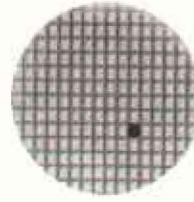


# Measure

For the men and women of Hewlett-Packard / JULY 1967



When photograph of an HP monolithic integrated circuit at right is finally reduced, it will fit into one of the tiny squares on the silicon wafer shown actual size at left. Hundreds of such images, known as chips, are produced on each wafer.

## ICs:

# New generation of migh

□ It seems like only the day before yesterday, or at most the year before last, that the electronics industry first began to talk much about integrated circuits.

There was broad speculation about how these tiny microelectronic devices—third generation functional descendants of the vacuum tube and the transistor—would affect existing types of products, and how their size and low cost would encourage development of entirely new types of products. There were reports and rumors concerning the impact their use would eventually have within our own industry.

Well, now ICs have arrived. Already any of a number of types are being used in computers, in car radios, in portable television sets, hearing aids, missile components, appliance controls, and in electronic measuring instruments such as HP's new counters. And there are great expectations for further important advances in their use. For its part, HP now is manufacturing ICs of its own design for its own use, and is marketing a number of products using these and other ICs.

The most obvious thing about an integrated circuit is its size, or rather, its lack of same. The thin little chip which is the real heart of the IC could easily be picked up and carried off by an ant. Even in finished form, with its wire leads protruding from a protective plastic shell, an HP integrated circuit has about as much bulk as a jelly-bean. Yet, that insignificant looking unit can do jobs that previously required dozens of separate electronic parts. The IC has all these—diodes, transistors, resistors—but in miniature.

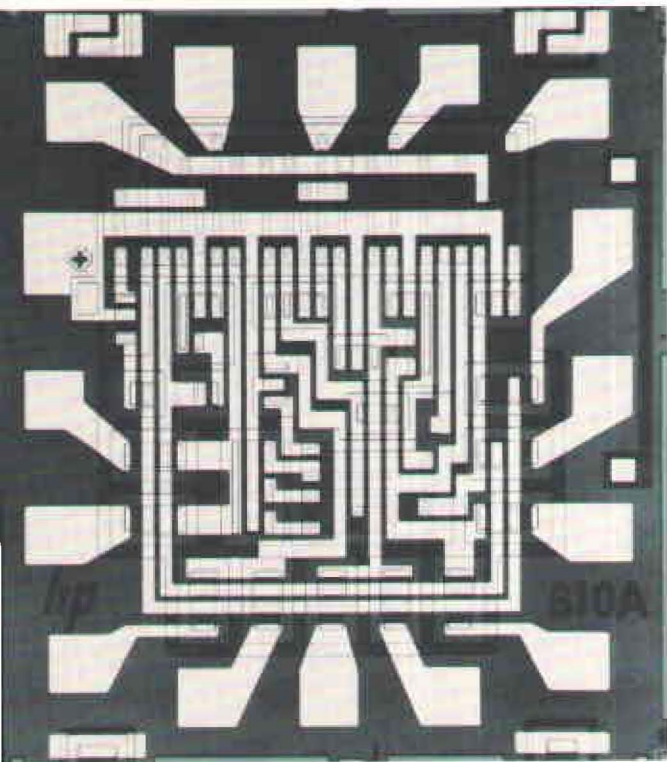
In spite of this real breakthrough to compactness in circuit design, it does not necessarily follow that all products will be scaled down in size. In the first place, according to F&T Division's Ed Hilton, products still must be engineered for use by human beings. This sets a limit to how small many product components such as knobs, displays, and panels can be made. But more importantly, for instruments at least, it is expected to lead to the addition of more and more functions in each instrument. In this way, many of the descendants of present-day HP instruments may not show great reductions in size, but they will be much more versatile.

Job for job, though, there is no doubt that integrated circuits will lead to lower costs and product prices. Using integrated circuits, the new HP 5221A and 5216A electronic counters, for example, perform all the functions of conventional counters available today, but at about half the price.

Toughness and reliability are two other major claims made on behalf of ICs. Lacking the usual maze of separate components and interconnections, IC-based products simply have fewer connections and parts that might go wrong. Moreover, the tiny ICs themselves are rugged and can be easily encapsulated in protective plastic.

