

Measure

For the men and women of Hewlett-Packard / AUGUST 1975



How sound is our financial structure?

(pages 8-13)

Is this the world's greatest picnic?



□ Only an editor in search of a headline would think up a dumb question such as that. Who cares if it's the "biggest" or the "most"? The main point is that an HP picnic — whether it's the big corporate headquarters barbecue, a division steak fry, or one of the many sales-office gatherings — appear to be a lot of fun for HP people and their families and guests, a way of meeting one another informally and festively.

By now the HP picnic is a worldwide company tradition. Generally it's a summertime event, which accounts for the fact that the Southern Hemisphere organizations were holding their 1975 picnics

last January and February.

For the most part these company-sponsored festivals are arranged and staged by HP people themselves, many of them putting in lots of extra hours. But there's no requirement that they set up in a park or a forest. In fact, some events have found HP people promenading on the deck of a river boat, prowling through haunted castles or simply taking over amusement parks for the day.

This year the picnic spirit seems to have been just as high and happy as ever. At least that thought comes to mind when you view these scenes selected from the wide world of HP picnicking in 1975:

San Diego, the so-called Surf & Turf Division, went all-out Western style with a deep-pit barbecue capable of cooking 2,000 pounds of beef. More than 3,000 people showed for a non-stop day of sports, games, rides, dancing, feasting and relaxing. COVER photo shows a typical barbecue scene at Little Basin, the area serving many picnics of the Bay Area.



One of the joys of the HP picnic is being served by people one would not ordinarily see wearing aprons. Such is the case of these youngsters as they approach a Little Basin serving line manned by Ray Wilbur, vice president-Personnel (left), and Frank Cavier, vice president-Secretary.



Hermit Park in the Rocky Mountains provides a well-equipped getaway for HP's Loveland people. Like so many HP picnic sites, the park is owned by HP and provides a very accessible yet serene spot between picnics.



Who says it's all just for youngsters? Italo Cianci of the Buenos Aires sales office demonstrates good swinging form at the HP Argentina and distributors picnic.

Why not an indoor picnic? That was the choice of the HP do Brasil sales office in Sao Paulo. The fellow at left staring down the photographer is Ary Santos, EPG sales manager. The party was just getting warmed up.

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Shucking corn husks is one of the necessary rituals prior to a proper Western cookout. The Palo Alto cafeteria serves as husking headquarters, and volunteers go to work on some 4,000 corn ears three days before picnic time.

World's greatest picnic



This is apparently one of the better-behaved moments at the Boise Division picnic, held in a downtown municipal park. Contestants nervously await the gun before smashing their faces into another mashed-potato pie, a specialty of the Idaho region. Actually, it was a super picnic — “the best ever” — according to one experienced HP observer.



Bob Williams gives a sign of approval to the first meatball cooked at the new HP “Camp Akenac” recreation site in Pennsylvania. Bob was one of 66 New Jersey Division people to offer their services as cooks for the 600 picnickers.



The two girls nearest the camera appear to be in no way handicapped by their potato sacks as they race down the main street of Frontiertown, site of San Diego's big frolic.



The competitive spirit finds its most basic outlet in tug-of-war contests, as demonstrated at left by some of the lads from the Johannesburg, South Africa sales office, and at right by girls of the Penang, Malaysia plant. One more time, heave!



Just about every kind of danceable music has been performed at HP picnics. Here, Advanced Product Division people glide through a reel or two of square dancing. Dixieland is another big favorite.



To promote their event, these Automatic Measurement Division picnic organizers staged a plant-wide bicentennial-style parade and delivered a "Little Basinburg" address — all in the spirit of '76.

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A gentle moment at the Stanford Park Division picnic. One day that little foal will grow up to be a little pony and perhaps give a ride to that little girl.

World's greatest picnic

Peter's Pond in Massachusetts is a year-round recreational facility operated by the Medical divisions. On this day the Lexington sales office had it booked. Other HP organizations also have chosen this kind of facility, notably in Germany where GmbH has a beautiful chalet near excellent summer-winter sports.



Dunk the boss in the "boss wash"! That's the kind of reward APD's Ray King gets here for being the kind of division manager he is. Good clean fun.



Here's some of that corn-on-the-cob served up with a full dip of melted butter. Who counts calories at a picnic?



This picture tells you something about those clever Swiss at HPSA: Bring on a clown and you can forget about the kids for hours.

