduced—alumni of the classes of '48 and '49. (After looking at the graduation dates on some of the name tags around him, W. N. Jarmie '48 decided he would feel more at home if he wrote down his birth date, which he did—1928.) Besides Jarmie, Byron Youtz '48 and Kent Terwilliger '49 were welcomed to the chapter. The group then adjourned to the second floor of the club house for dancing—and some spirited group singing—until midnight.

Alumni attending the dinner dance included: E. E. Dorresten '22, L. H. Erb '22, H. G. Vesper '22, M. W. Edwards '26, M. T. Jones '26, D. J. Pompeo '26, .H E. Larson '27, A. Hazard '30, R. Stirton '30, J. S. Detweiler '31, E. S. Hill '31, C. K. Lewis '31, G. E. Liedholm '31, J. F. McGarry '31, E. C. Keachie '32, R W. Haskins '34, J. J. Halloran '35, R. G. Heitz '36, T. Vermeulen '36, A. L. Grossberg '42, L. J. True '42, J. W. Hadley '45, W. N. Jarmie '48, B. Youtz, '48, and K. Terwilliger '49.

# PERSONALS

## 1903

*Richard W. Shoemaker* writes from Oakland that he is preparing a second edition of his book, *Radiant Heating,* and "getting ready to watch the world go by from my Grass Valley retreat."

## 1911

*Harold C. Hill* brings us up to date on his activities since his graduation at the first commencement to be held on the present campus. From 1911 to 1917 he worked for the General Electric Co. in Lynn, Mass. In 1917-18 he served as an instructor in electricity with the Coast Artillery Corps at Fort Monroe. From 1919 to 1923 he was in charge of motor and control sales for International G.E., and from 1923 to date he has been in charge of the User Section of the Industrial Division of General Electric in Los Angeles. A former member of the Alumni Board he also served on Dean Thomas' Committee on Student Activities and assisted in the formation of Throop Club. To date he has one daughter, and one granddaughter.

## 1917

*A. R. Kemp,* M.S. '18, after 30 years with the Bell Telephone Laboratories, where he was in charge of Organic Chemical Plastic and Rubber Research, retired in 1948 and is now a Consulting Chemist in Long Beach.

## 1921

*Truman F. McCrea* writes from Mill Valley, in the San Francisco area, that he'll become a grandfather sometime this spring. "The job part," he says, "is a little more depressing. After my return from Shanghai just prior to the recent war, I joined the Treasury in the Foreign Funds Control Division, and was with them for five years—including 13 months in the Philippines.

"Returning from the Islands in June, 1946, I opened a little export firm and did pretty well for a couple of years, but export controls here, import controls overseas, and the rapidly-diminishing U.S. dollar balances held by foreign countries have combined to bring the business to the point where I am polishing up my voice to sing *requiescat in pace* over it."

## 1922

*E. T. Groat* writes from Chicago that his son, Leonard, was married to Mary Ann Hull of Wheaton, Ill. on December 30, 1949. His younger son, Russell, is a freshman at Occidental this year.

*George C. Henny,* M.D., was recently made Professor of Medical Physics at Temple University's School of Medicine in Philadelphia. His work is mainly in medical research with isotopes and x-rays. His daughter, Jeanette, was married last October; his son David is beginning to develop a consuming interest in science.

## 1925

*Byron C. Hill,* after many years of construction of the Observatory on Palomar Mountain, is now in the midst of the transition from construction to its operation.

*Henry R. Freeman* writes that his daughter Shirley was married on December 21, 1949 to Paul Kriet, who graduated from Stanford last year.

## 1930

*Robert I. Stirton,* Ph.D. '34, writes to say that the latest news with him is the fact that his 18-month-old son forced the family out of its San Carlos apartment last fall. Now the Stirtons own their own home at 745 Alvarado Road in Berkeley.

*Clyde Giebler,* M.S. '32, is working as manager of Market Research for U.S. Electrical Motors, Inc., in Los Angeles. He forecasts production schedules on all types of electric motors, from 400 cycle magnesium aircraft geared motors to 50 hp varidrives. The Giebler family now includes a 7-year-old daughter and a 10-year-old Cub Scout.

## 1931

*William M. Cogen,* M.S. '33, Ph.D. '37, research geologist with the Shell Oil Co. in Corpus Christi, Texas, became a father last December 27—a girl, Lorna Ann.

## 1932

*David Y. K. Wong,* M.S. '33, writes from Hongkong that he was assistant chief engineer of the Canton Harbor Construction Bureau under the National Ministry of Communications, and in charge of the Whampoa Harbor District up to the time Canton was "liberated" by the Reds. He is now doing some private contracting business in Hongkong—at No. 1 United Terrace, Ho Man Tin St., 1st Floor, Kowloon, Hongkong.