Well, just what is an integrated circuit? One engineer has suggested that it can best be visualized by imagining how a familiar printed circuit board would look if it were shrunk to a small fraction of its original size. This chip would be on the order of one-tenth of an inch square and only a few thousandths of an inch thick. Yet a mag-





## ty midgets

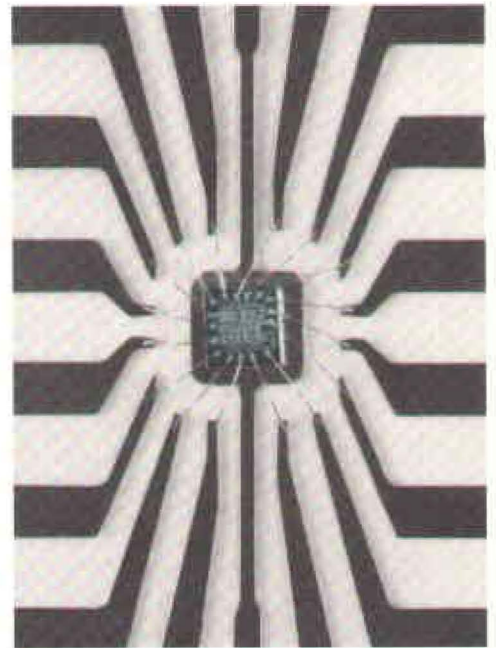
nified view would reveal an amazing complexity of electronic circuitry on its surface.

Actually, an IC does start out as a series of large-scale drawings on an engineer's drafting table. The drawings present a pattern of active, passive, isolation, and interconnection regions that will function as a circuit within the square surface of the chip. By a process of microphotography, the master artwork is so reduced that hundreds of reproductions are patterned on the surface of a silicon wafer that's smaller than a half-dollar. Following a series of six complex steps that involve repeated masking, etching, and depositing of ultra-thin layers of conductive or resistive materials, the wafer is scribed and broken into the individual chips known to the industry as monolithic integrated circuits.

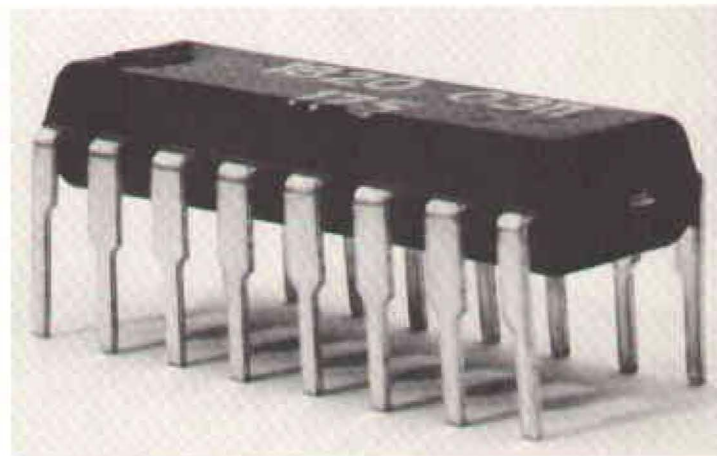
There are other types of ICs—thin film, thick film, and hybrid variations—and HP has the capability to design and manufacture these, too. At present, many firms produce ICs commercially. Prices have shifted rapidly downward as volume and technology have advanced. Early models of ICs sold for hundreds of dollars each; today some are priced under a dollar, depending upon complexity and volume.

HP has kept an interested eye on integrated circuits right from their inception. About two years ago, after all of the pros and cons had been weighed, the decision was made to go ahead with development of the company's own capability in IC design and production.

The reasons were clear. Only by maintaining control of the design of the circuitry in its products could the



Single chip, above, is shown mounted in center of an IC frame, to which it is connected by microscopic wires. HP integrated circuit module, as shown below, has been completed by encapsulating it in plastic with legs bent downward so the IC can be soldered to a printed circuit board.





# ICs *(continued)*

company expect to remain creative in the development of those products. In addition, HP's requirements for complexity, performance and unique design frequently would rule out the use of commercially produced ICs.