The game Scotsmen play



□ There's good cause for the smiles exhibited by the six coatless chaps from HP's South Queensferry plant. They've just been declared winners of the Scottish Management Game for 1975 by the fellow in the coat, Sir Monty Finiston, chairman of the British Steel Corporation. And just what is the Scottish Management Game? Actually, it's not so much a game as a creative intellectual exercise in the skills of managing a mythical company. In any case, in this the fifth running of the Game as sponsored by *The Scotsman* newspaper, the HP team managed their venture so profitably as to forge far ahead of the five other finalists out of a field representing the leading industries and universities of Scotland. The HP six include team leader Sam Bateman (production module manager), Andy McAvoy (production engineering supervisor), David Goodwin (manufacturing engineering manager), Bill Oliver (materials manager), Hugh Smith (product support manager), and John Anderson (accountant). In all they made over £200,000 (about \$500,000 U.S.) — on paper — plus a real prize of a week's trip to West Germany to observe aspects of the business scene in that country. □



How sound is our financial structure?

a look at HP's hard-working dollars...



In his letter for the June issue of Measure, President Bill Hewlett commented on the woeful ignorance of the public about such basic concepts as the size of corporate profits and their basic role in the free-enterprise system. He also discussed briefly how each dollar of sales at Hewlett-Packard was distributed among manufacturing costs, R&D, marketing and other major functions of the organization. After finishing the letter he had a feeling that a fuller understanding of the financial structure of HP was needed, something more extensive than could be put in a President's letter.

The following is his discussion of that important subject:

a special review by President Bill Hewlett

□ It is true that much of what will be said here may be found in condensed financial form in the back of our annual report. But I suspect that you, like many people, pay scant attention to these financial details, and are more concerned with the main theme of the report and with a few key numbers such as sales and profits. No doubt my description of some of the accounting terms will cause Ed van Bronkhorst, the company's vice president of Finance, some pains of anguish, for I intend to describe the various items in very simple terms, without all the ramifications that a professional accountant would want to include. Van, however, has approved this in general form to be sure that I am in no way misleading you as to the pertinent data.

Let me begin with the statement of an obvious fact: it takes money to start and run a company. Such money tends to be used in two basic ways: 1) to acquire fixed assets, and 2) to provide working capital. Each of these tends to have its own special characteristics, and each tends to be financed in different fashions.

Fixed Assets and Depreciation

Fixed assets are perhaps the easiest to visualize. In general, fixed assets consist of the land we own, the buildings we put on the land, and the machinery and equipment we install in these buildings. But a building or a piece of machinery does not last forever, and an accounting system must, and does, recognize this fact. This recognition is accomplished through a technique called depreciation.



CONSOLIDATED FINANCIAL POSITION

October 31, 1974 and 1973

ASSETS

	1974 (Thousands)	1973 (Thousands)
CURRENT ASSETS:		
Cash and marketable securities (note 2)	\$ 13,828	\$ 8,925
Notes and accounts receivable, less provision for losses in collection (1974 - \$1,539; 1973 - \$1,418)	193,735	187,473
Inventories, at standard cost, which approximates first-in, first-out and average, not in excess of replacement market:		
Finished goods	51,627	52
Work in process	82,410	4,687
Raw materials	61,177	32,307
Deposits and prepaid expenses	13,791	10,147
TOTAL CURRENT ASSETS	416,568	395,190
PROPERTY, PLANT AND EQUIPMENT, AT COST (note 1):		
Land	26,566	23,940
Buildings and improvements	128,274	87,961
Machinery and equipment	109,342	94,210
Other	26,846	11,992
Leaseholds and leasehold improvements	10,002	32,111
Construction in progress	41,541	267,899
Accumulated depreciation and amortization	342,571	93,882
	117,709	173,770
	224,862	
OTHER ASSETS AND DEFERRED CHARGES:		
Investment in unconsolidated Japanese affiliate (note 1)	4,391	3,668
Patents and other intangible assets	2,243	2,798
Other	6,317	4,240
	12,951	10,706
	\$654,381	\$579,666

The accompanying notes are an integral part of these financial statements.

HEWLETT-PACKARD COMPANY AND SUBSIDIARIES

LIABILITIES AND SHAREOWNERS' EQUITY

	1974 (Thousands)	1973 (Thousands)
CURRENT LIABILITIES:		
Accounts payable (note 2)	\$ 43,527	\$ 94,749
Accounts receivable	26,491	28,750
Accrued expenses	74,778	36,072
Federal, foreign and state taxes on income (notes 1 and 3)	34,476	51,471
TOTAL CURRENT LIABILITIES	179,272	123,042
LONG-TERM DEBT, less current portion included in notes payable above (1974 - \$760; 1973 - \$748) (note 2)	2,809	2,182
DEFERRED FEDERAL TAXES ON INCOME - Domestic International Sales Corporation (note 1)	14,531	7,500
COMMITMENTS (notes 2 and 3)		
SHAREOWNERS' EQUITY (note 4):		
Common stock, par value \$1 a share:		
Authorized	40,000,000	40,000,000
Issued	774,892	476,690
Paid-in excess of par value	967,697	243,267
Stock options	31,130	36,670
Service awards	27,298,473	28,815,566
Issued and outstanding	112,157	22,568
Capital in excess of par value	318,224	82,763
Retained earnings	247,679	239,618
TOTAL SHAREOWNERS' EQUITY	\$54,381	\$49,197
	\$579,666	\$579,666