*Merit P. White,* Ph.D. '35, brings us up to date on his activities since graduation. He spent three years at the Illinois Institute of Technology in Chicago, two years with OSRD in Princeton and one in London, three years with the War and Navy Departments in London, Washington and Frankfurt, Germany. For the last two years he has been head of the Civil Engineering Department at the University of Massachusetts in Amherst. The Whites have one daughter, Mary Jessie, 2½.

## 1934

*Duncan H. Douglas* and his family (Bruce 8, Allan 6, Alice 4, and Roger 1) moved back to Pasadena recently, where he is chief draftsman at the Utility Trailer Manufacturing Co.

*John F. Pearne,* patent lawyer with the firm of Evans & McCoy in Cleveland, Ohio, writes that he checked through the last alumni directory the other night and found that he was the only man listed as residing in all of northern Ohio. "This," he says, "has been a disappointment. Can't you send someone out to keep me company for I seem to be rooted here? My wife says it's not bad here either—and we have no smog."

## 1936

*T. G. Geddes* writes that he's engaged in aircraft hydraulics work, as chief engineer of Bertea Products in Pasadena. He lives in Altadena (at 1270 Westlyn Place) and raises "the tallest weeds in the state."

*Howard F. Hamacher* was elected Assistant Treasurer of Arthur D. Little, Inc. in Cambridge, Mass. last month. The Hamachers (Susan 5, John 1½, and Christine 6 months) live at 109 Follen Road, Lexington, Mass.

*Ray Jensen,* M.S. '37, completes his 10th year at the Hughes Aircraft Co. this spring. He is project engineer in charge of the world's largest helicopter, now being designed and built for the U.S. Air Force.

## 1937

*E. W. Cornwall* writes that he is presently employed by Douglas Aircraft in El Segundo, where he works with heat transfer problems on aircraft. "In the past ten years," says Bill, "I have accumulated a wife, two daughters (aged 2 and 6) and a half-acre combination flower and weed patch in the San Fernando Valley, where I now live. I am patiently trying to replace the weeds with flowers and fruit, but it's an uphill job."

## 1938

*Harper Q. North* lists the following events that have occured since his last communique: A position as Research Associate with General Electric in Schnectady, New York; a Ph.D. in Physics from the University of California in February, 1947; a return to GE, until February, 1949; a daughter, in August, 1947; a position with Hughes Aircraft, in March, 1949, in the Department of Electronics and Guided Missiles, doing semi-conductor research and development.

*Henry S. Hopkins* is now an economic analyst with the Boeing Airplane Co. in Seattle. He was married in April, 1948, to Eleanore Hamlin, has one son, Robert Alan, born in January, 1949.

## 1939

*Fred Hoff* is still a mechanical engineer with Industrial Engineers, Inc., where he has charge of the design and drafting section. The organization designs and manufactures custom-built heat-transfer equipment, principally for natural gas and gasoline processing. The Hoffs live in Bell, Calif., have two children—David 6½, and Laura 1½—"who provide the basis for a most active home life."

## 1940

*Francis Morse* is practicing architecture in Westport, Conn., and "devoting an increasing amount of time to the cause of World Federation." The Morses have two daughters and a son.

*Frank Dessel* and his father have just sold their drug store in San Francisco, which was established 41 years ago. Frank is now working as a pharmacist for the new owners but hopes to locate a drug business in the Los Angeles area in the next year or two.

## 1941

*Roy Acker* is employed as a designer in the Engineering Department of the Hughes Aircraft Co. at Culver City. He is now serving as group leader in charge of controls and hydraulics design on the world's largest helicopter.

*H. G. Stever,* Ph.D., is Executive Assistant to the Chairman of the Guided Missiles Committee at M.I.T.

## 1942

*Fred M. Ashbrook's* second son, Donald, was born on December 17. Fred is head of the Missile Instrumentation Unit at the Naval Ordnance Test Station in Inyokern. He has been elected Chairman of the Inyokern IRE section for 1950.

*Willar P. Fuller,* M.S., is the father of a daughter, Frances Elizabeth, born Dec. 27 in Salt Lake City. He has been with Anaconda Copper since 1942 and is now chief geologist at their North Lily mine in Eureka, Utah.

*Charles B. Metz,* Ph.D., a member of the zoology department at Yale, returned to the Caltech campus last month for three months' work as a Gosney Fellow in the Biology Division.

*Robert E. MacKenzie* received a Ph.D. in Mathematics, and *Warren S. Torgerson* an M.A. in Psychology from Princeton in January.

## 1943

*Robert M. Francis* has been an equipment design engineer for Pacific Airmotive Corp. in Burbank for the past year and a half. His family consists of Leslie Louise, 2 years old, and Raymond Warren, 13 months—"plus a new home in Sherman Oaks which keeps us busy and broke!"