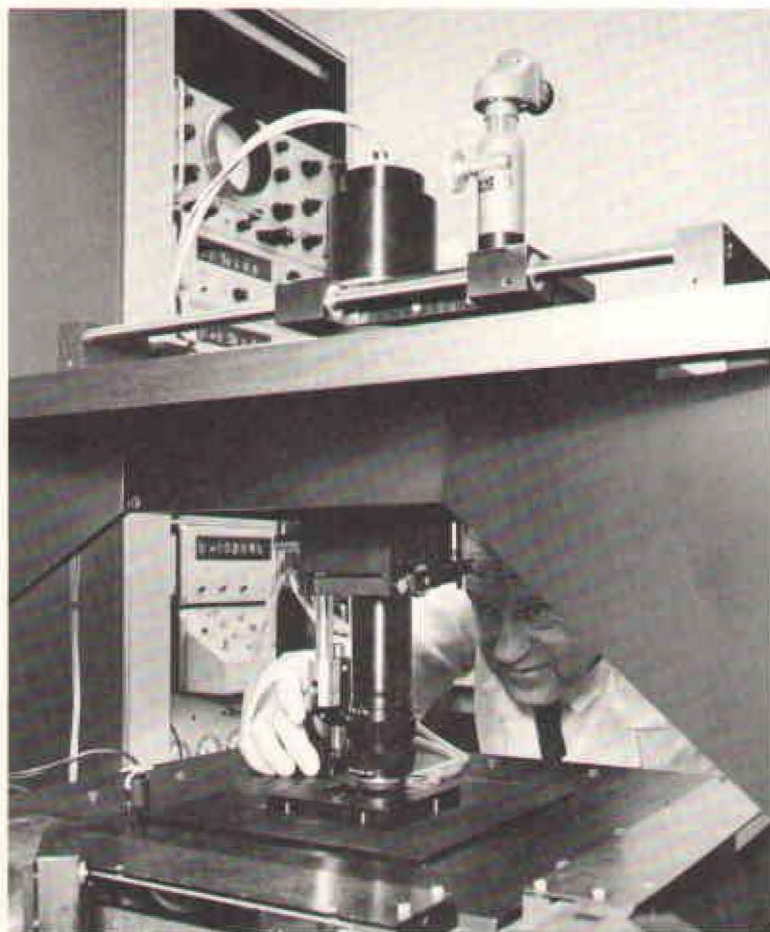
Though most HP divisions now are involved in ICs, there is no likelihood of any sudden mass changeover from existing circuitry, but rather a continuing shift toward their use as more and more circuits become available in IC form.

As this change occurs, other changes will become apparent. By replacing many components with HP's ICs, the company's purchasing pattern will change. A correspondingly higher proportion of HP-produced parts will be in use. There will be a modification of production

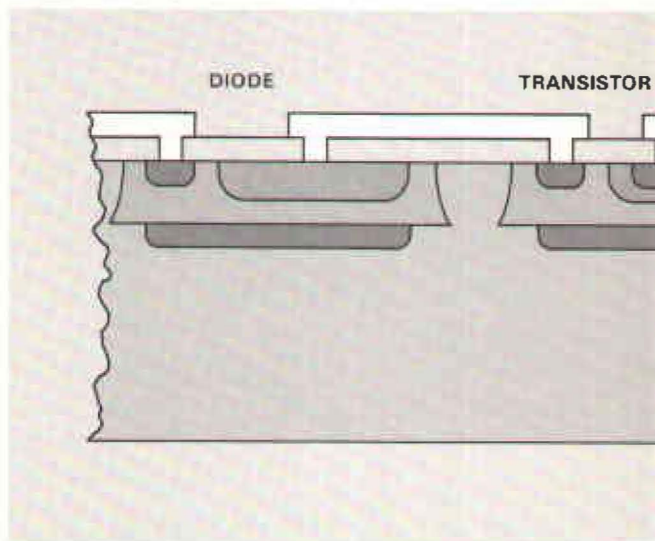
procedures reminiscent of the shift to printed circuits some years ago.

