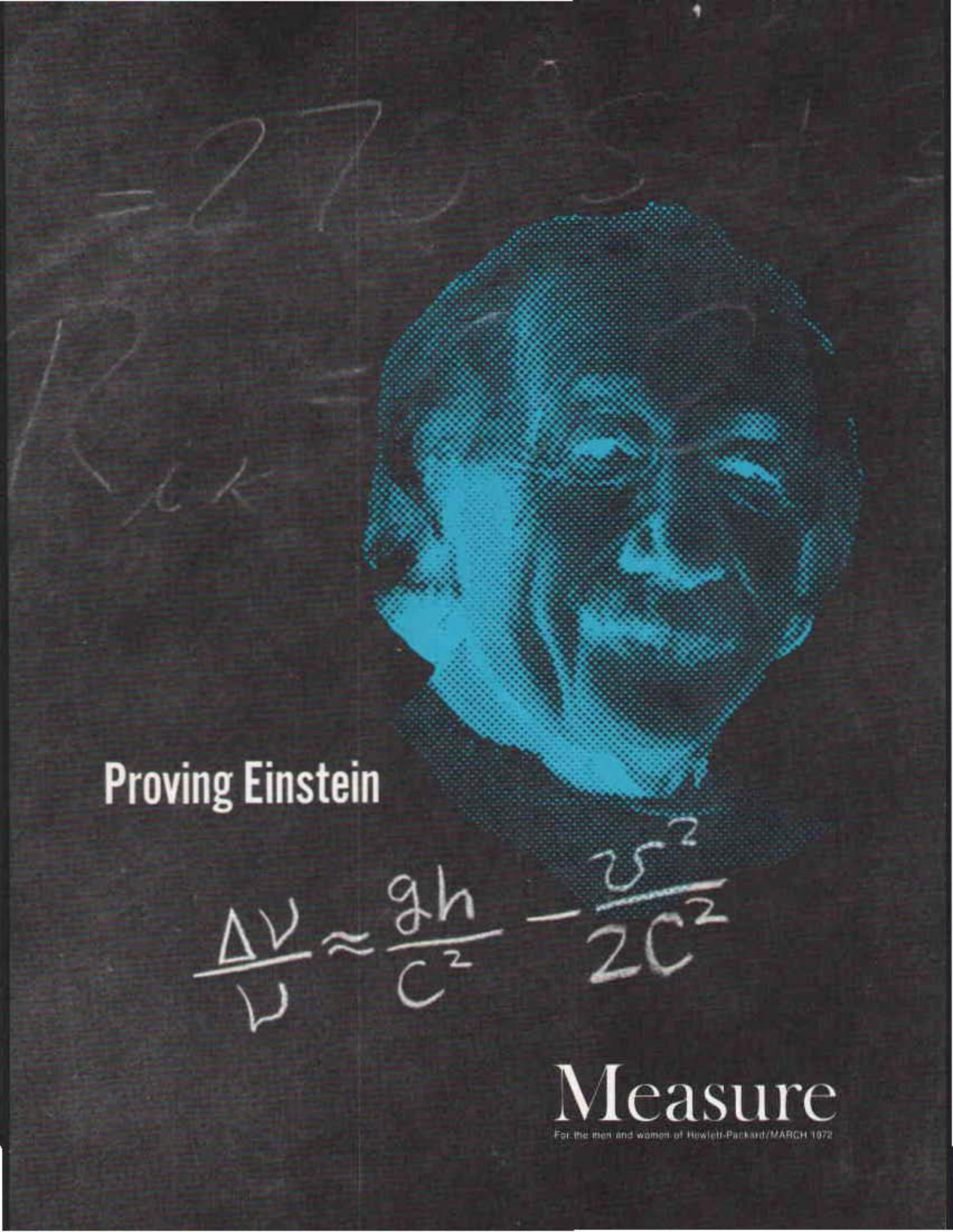