*Robert L. Bennett* (Bob Francis' brother-in-law) and his wife are proud parents of a son, Charles Laurence, born January 24. Bob is with the Telephone Co. and has a new home in Chapman Woods, Pasadena.

*Ed Wheeler,* Ex '43, writes that he is still running station WEAW in Evanston, Illinois. Also that he is President of Storebroadcasting Service, Inc. and has just bought WOKZ-AM-FM in Alton, Illinois.

## 1944

*Howard Chang* has been on the faculty of Clarkson College, Malone, N.Y., since September as a physics instructor.

*Harrison Sigworth* says his best news is a new baby—their second boy. He has been working for the past four years for the California Research Corporation in Richmond, Calif., in the Engine Fuels Research Laboratory.

*J. Ben Earl* is working for O. K. Earl, Jr., General Contractor, in Pasadena. Ben is married and has two daughters—ages 3 and 1.

## 1945

*George Fenn,* M.S. '46, is employed at Northrup Aircraft as Supervisor of Theoretical and Analytical Work in the Special Weapons Department. He writes that Northrup is well populated with Tech men, including *L. D. Hindall,* M.S. '46, *F. Stevens,* M.S. '47, *R. V. Rhoades* '43, *K. M. Stevenson* '45, and *I. S. Reed* '44 in his department.

## 1946

*Edwin Gould* is at UCLA working on organo-selenium compounds. He expects to receive his Ph.D. in June.

*Rexford R. Cherryman,* Lt. (jg.) USN, will be married this spring to Beatrice Wishard of San Francisco. He is now serving aboard the USS Fletcher.

*Howard Morgan* has left his government position in Washington to go into the Allis-Chalmers training program. Now in the New York District Office, he expects to go to Milwaukee soon.

*James Densmore,* M.S. '48, Eng. '49, was married this winter in Phoenix to Linda Mae Hardesty. They are living in Claremont where she is studying at Scripps. He is working at the Jet Propulsion Lab in the Design and Development Section.

## 1947

*Harold Kuhn* received a Ph.D. in Mathematics from Princeton University in January.

*Dean Watkins,* M.S., is working for a Ph.D. at Stanford in Electrical Engineering.

*Lt. Cdr. A. H. Wellman* is on aeronautical duty in Hawaii with the Fleet All Weather Training Unit, Pacific. After leaving school he was stationed at the Bureau of Aeronautics Office at Lockheed until his assignment to Hawaii last February.

## 1948

*Vincent Honnold* is in his second year of graduate study at the University of Notre Dame, working towards a Ph.D. in Physics. He and his wife have a ten-months-old baby girl, Maryanne.

*Donald and Mary Wilkinson* announce the arrival on January 30 of their first child—a boy, Ronald James Wilkinson. Don is still with Boeing in Seattle.

*Rupert M. Bayley,* who claims the longest continuous attendance at Caltech for a B.S. degree—continuous 1928 to 1948 except for a short leave of absence from 1929 to 1946 (!)—writes that he is an electrical engineer for the Department of Water and Power, City of Los Angeles, in Transmission Design and Research. He has three children, ages 14, 10, and 4.

*Frank J. Wolf* has been working since graduation for the Allis-Chalmers Mfg. Co. Last month he was graduated from the Graduate Training Course. During his 18 months on the course he saw a considerable number of the various shops and offices which are offered as training locations. Just recently he was transferred to the company's Norwood Works, in Cincinnati, for a closer view of the products manufactured there—small pumps and small motors. Towards the end of the year he hopes to be in one of the company's sales offices as a "peddler".

## Books CONTINUED FROM PAGE 4

something which will include the Maxwellian field on ignoring the gravitational effects.

Here he finds encouragement for the fact that he is indeed able to find a set of field equations which have the requisite formal property of reducing to those of the previous theories in the two limiting cases. For those who wish a more extended account of this development, reference may be made to Einstein's paper in the January issue of the *Canadian Journal of Mathematics.* But the question of whether the further development of this unified field theory will grant a deeper understanding of the relation between gravitational and electromagnetic phenomena is one which only the future can answer; of it, Einstein only asserts, "I have not yet found a practicable way to confront the results of the theory with experimental evidence."

* * *

*Reviewer's Note.* The above rather factual (and possibly rather dull) review of the content of Einstein's excellent *The Meaning of Relativity* may seem anticlimactic to some, in view of the frenetic journalistic reception of the publisher's announcement of the book some weeks ago. To such I would only say that it is disappointing to note that there are yet those among the reporters and literary critics who seize upon such an announcement to inflict upon the general public their untrained judgement in matters scientific—and this in spite of the patent reluctance, in this case at least, of their principal victim! But science reporting is growing up, in pace with the increasing public interest in matters scientific: perhaps we should most charitably write off its present excesses as a transitory kind of intellectual growing pains.