Many observers believe that the total electronic products market will surge upward with an avalanche of completely new or improved industrial and consumer products based on integrated circuits. Many of them may take "mini" form—perhaps wristwatch radios, pocket-size color TV sets, or portable computers within pocketbook range of the average student.

As one writer put it: "Any nation that could fall in love with the electric toothbrush is really ripe for the great new gadgets that integrated circuits will make possible for the consumer." □



Walt Smith, head of F&T photo lab, checks adjustment of HP-designed step-and-repeat camera that makes final photo reduction of integrated circuit designs. Using the light of a laser beam as a guide, the camera is programmed to position itself automatically to an accuracy of 12-millionths of an inch for each of the hundreds of photographs reproduced on a single plate. F&T's Don Cross was largely responsible for development of the camera.

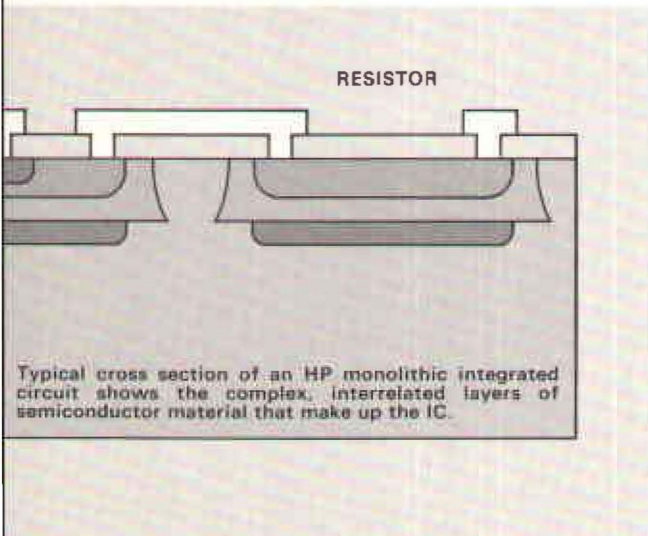


Max Schuller, technical director of HP's largest integrated circuit facility and major contributor to the company's IC capability.





Sharon Martin inserts a "boat" of IC wafers into furnace that treats them at high temperature, one of several major steps in creating finished chips on surface of a silicon wafer.



Using gossamer-thin aluminum wire, microscopic connections are made by ultrasonically joining points on an IC chip to the frame. At the controls is F&T's Frances Hartman-Kok.



Production and testing of ICs require microscopic techniques. At left, masking and alignment machine operated by Ilona Lehel is visible in background, while Sonia Whitelaw, foreground, inspects a stage in wafer manufacturing. Above is multiple probe, with which operator can simultaneously and automatically test each chip while in wafer form.



# 1967 HP OLYMPICS

As produced by Loveland and Colorado Springs Divisions . . . dedicated to those spirited HP men and women who risk arthritis and reputation to defend their division's athletic honor

A saga of brains and brawn, skill and strategy, speed and daring, gamesmanship and guile, of the joys of victory and the agonies of defeat, plus the agonies of strained muscles and the sorrows brought on by that extra helping of potato salad.



In the spirit of 776 BC, year of the first recorded Olympic Games, the heroic torchbearer, Loveland's Bob Foster, speeds over the Colorado countryside with the sacred fire to light the eternal flame.



Striking a noble pose, the torchbearer holds the flame that signals the opening of the games. The flame set an all-time record for the eternal flames by flickering for 10 minutes.



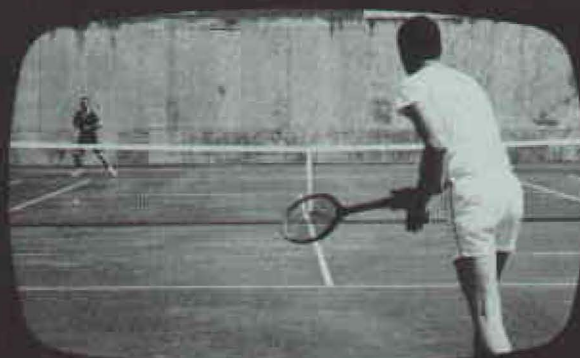
"Touche!" says the Loveland player. "Drat that southpaw!" say his opponents from the Springs.