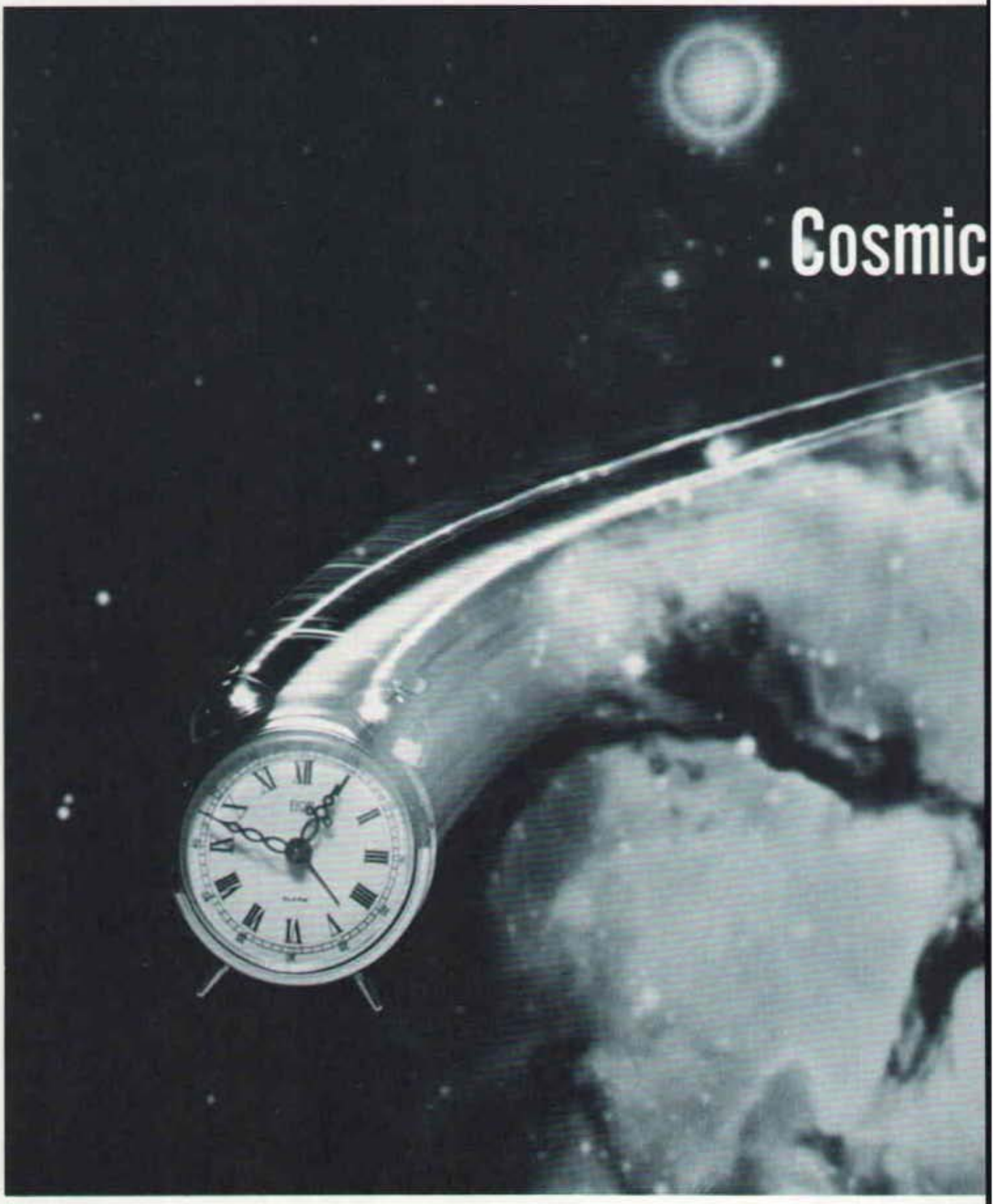