# SCIENCE IN THE NEWS

## Low Temperature Laboratory

■ Columbia University's Physics Department is about to start full operation of a laboratory where researchers will be able to study the properties and reactions of matter at extremely low temperatures.

Physicists have already produced temperatures as low as within one degree of absolute zero (459 below zero Fahrenheit). The low temperatures are produced by liquefying helium, with the aid of a machine known as the Collins helium cryostat.

Future studies will include examinations of the electrical and magnetic properties of metals and the dielectric or non-conducting properties of liquid helium.

## Laboratory of Physical Chemistry

■ Harvard University last month announced the establishment of an independent laboratory to make fundamental studies of body tissues and fluids, in a search for general principles applying to all living matter. Chiefly an administrative refinement of existing facilities, the new unit will be known as the University Laboratory of Physical Chemistry, related to Medicine and Public Health. It will center its research on proteins.

## Conservation Course

■ Starting next Fall Yale University's Division of Sciences will establish a program of research and instruction in the field of conservation of natural resources. Limited to graduate students, the courses will require two years of study and research, leading to the degree of M.S. in Conservation.

## Atomic Diaster Control

■ The University of California recently released details of a hitherto undisclosed graduate course for training experts in atomic disaster control. Students of the initial classes consist of 27 officers of the armed services—ranging from colonel to lieutenant—and one public health expert. Half of these will finish the course this June, at which time they will have completed two years of intensive study at Berkeley plus one summer session at the AEC's Oak Ridge plant.

Upon graduation the students will be given the degree of Master of Bioradiology and will be assigned to work under military commanders of vital areas in the country.

The course has never been announced, and is not yet in the UC catalogue—but the university says this is not because there's been anything hush-hush about it; it's just that it doesn't belong to any one department.

## Institute of Microbiology

■ Rutgers University last month dedicated the first unit of its new Institute of Microbiology. The $65,000 building will serve temporarily as a virus research center, though work is to start soon on a $1,000,000 building for this purpose. Funds come from the Rutgers Research and Endowment Foundation, which, in turn, gets most of *its* funds from royalties from the manufacture of streptomycin — which was discovered by Rutgers' famous microbiologist, Dr. Selman A. Waksman.

# This is a picture of "PING"

**It's a picture that gives automotive engineers clear-cut facts on performance—a picture that suggests how photography with its ability to record, its accuracy and its speed, can play important roles in all modern business and industry.**

No, this is not the "doodling" of a man on the telephone. Far from it. It's the photographic record of an oscilloscope trace that shows, and times, detonation in a "knocking" engine. It all happens in a few hundred-thousandths of a second—yet photography gets it clearly and accurately as nothing else can.

Oscillograph recording is but one of countless functional uses of photography in bettering products and improving manufacturing methods. High speed "stills" can freeze fast action at just the crucial moment—and the design or operation of a part can be adjusted to best advantage.

And high speed movies can expand a second of action into several minutes so that fast motion can be slowed down for observation—and products be made more dependable, more durable.

Such uses of photography—and many more—can help you improve your product, your tools, your production methods. For every day, functional photography is proving a valuable and important adjunct in more and more modern enterprises.

**Eastman Kodak Company, Rochester 4, N. Y.**

**Functional Photography**

**. . . is advancing business and industrial technics**

Kodak
TRADE-MARK

"Nothing is stronger than public opinion. Given the facts, nothing is wiser."

# *On Competition*

Hatch a good idea and you hatch competitors.

It works this way—to take General Electric as an example:

In 1934, the automatic blanket was initially developed by General Electric. Today there are twelve other companies making electric blankets in competition with G. E.

In 1935, General Electric first demonstrated fluorescent lamps to a group of Navy officers. In 1938, the first fluorescent lamps were offered for sale. Today they are being manufactured by a number of companies.

The first turbine-electric drive for ships was proposed and designed by G-E engineers. Today four companies in this country build this type of ship-propulsion equipment.

After several years of laboratory development, General Electric began production and sale of the Disposall kitchen-waste unit in 1935. Today fourteen other companies are in this field.

The first practical x-ray tube, developed at General Electric years ago, is now a highly competitive business for seven manufacturers.

In 1926, a practical household refrigerator with a hermetically sealed unit was put on the market by General Electric. Today 34 companies are manufacturing household refrigerators with hermetically sealed mechanisms.

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Research and engineering snowplow the way, not only for new public conveniences, but also for new companies, new jobs.

There are 20% more businesses today than there were immediately after the war.

Industry furnishes over 10,000,000 more jobs than ten years ago.

The average family owns more and better products of industry than ten years ago.

Any American company that plows back money into research and engineering development makes new business not only for itself, but for others.

The economy that does most to foster competition is the one that makes easiest the establishment and growth of business.

*You can put your confidence in—*

**GENERAL ELECTRIC**