What can you say about a bunch of people who stand around all day potting arrows at hay bales? Just don't say anything. Just stay out of the way!



"All right, ball, get it swinging left into the 1-groove—that's the guttural sound."



The idea is to hit the ball over the net into the area within the lines, but out of your opponent's reach. So quit hitting it into the net!



Ah! Power volleyball. Newest of the events added to the roster of approved Olympic games. Do these guys *really* think they can win their way to Mexico City?



Why do they make the





The torchbearer lights the official start of the games. Time speed record for lighting out 15 minutes later.



"Okay, fella, since your team completely neglected its training, maybe you'd better try to scare the opposition!"



"It certainly is a great honor to be chosen as your 1967 Olympics queen, just so long as I don't have to wear one of those crazy feather hats!"



...the groove and then pocket. No, not that r!"



"Now we take you out to the old ball park for a taste of the national pastime. If that pitcher would move over a bit we might be able to bring you an up-to-the-minute score . . ."



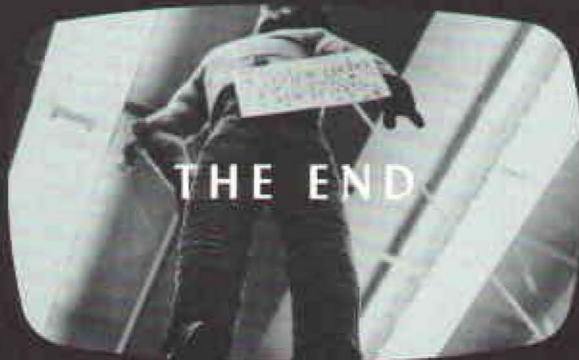
"Same scene. New players. Home team is comfortably ahead, but there's always doubt until the last out (big league announcers always say that)."



...net so high?



Well, here we are, down to the last shoe of the last match of the glorious 1967 HP Colorado Olympics. Give it a go, Tiger!



Aaargh!!  
(For the record, the Springs did indeed fail to capture the 1967 trophy, as did Harrison Olympians for the first time in their struggle with Rockaway. Wait till next time?)





# TAKING \$ STOCK



□ In the minds of many people, Wall Street and the stock exchanges are places of mystery inhabited by frock-coated financial wizards making complicated transactions on behalf of jewel-clad dowagers.

Actually, the basic functions of the stock market are quite simple. On the trading floor of the 175-year-old New York Stock Exchange, for example, what looks like chaos is in reality an organized and regulated arena where representatives of people who wish to buy stock meet with the representatives of people wishing to sell.

Let's see what happens when shares of HP stock are bought or sold. First, such buy and sell orders can be initiated by an investor through any of the 3,800 offices of the 651 brokerage firms licensed to trade on the New York Exchange. As quickly as it is received, an order is phoned or wired to the exchange floor.

Here is where the action takes place. If the order is for an even or "round" lot of shares—increments of 100—it is phoned directly to one of the broker's representatives on the floor.

He carries the order to the floor position occupied by Marcus & Company, an exchange firm specializing in Hewlett-Packard stock along with the securities of 37 other well-known corporations. Here, in the hands of the HP specialist, the buy and sell orders coming in from all sources are executed. In effect, the specialist buys the stock himself and then makes it available to buyers. In most cases he will maintain an inventory of stock for trading purposes, and in the event of a heavy selling surge he will buy heavily for his own account in order to insure an orderly market.

Another, slightly different procedure exists for stock sold in odd lots—lots of less than 100 shares. Such orders are placed in the hands of one of the several brokerage firms whose principal business is odd-lot trading. Slightly higher brokerage fees are charged for handling such orders, which they then package into round lots and trade in normal fashion through the specialist.

Hewlett-Packard common stock first came into being in 1947 when the original partnership was transformed into a corporation having a capital structure of 3,000,000 shares (now authorized to 15,000,000 shares, of which 12,361,966 shares were outstanding at the end of the first half of HP's 1967 fiscal year).