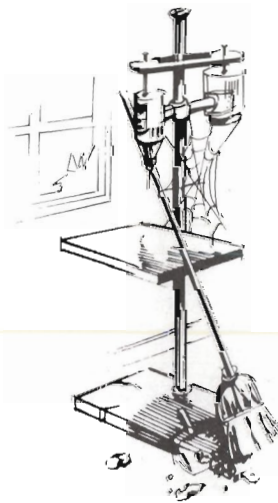
HEWLETT-PACKARD COMPANY AND SUBSIDIARIES

In its simplest form, depreciation recognizes that a given asset — for example a building — has a given useful life of, say, 30 years. Then each year 1/30th of the original cost of the building would be charged as an item of expense under the category of depreciation. Thus, in an ideal situation, at the end of 30 years the building would be considered to have zero value, and all the original costs would have been charged to the 30 years of operation. This is called “straight line” depreciation.

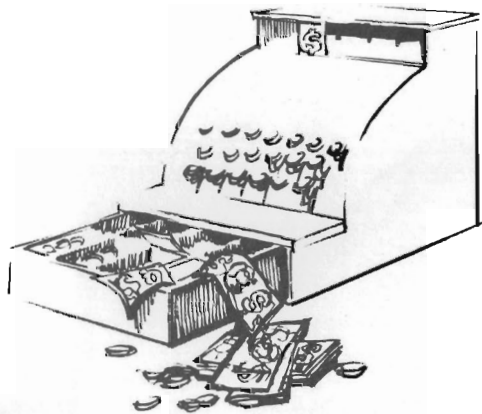
Two items should be evident from this simple example. One is that anything charged as an expense must reduce earnings, and as the U.S. government considers itself as a partner in a company to the extent that, through taxes, it takes half the profit, it has a direct interest in anything that affects the earnings of a corporation. Depreciation is a very important item of expense, and thus most governments tend to establish very rigid guidelines on the expected life of the various assets being depreciated. The second fact that should be evident is that any level of inflation is going to seriously disturb the effectiveness of “straight line depreciation” previously described. This is best seen if one thought of taking each year’s depreciation and placing it in a segregated fund. If there had been no inflation, at the end of an asset’s useful life there would have accumulated just enough money to replace that asset.

To cope with this problem the government has allowed varying forms of “accelerated depreciation” — a technique that allows one to charge off as an expense a larger amount during the early years of an asset’s life, but at a much smaller

(continued)



Our financial structure



amount during the later years. In no case is the total amount of depreciation larger than the original investment, only that you recover a share of it sooner. Accelerated depreciation is not a tax loophole, it is only a makeshift way to compensate for inflation that has been so much stimulated by government excesses.

There is one important item to realize about depreciation — it becomes a temporary source of funds for the company. Consider the simple case referred to earlier, in which each year's depreciation was set aside in a special fund. One may properly ask: "Why let this fund sit idle? Why not let the company use it to support its day-to-day needs?" In practice this is exactly what does happen — which is the reason why depreciation is considered a "cash flow" item. But it also must be remembered that this money is not free — that is, at some time it needs to be used to replace old, worn out assets. I will discuss this later in terms of our policy of using depreciation. Needless to say, although buildings, machinery and equipment are depreciated, land is not.

Working Capital

If fixed assets are easy to explain, working capital is not. Working capital represents funds that are needed for the day-to-day operation of the company. Let me give examples of a few:

Our customers do not pay us as soon as we bill them — in fact, on the average they currently pay us in about 59 days. These are our accounts receivable. The time from billing to payment varies, of course, from country to country. Domestic accounts pay on the average of about 52 days, whereas international as a whole pays in about 67 days. True, we also buy from our suppliers and there is some delay in our payment, but two factors reduce this effect. One, only about 25 percent of our selling price is represented by items purchased outside. Two, in order to maintain our good credit rating we tend to pay more rapidly than many of our customers pay us. For these reasons, our amounts payable to other people represent only about 15 percent of what is owed to us.