Measure

For the men and women of Hewlett-Packard/MARCH 1972


Cosmic

☐ You've all heard of Albert Einstein's Theory of Relativity. That's the theory that says if you take a long round-trip journey at high speed through the stars, you could inherit a great deal of money from your relatives. Because, when you return you might be, for example, 95 years younger than your twin brother, relatively speaking. You could end up owning Wall Street.

That's one view of the portion of Einstein's theory dealing with certain effects of velocity, acceleration and gravity when an object is in motion relative to an unaccelerated object.

According to the Theory of Relativity, time is stretched or slowed down for the object in motion; close to the speed of light it is almost at a standstill relative to the fixed object. Thus an identical twin transported out and back through deep space should return still young, while his twin would be old and gray or even ancient history. With such paradoxical possibilities, the Einstein theory has naturally become a favorite playground for science fictioneers, as well as a debating ground for serious scientists.

The debate revolves around the question of whether the effect of time lag is real or whether it is only an illusion. Most scientists say the

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HP atomic clocks figure prominently in attempts to affirm important aspects of the Theory of Relativity

Following eastward then westward jet trips around the world, Prof. Joseph Hafele of Washington University, left, and Astronomer Richard Keating, of the U.S. Naval Observatory, right, are greeted by HP's Al Walcek, instrument field engineer of the Rockville (Wash., D.C.) office. In the foreground are the four HP atomic clocks that accompanied the two scientists. The clocks were later compared with other stationary HP atomic clocks at the U.S. Naval Observatory. Indications are that the results support the "real" effect predicted by Einstein's theory of relativity.

effect is real. Bring two clocks together, they say, then launch one on a long, fast round-trip voyage. There would be, it is claimed, a lag in the time keeping of the traveling clock—a small but measurable attenuation of time. The effect is caused by the accelerations necessary to bring the traveling clock back to its companion.

But a few scientists still contend that the effect is more or less the illusion an observer would experience in viewing both clocks while the traveling clock was still in motion. Bring the clocks together again, these scientists say, and there would be no difference.

And so the stage has been set for some very interesting and dramatic experiments. You might even call them a showdown. Because they do involve the face-to-face confrontation of clocks—and interpretations of theory. And it just so happens that the clocks involved are Hewlett-Packard atomic clocks, cesium standards produced at the Santa Clara Division. In fact, without these HP instruments, the various experiments would not be possible at this time.

The first of these experiments was begun last October by Physicist Joseph Hafele of Washington University in St. Louis, and Astronomer Richard Keating of the U.S. Naval Observatory. They flew once around the world in an easterly direction with a set of four HP atomic clocks they would later compare with identical earthbound clocks. On the first leg, the flying clocks would appear to a stationary observer in space to be moving faster than the earthbound reference clocks. The jet-borne clocks therefore would show a slowing in relation to the reference clocks.

Then the team did an about-face, and jetted westward around the world. In this case, to the observer the earth—due to its rotation—would appear to be moving faster than the aircraft, and thus the flying clocks would gain time relative to the ground clocks. In each case, the increments of time gained or lost would be infinitesimal—in ten millionths of a second, but still measurable by the super-precise oscillations of the cesium atoms in the HP instruments. There are also effects due to the gravitational field of the earth.

The Hafele-Keating data is still being evaluated, but preliminary results indicate agreement with the effect predicted by relativity theory. Meanwhile, excitement has been brewing over a much expanded version of their experiment. This one would involve flying an atomic clock to the moon and back aboard an Apollo spacecraft. The target date for this test now appears to be Apollo 17, presently due for launching early in December. According to Prof. Carol Alley of the University of Maryland, who proposed the Apollo test, the experiment has the backing of the astronauts as well as scientists. In fact, there is a feeling the relativity project could be among the most exciting of scientific adventures yet undertaken in space. HP people are certainly very interested, including Len Cutler, head of the Physical Research Laboratory of HP Labs, where development of HP's cesium beam tubes takes place, and Ron Hyatt

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What makes an atomic clock tick?

The secret is the special property of cesium atoms to resonate or oscillate "sympathetically" in response to one exact radio frequency. It turns out that this beat occurs 9,192,631,770 times per second. Thus, in the cesium atom man has discovered what one science writer called "a virtually perfect measurement of the passage of time." HP's atomic clocks enable scientists and engineers to tune in to that fantastically precise pulse. The cesium clock, in fact, has been accepted as the international time standard since 1967 when it replaced the former celestial method of time measurement. The present definition of a second is that time interval during which 9,192,631,770 oscillations of the free cesium atoms occur.

...more than scientific curiosity is involved. Indeed, the theory of relativity has become one of the chief underpinnings of our scientific view of the evolution of the universe... an important philosophical and psychological relevance to man's view of himself as a member of the universe.

and Lee Bodily of Santa Clara Division's Precision Frequency Sources team.