The first public offering of the company's stock was made in 1957 when Dave Packard and Bill Hewlett sold 300,000 shares through the investment banking firm of Blyth & Co., Inc. At the same time, HP distributed 60,000 shares to employees as bonuses and made available another 50,000 shares for purchase under stock options.

HP shares then began public trading in the over-the-counter market.

Results of these developments, plus a three-for-one stock split in 1960, were a broadening of HP stock ownership and a widening of national distribution of 100-share lots of the stock.

Another result: making HP stock more readily available to employees in order, as the prospectus to the Hewlett-Packard Company Employee Stock Purchase Plan of 1959 stated, "to foster continued cordial relations by allowing the maximum number of employees to participate in the ownership of the company under conditions financially attractive to the employees."



Chaos? No, just typical activity on the floor of the New York Stock Exchange, where each day some 10,000,000 shares of stock are bought and sold in almost 90,000 individual transactions. Since 1961, Hewlett-Packard stock has been traded here and on the Pacific Coast Stock Exchange.

A final result was the listing in 1961 of HP stock on the prestigious New York Stock Exchange and on the Pacific Coast Stock Exchange.

How has HP stock performed? As most stock brokers and security analysts will testify, HP stock has been a quiet performer compared to many stocks in the electronics industry. Fluctuations in its market price have generally been mild, and seldom has the stock gained a position on the daily "most-active" list. Nevertheless, its quoted trading price has moved in 10 years from a low of \$15.75 a share (equal to \$5.25 after adjusting for the stock split) to a high that was hovering around \$80 last month.

Eligible HP employees, of course, receive the benefit of a 25 percent contribution by the company for shares purchased under the stock purchase plan. As of last January there were 5,333 employees participating in the plan—well over half of all eligible employees. Many employees who invest the maximum allowed under the plan also purchase additional shares through their own brokers.

One question that keeps coming up before company personnel officers is whether the stock purchased under the plan can be sold at any time. The answer is *yes*, by signing over your stock certificates in the presence of a stock broker or banker. There are no restrictions on resale or transfer of the stock. Under New York Stock Exchange rules, you will receive cash settlement in five working days.

Today, America's 22-million investors hold 11-billion shares of listed securities worth more than \$520-billion. On an average trading day, about 10-million shares (about 5,700 of them HP stock) are bought and sold in almost 90,000 individual transactions. No wonder the stock exchange floor's brisk activity gives the impression of chaos! □





# News in brief

**Colorado Springs**—Occupancy will begin in mid-July at Colorado Springs Division's new 154,000-square-foot building. More than doubling plant size, the new structure will house engineering, manufacturing and warehousing activities as well as an employee cafeteria.

**Palo Alto**—HP Labs has moved into a newly completed, 30,000-square-foot addition at the Stanford plant.

**Sacramento**—Two HP executives—Frank Cavier, vice president and secretary, and John Cage, director of the special projects laboratory, HP Labs—are on loan for 16 weeks to the State of California. They are among 150 key management personnel from California industry and professions who are serving on the Governor's Survey on Efficiency and Cost Control. Survey teams are studying all functions of the executive branch of California government with the goal of providing "essential services at the least possible cost and in the most efficient, businesslike manner." Cavier is serving on the agriculture and resources study

team. Cage on the education team. Survey results are to be given to Governor Ronald Reagan by September.

**Avondale**—For active marketing of its Pennsylvania-made instruments to countries abroad, F&M Scientific Division has been made a charter member of the state's "export corps" formed by Governor Raymond P. Shafer. Jim Tebay, division marketing manager, received the award during the first Pennsylvania international trade seminar, held recently in Harrisburg. F&M and the other 57 charter members have received the President's "E" award for exceptional accomplishments in exporting. A third of the division's production is sold abroad.

**Palo Alto**—Bill Hewlett has been elected a vice president of Stanford University's board of trustees, of which he has been a member since 1963.

**Mountain View**—Deleon Division has been awarded a 1967 Putman Honors Award for its ultrasonic translator detector—cited as "a major contribution

toward more efficient and effective operation of food plants." Alan Simpkins, Deleon's general manager, accepted the award June 15 from Putman Publishing Company, publisher of *Food Processing & Marketing* magazine.