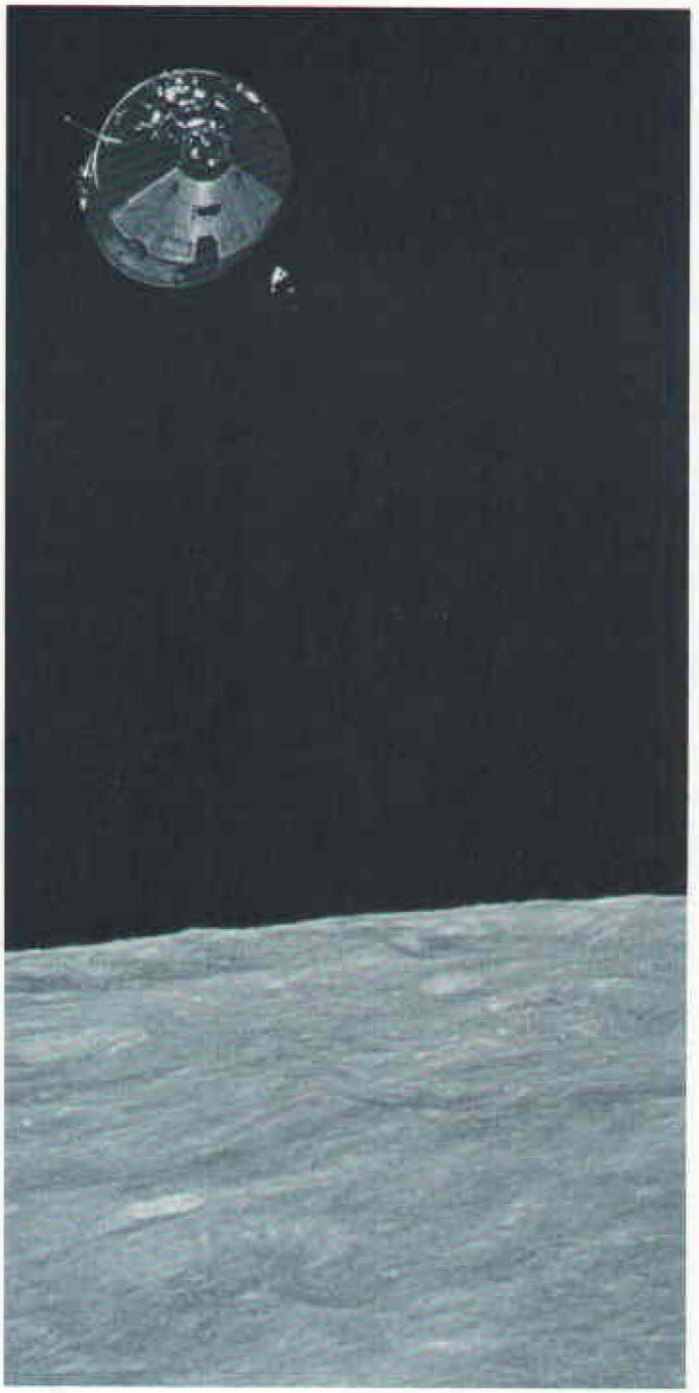
According to Len Cutler, himself a physicist who maintains close contact with the various scientific endeavors, the Apollo people would prefer to take up the large 16-inch cesium tube model of the HP atomic clock. But chances are that they will settle on the smaller tube developed for applications such as the Collision Avoidance System.

These tubes have been developed by the Physical Research lab in a continuing effort to maintain and improve HP's position as the leader in time-frequency technology. Some of the lab people were originally with the Bomac quantum electronics division of Varian, in Beverly, Mass., and had developed and manufactured the first 16-inch tube used in HP's 5060A and 5061 cesium standards. This group was bought by HP in 1967. Len Cutler, who had been heading HP's beam-tube effort, became its manager. In 1969 the whole division was moved to California. The research portion formed the nucleus of the Physical Research lab, while the tube-production group went to the Santa Clara Division under Lee Bodily.

"In the Apollo 17 project, in order to protect the experiment," said Cutler, "we would telemeter the data at all times. This should give us the same results as the face-to-face comparison of clocks after the voyage. Still, telemetry is not as convincing to the public as a direct confrontation of instruments.

"We estimate the difference between the clocks after the Apollo flight would be around 700 microseconds, most of which would be caused by the gravitational effect; the velocity effect would be relatively small."

A third relativity experiment, this one involving hydrogen maser clocks, is scheduled for some time in 1974. The masers will be very similar to those Hewlett-Packard became



HP's atomic time-keeping capabilities were filmed recently at Santa Clara Division's Measurement Standards Department by *Encyclopaedia Britannica* crew. Film will deal with time—a subject very dear to the division's heart. Here, Jim Marshall, standards manager, discusses the Time and Frequency Standard that is certified as a reference station by the National Bureau of Standards and the Naval Observatory. HP guarantees the standard, using three cesium-beam atomic clocks, will maintain accuracy withing ±5 microseconds. A similar standard is maintained in European headquarters near Geneva. Users pay for the service of calibration.

involved with in the former "F&T East" operation at Beverly, Mass. (due to its limited application and consequent small sales potential, HP eventually turned over the maser work to the Smithsonian Astrophysical Observatory). As now planned, one hydrogen maser will be rocketed in a trajectory that carries it out a distance equal to several earth radii, then be dropped into the sea. The data would be telemetered all the way down and compared to a maser on the ground. Presumably it would be a very accurate experiment due to the great stability of the hydrogen atom as a frequency source.