**San Francisco**—The HP "showboat"—a suite aboard the *Santa Leonor* in which electronic instruments are demonstrated—sailed again late last month. On this fourth voyage she is carrying such industrial electronic instruments as counters, oscilloscopes, signal generators and voltmeters to seven Latin American ports.

**Avondale**—The F&M Scientific Division is among the initial members of the newly formed analytical instrument section of the Scientific Apparatus Makers Association. The section's members are manufacturers of instrumentation designed to analyze the composition or characteristics of matter.

**Palo Alto**—HP's future plans rate tops in employee interest among all categories of articles and features in *MEASURE*, and 94 percent of the HP work force read the magazine. These were among key findings of a recent survey of readers' attitudes toward the company and *MEASURE*.

## People on the move

**Delcon**—Ken Conroy, R&D staff, Microwave Division—to engineering staff, Delcon; Noel Damon, development engineer, systems group, Dymec—to engineering staff, Delcon.

**Dymec**—Tom Perkins, administrative manager, corporate R&D—to marketing manager, Dymec.

**Eastern Sales Region**—Sal Di Giovanni, chemical staff representative—to field representative (chemical), Englewood; Jim Fitzpatrick, staff engineer—to field engineer, Englewood; Al Napolitano, accounting staff, Microwave Division—to administration manager, Eastern Sales-Burlington.

**F&T**—Len Kraska, engineering—to manufacturing engineering; Dale Ridenour, production engineer, Dymec—to frequency standards manufacturing, F&T; John Templeman, section manager, transformers, Paeco—to printed circuit prototype shop, F&T.

**HP Associates**—Jim Courtice, corporate exhibit manager, corporate Marketing—to marketing staff, HP Associates.

**HP Labs**—Charles Adams, frequency standards, F&T Division—to Physical Electronics Lab, HP Labs; Bob Gray, manager computer memory section, Dymec—to Physical Electronics Lab, HP Labs; Dan Lansdon, engineering manager, F&T Division—to administrative manager, corporate R&D; Darlene

Watson, frequency standards, F&T Division—to Physical Electronics Lab, HP Labs.

**Harrison**—Harry Mayo, field engineer, Eastern Sales-Englewood—to product manager, TV picture monitor, marketing staff, Harrison Division.

**HP-Palo Alto**—Frank Burkhardt, editor HP Journal—to corporate Engineering staff; Bill Gross, marketing manager, Dymec—to corporate Marketing staff; Vince Morgan, Palo Alto office services—to Palo Alto finance staff; Larry Rayher, R&D staff, Microwave Division—to corporate engineering, EDP coordination, corporate Management Services; Stan Smith, corporate Customer Service—to corporate systems planning, corporate Management Services; Frank Westley, personnel manager, Dymec—to corporate Personnel staff; Gal Worley, marketing manager, Mountain View Division—to corporate Marketing staff.

**International**—Ashburn Hunt, in training, Palo Alto International Operations—to sales department, HP&A; Mike Meara, in training, Palo Alto International Operations—to electronics sales engineer, Export Marketing.

**Microwaves**—Mike Chamberlain, corporate Management Services—to production control systems staff, Microwave; Ev McKen, infant production engineering—to manufacturing engineering; Bob Pedrian, special products engineer, Sanborn—to contract engineer, Microwave; Russ Perricone, from section 2 production supervisor—to master scheduler, production control; Larry Stratford, corporate Manufacturing Engineering—to manufacturing engineering,

Microwave Division; Bill Swift, R&D staff—to applications engineer; Nancy Thoman, secretary to general manager, Dymec—to secretary to general manager, Microwave; Dave Weibel, computer manufacturing supervisor, Dymec—to manager, computer systems manufacturing, Microwave.

**Mountain View**—Lew Bohstedt, manufacturing manager—to division planning manager, Howard Bossert, production engineering, Microwave Division—to manufacturing engineering, Mountain View Division; Mel Burns, production control, Microwave Division—to production control, Mountain View Division; Ed Daw, sales manager, Melabs—to marketing manager, Mountain View Division; Bill Girdner, magnetic tape engineering staff, Microwave Division—to engineering staff, Mountain View Division; John Hartman, production control, Microwave Division—to materials manager, Mountain View Division; Curt Kohanek, production control, Dymec Division—to production control, Mountain View Division; Ray Smelek, manufacturing manager, HP Ltd—to manufacturing manager, Mountain View Division; Gordon Smith, machine shop supervisor, Dymec—to model shop lead, Mountain View Division.