The central purpose of all of these experiments is scientific. Yet far more than scientific curiosity is involved. Indeed, the theory of relativity has become one of the chief underpinnings of our scientific view of the evolution of the universe and its basic space-time geometry. These cosmological aspects of the theory, therefore, have an important philosophical and psychological relevance to man's view of himself as a member of the universe as well as deep scientific importance.

On the more practical side, there has been some real discussion that if men ever undertake interstellar travel, they theoretically could make voyages far beyond their normal life span on earth, because at speeds approaching light they would age very slowly as viewed from earth. There is also the Navy's stated purpose in supporting the Hafele-Keating experimentation as a means of testing the accuracy of worldwide systems of navigation and communication. Finally, it is possible to see benefits to HP and the cause of aircraft collision-avoidance systems through the association of the new small cesium beam tube with Apollo and attempts to prove relativity theory.

Meanwhile, the great time controversy seems to be running out of time. □

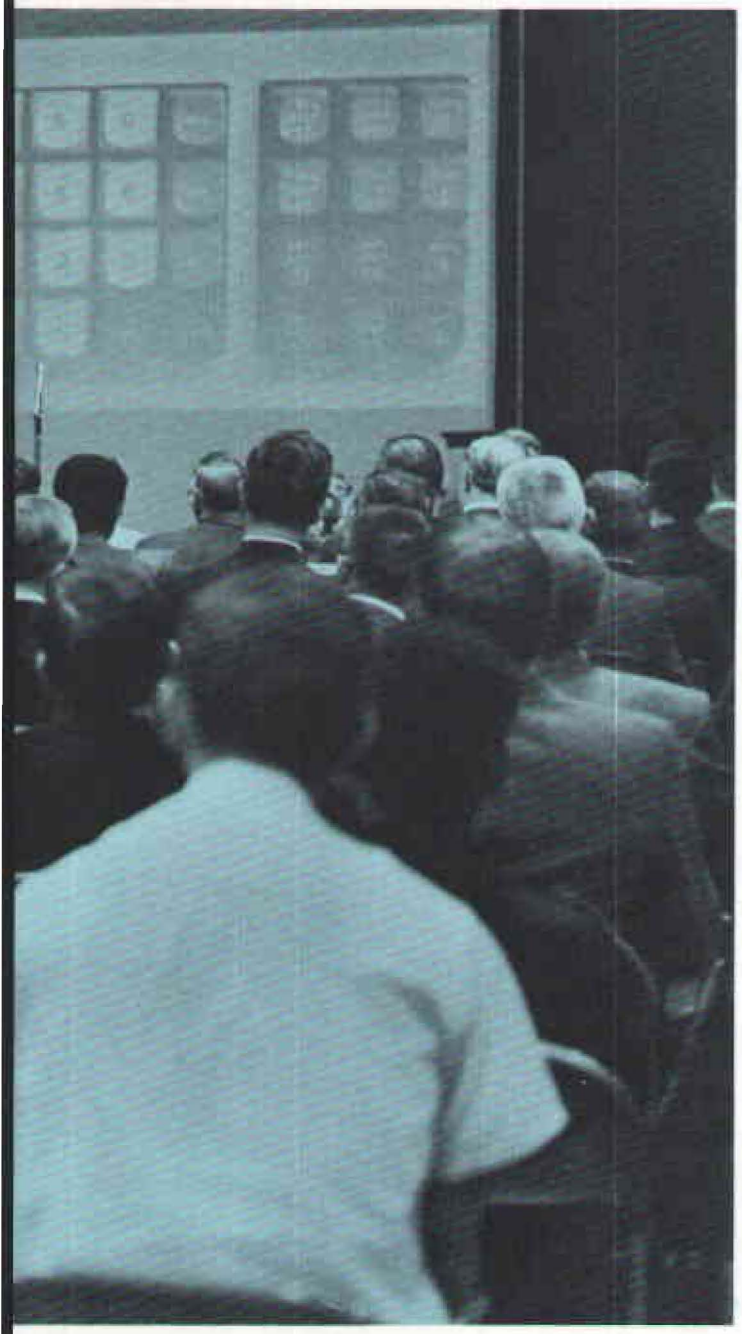
New view

Few people have seen the Hewlett-Packard Stanford complex from this vantage point. It was made possible only by the recent completion of a 10-story building a few blocks to the north of the headquarters plant. The complex presently is home base for Corporate offices, HP Labs, Manufacturing Division, and Microwave Division. Parts of all six buildings are visible in sequence, starting with number six—the newest—on the left. Page Mill Road and the main plant entrance are at the right. Beyond loom the Santa Cruz Mountains and a sunset sky. Photographer Hal Smith used double-exposure and double-negative techniques to combine the best effects of day and night lighting.

Measurers take measure

☐ The art, science and business of measurement—metrology, as it's called—made some startling progress in the Sixties. But the coming decade is likely to provide an even greater challenge.

That's a major conclusion most participants must have reached after attending the Fourth Measurement Managers' Symposium hosted by HP at Palo Alto. The 175 visitors from major calibration, test and quality-assurance facilities around the U.S., Canada and Mexico had some very broad and exciting perspectives held up for their viewing during the three-day gathering.



State of the art in instrumentation was topic for Loveland's Marco Negrete before meeting of 175 metrologists hosted by HP at Palo Alto.

Large on the horizon, for example, is the prospect of U.S. conversion to metric measurements. For industry at large and the public there remains a big job of education and change. But it's a job that needs to be done if the U.S. is not to find itself isolated forever in the non-decimal world of pounds and inches. The U.S. is the only major country without an official plan for metrication. However, according to various speakers at the symposium, it's reasonably certain that a future Miss America's classic measurements will be publicized as "90-60-90"—centimeters, that is.

Another important general trend was described by Bill Hewlett in his opening remarks to the visitors. Precision measurement, he indicated, will become more than a lab or Q.A. function; increasingly it will take an important place on the production floor as users seek more accuracy in their operations. Motivating this trend is the overall shift to high-density integrated circuits, the decreased size of many electrical functions, and the development of sophisticated systems such as collision avoidance or color TV transmission that demand utmost precision for their operation. Making these shifts possible are new developments in automation, and the greater ease with which precision measurements can be made because of improved technology. He cited HP's laser interferometer and atomic clock as examples of lab standards brought to wide practical applications.

Economically, the worldwide electronics business faces very considerable growth, according to Bob Peters, Senior Industrial Economist at Stanford Research Institute. He reported to the Symposium that at the beginning of the 60's the world total for electronics was $14 billion. By 1970 this had grown to $50 billion. By 1980 it will reach $124 billion.

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measurers take measure

But it's not all clear sailing: There will be significant shifts in emphasis between the various lines of consumer and professional products, and between the countries producing and consuming them. The U.S. is forecast to have a smaller percentage of the world market in 1980 than 1970 (59 percent versus 67 percent). Japan will continue to set the growth pace at 16 percent per year, twice the U.S. rate.

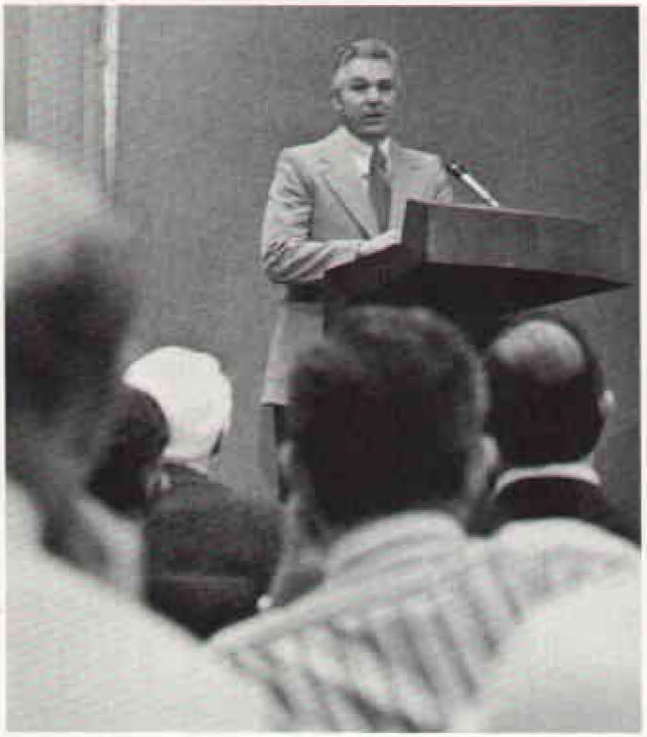
The meeting naturally covered a lot of ground that only a professional metrologist would appreciate—the organizational side of metrology, some how-to-do-it discussions, and the problem of managing metrology. It was noted, for example, that considerable metrology help will come from the National Bureau of Standards. Anything but the "feather duster custodian" of standards of measurement, it is a vigorous and user-oriented organization that's very involved in advancing man's ability to better cope with his environment through metrology.