**Neely Sales Region**—Glenn Stewart, product training, corporate Marketing—to staff engineer, Neely-Palo Alto.

**Western Service Center**—Earl Norris, counter manufacturing, F&T Division—to F&T repair department, WSC; Stewart Peck, data processing supervisor, Dymec—to inventory control staff, WSC.





## *from the chairman's desk*

Last month in Palo Alto we had a two-day meeting of all our manufacturing division managers and marketing region managers. The purpose of the meeting was to review our performance for the first half of the fiscal year, to evaluate targets for the second half, and to exchange ideas and views on a number of different subjects affecting our operations, both short and long term.

As our company grows larger, these meetings are especially useful in strengthening inter-divisional communications, in generating fresh approaches to problems, and in setting common goals and objectives for all our divisions. We covered a broad range of subjects at the June meeting, a few of which I would like to review here.

We discussed, at some length, our product quality and reliability. An analysis of warranty costs over the past several months indicates that we have to put increasing emphasis, in every division, on maintaining the high standards of quality associated with HP products. As I have pointed out in the past, quality can't be added on to an instrument; it must be built in. It begins at the design stage, and carries on through every step in manufacture and testing.

Good quality requires careful attention to details and an awareness on everyone's part that the customer is our ultimate taskmaster. If we cannot consistently provide him with instruments that work properly and reliably, he will buy them from someone else. I hope all of you will remember this and will do your utmost to see that every HP instrument merits our customers' confidence.

Another important subject discussed at the meeting was the increasing need for qualified, well-trained people at all levels in the company. Because of the rapid growth of our product line, the need for good engineers and technicians is especially great in our field sales organization and our other marketing groups.

We are tackling this problem in a number of different ways. It was agreed at the meeting, for example, that we need to do a more effective recruiting job at various colleges and universities. We need to have more of our people take advantage of the many training programs that are offered throughout the company so they can broaden their knowledge and skills. We also need to do a better job of evaluating individual performance and determining which of our people have the potential to be good supervisors and managers. The whole subject of management development is one that demands our increasing attention as we continue to grow and thereby create more opportunities for our people.

We also talked about, and re-emphasized, the importance of broadening employment opportunities for minority groups. Several of our divisions have taken the lead in their respective communities in developing programs to train these groups and to help them find worthwhile jobs. We want to continue and accelerate our efforts in this direction as a means of obtaining good people and doing something constructive about a pressing social and economic problem.

Our meeting covered a number of other subjects, all of which were discussed with considerable thoughtfulness and enthusiasm. I sensed from this meeting a real determination throughout our management group to turn in a record-breaking performance in the second half of our fiscal year, and to build a solid foundation for continuing growth in the years ahead.

*David Packard*



# Measure

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Merle Mass

ASSOCIATE EDITOR  
Les Carpenter

ART DIRECTOR  
Tom Martin



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## HP goes to the races

One's a soap box racer and the other a powerful stock car, but they're both running against precision HP electronic counters! The last weekend in June saw Colorado Springs HPites loaning their time and equipment to two local racing events: the Colorado Springs Soap Box Derby and the world-renowned Pikes Peak Hill Climb.

When 80 youngsters trundled out their homemade racers to vie for a trip to the National Soap Box Derby finals in Akron, Ohio, HP was ready and waiting. Two cars at a time, each clocked by an HP counter, were released at the top of a hill. As they zipped across the finish line at the bottom, the counters stopped, giving a readout of elapsed time to the nearest thousandth of a second.

HP scored a "first" the next day at the Hill Climb: initial use of electronic timing equipment in the event. As the powerful stock and racing cars, piloted by top flight drivers, roared up the winding road to the peak their elapsed times were counted and then printed out by HP digital printers, giving judges an immediate and accurate record of each car's performance.