But probably the most pervasive theme concerned the powerful effect of the computer and computer technology on measurement and the people involved. The computer theme came up many times; Elgen Long, air adventurer, documented the flawless navigation job the computer navigation system performed on his recent around-the-world trip. Several metrology managers pointed out that computer systems were the only way that productivity could be increased to get the job done in today's competitive environment.

Yet through it all the difficulties of adapting technology to the workplace was stressed. The real management challenges of the '70s will be in helping the "now" people develop into "new" so industry can take advantage of new methods and the employees can have additional challenge and personal growth.

Finally, the growth of "consumerism" and product liability movements, coupled with more government involvement and a multiplicity of standards agencies, is sure to put an extra challenge—and an opportunity—on the whole field of measurement. □

The nimbleness of mind of Nobel Prize-winning physicist Luis Alvarez was evident in his discussion of the role of instrumentation in research. He contrasted the problem of accuracy in some notable physics experiments with the much greater accuracy available in today's off-the-shelf instruments.



Elgen Long, air adventurer and Flying Tigers pilot, described recent record-breaking 28-day journey that took him over both poles in small plane laden with gas and instruments. Modern communications kept him always in reach of home or help, he said. But aviation needs some new approach in instrumentation; the load is becoming too much for even a jet plane.

Super winner Rich Nielsen, left, is congratulated on his first place entry by George Newman, Data Systems manager.

Mr. Software

a contest everyone wins

□ For 21 HP employees happiness was winning in HP Data Products Group's first Software Contest.

The group sponsored the contest as a means of increasing the number of computer programs available to HP users. The Cupertino-based group actually awarded 23 prizes, but employees were eligible to submit as many entries as they wished. As a result, two talented gentlemen, Rich Nielsen of the Bay Area EDP Center in Palo Alto, and Paul Gavarini of HPSA, Orsay, France, won twice.

Rich was awarded the Grand Prize of 10 shares of HP stock for submitting the most valuable program; one which allows data to be transferred between an HP 2100 computer and an IBM 360 computer.

All other winners received $50 awards and plaques recognizing their contributions. The winners, representing many U.S. and international HP offices are:

Jerry Reaugh, Mountain View; Bill Williams, Jim Katzman, Herb Shear, and Marlin Schell, Cupertino; Warren Nelson, HPIC, Canada; George Anziger, AMD/DAS; Roland Jahn, Medical Electronics; Tom Winker, Neely/No. Hollywood; Bill Alexander, Midwest Region/Skokie; Elisabeth Caloyannis, HPSA, Orsay; Eugene Burmeister and Glen Worstell, Loveland; Enrico Mariani, HPSA, Milan, Italy; George Taylor, Neely/Englewood; Ferdinando Longoni and Frank Rochlitzer, GmbH, Boeblingen; Robert Saunders, AMD/ATS; and Ed Smith, Data Products Group, Cupertino.

The contest covered three categories: data communications (transferring information between computers); business data processing; and utilities (computer routines that simplify data handling).

Jean Toth, in charge of the user's library at the HP Software Center in Cupertino, coordinated the contest. It took Jean, her secretary, Peggy Pattison, and a temporary employee, three weeks to process the more than 60 entries.

Surrounded by entries, Peggy Pattison logs in contest material at the HP Software Center in Cupertino.

All entries had to be properly named, categorized, and assigned numbers, plus checked for errors and incompleteness; and their abstracts edited.

Ron Raecker, communications specialist in the Cupertino Division advertising and sales promotion group, was in charge of contest promotion.

On the judging committee were HP software specialists from each of the contest categories, plus representatives from Cupertino Division software engineering and the HP Software Center.

Winning programs are now being added to the Contributor's Library at the HP Software Center in Cupertino. □

News in Brief

The new breed . . .
With side panels off and inner workings on display, a Model 5700 gas chromatograph was introduced in London recently to a press conference of trade and technical editors. As it has in other areas since its first U.S. introduction late last year, the 5700 attracted much interest in terms of its potential contribution to the detection and control of pollution. The HP chap on board here is Dennis Owens, analytical sales manager in Manchester, England. Actually, the 5700 has become much more than an interesting topic of discussion; in each of its first three months on the market, sales have surpassed forecast. Because of its success and because of the many production and marketing innovations associated with it, the new analytical product has been dubbed by its Avondale builders as "An entirely new breed of GC."

Washington, D.C. – The James Forrestal Memorial Award for 1971 has been presented to Dave Packard by the National Security Industrial Association. The former Deputy Secretary of Defense, now returned to Hewlett-Packard as chairman of the board of directors, received the award at a dinner held in the Sheraton-Park Hotel on March 9. The Forrestal Award has been made annually since 1954 to distinguished Americans "who have most effectively applied Mr. Forrestal's ideals of a close working partnership between industry and government in meeting the needs of national security."

Palo Alto – An increase of 15 percent in sales and a 29 percent increase in earnings have been reported for the first quarter of the company's fiscal year.

Sales for the quarter ended January 31 totaled $97,964,000 compared with $85,197,000 for the first quarter of fiscal 1971. Net earnings amounted to $6,202,000, equal to 24 cents per share on 26,187,282 shares of common stock outstanding. This compares with earnings of $4,797,000, equal to 19 cents a share on 25,779,799 shares, during the corresponding period last year.

The company also reported an item of extraordinary income of $427,000. This represents the amount of gain realized in the quarter by virtue of the revaluation of various currencies throughout the free world. With the addition of the extraordinary item, 1972 earnings totaled $6,629,000, equal to 25 cents a share.

President Bill Hewlett noted that all other figures are comparable for 1971 and 1972.

He said incoming orders for the first quarter totaled $109,852,000, an increase of 20 percent from the $91,504,000 booked in the corresponding period last year. "Reflecting the increasing strength of our U.S. markets, domestic orders totaled $64,243,000 up 31 percent from a year ago. International orders rose 7 percent to $45,609,000."

From the chairman's desk

I am very pleased to be back with all of my old friends at Hewlett-Packard after three very interesting and somewhat hectic years in Washington. Since I've been back I have visited a number of the company plants and activities on the West Coast and I hope to visit many other plants and offices during the next several months.

When one observes an activity on a day-to-day basis, progress is not always easy to evaluate. But after a gap of three years it is much easier to evaluate how much change there has been and whether or not the change is an improvement. So it is very encouraging to find excellent progress everywhere I have visited.

The most significant evidence of good progress is the many impressive new instruments which have been put into production or which are about ready for production. Every division has a number of new products on the market. Many of these are better products, and some represent such a significant advance that they simply could not have been built three years ago. This fine record of bringing out new products is most significant for it has established the company in a relatively better position in the market.

The outstanding job which has been done in new products is clearly the reason the company has done well during these past three years. In my job at the Pentagon, I had the opportunity to have a good view of many industries including the electronic and instrument industry. These have been difficult and troubled years for all technologically based industry, and your company under the fine leadership of Bill Hewlett has done exceptionally well. Of course, that is what I expected.

It has been most encouraging to get around the company and say hello to so many old friends. I hope to see more of you in the weeks ahead. I have also been greatly encouraged to see the many fine new people who have joined us in the last three years. I am especially pleased to see the traditional friendly HP attitude still prevails, combined with enthusiasm and dedication to the importance of doing a good job.

Bill Hewlett in the February issue of MEASURE made some cautiously optimistic projections for the year ahead. I concur with his projections, but might be a bit more optimistic. As to the longer term future, the years ahead, I come back with great optimism for the opportunities we have as a company and as individuals in the company.

The solid work you have all done during the three years I have been away has built a strong foundation for continued progress and success in the future. I am happy to be back and to have the opportunity to help.

David Packard

Nobody quite knows which customers are going to want an underwater oscilloscope, or what they might do with one, but the fact is that HP has developed just such a critter. It's the 1700E environment-proof scope that's being introduced to the world at this month's IEEE show in New York. The 1700E came about because of specifications that called for a ruggedized instrument able to take—among other things—a lot of salt water splashing. The Colorado Springs' designers turned to the 1700 series portable scopes because of their low power consumption and low heat dissipation requiring no vent holes. Then they added a system of gaskets and sealants. This made the instrument completely waterproof even with the front-panel cover removed. However, anyone planning an undewater test had better bring along an anchor—the 35-pound 1700E also floats.

Measure

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