As I mentioned in the President's letter last June, almost 50 percent of our sales dollar goes directly or indirectly to our employees. On an average you are paid within one to two weeks of the time actually worked. Again, another gap is seen between the time we receive our money from our customers and the time we must pay it out. Both these gaps must be covered by our "working capital."

To run a company you need another element of working capital — inventories. Such inventories may take several forms. You need material to be used in assembly — parts, raw stock, and some fabricated components. These items make up about 30 percent of our inventory. It takes a certain amount of time to get our products through the assembly line, tested and into stock. Such items include not only the cost of materials but also the labor that went into them, and the overhead that is assigned to them. They are classified as "work in progress," and represent about 42 percent of our inventory. A third form of inventories is "finished goods." At any one time we have some finished goods in transit to our customers all over the world. We need finished goods because in some product lines our customers want the item *now*, and if it is not available, they will buy from someone else. We need finished goods because when we start a run we have no assurance that by the time it is finished all items in that run will have been sold. Those which are not sold appear in inventory. Finally, we need finished goods so that we may demonstrate our products to our customers. In all, finished goods represent about 27 percent of total inventory.

In addition to the two major items of inventory and accounts receivable, a certain amount of cash is necessary just to be sure you have the right amount available at the right time, in the right place. There are also some items that you must prepay, such as insurance, certain types of import licenses, some deposits and the like.

Taken together, accounts receivable, inventory, cash and prepaid items are all lumped under the heading of "current assets."

As opposed to current assets, we have another set of items called "current liabilities."

Technically these represent amounts that must be paid within the next twelve months.

We have already talked about one of these in terms of the amount payable to our suppliers. In addition to this, there are a great many items of expense that we accrue on a day-to-day basis, but are only paid out periodically. Included in this would be payroll taxes, property taxes, import duties, interest and profit sharing, and some wages and salaries. This is not an insignificant item, representing over 40 percent of our current liabilities. A similar item — but one that is usually reported separately — is made up of federal, state and foreign income taxes, representing about 19 percent of current liabilities.

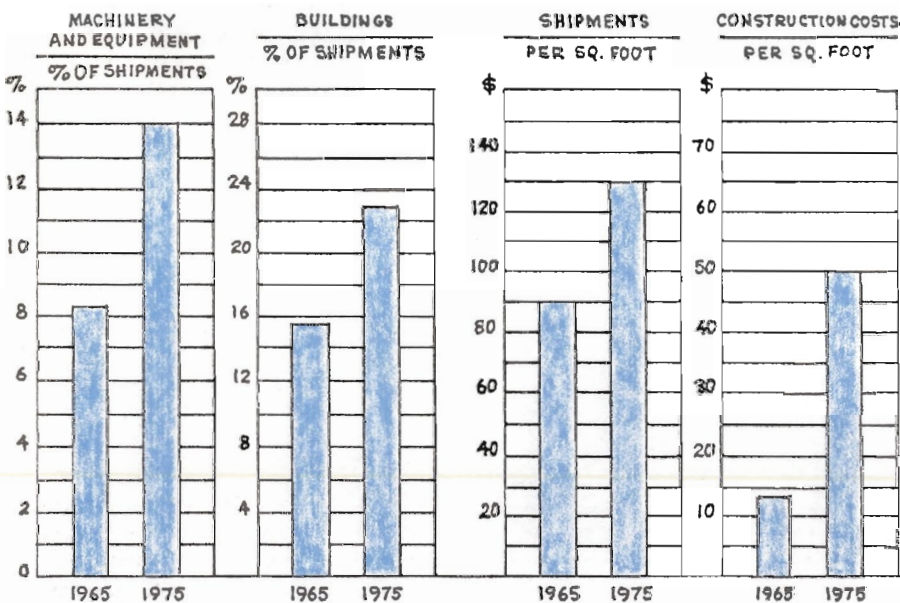
Finally, most companies, ours included, usually have some sort of short-term borrowing, simply because in general this tends to be the least expensive way of financing part of our current assets. But banks lending for this purpose like to know that what they lend can be covered by quickly available assets — assets such as I previously mentioned under the heading of Current Assets.

For a person on the outside it is very hard to tell how collectible are the claims we have against our customers and how valuable is our inventory should it be necessary to sell it. For this reason, lenders tend to look at the ratio of current assets to current liabilities. If the assets are more than twice the liabilities, the company is considered to be a good risk, and thus funds usually may be borrowed at a more favorable rate. This ratio is usually referred to as the "current ratio."



Historical Trends in Assets, Liabilities and Funding

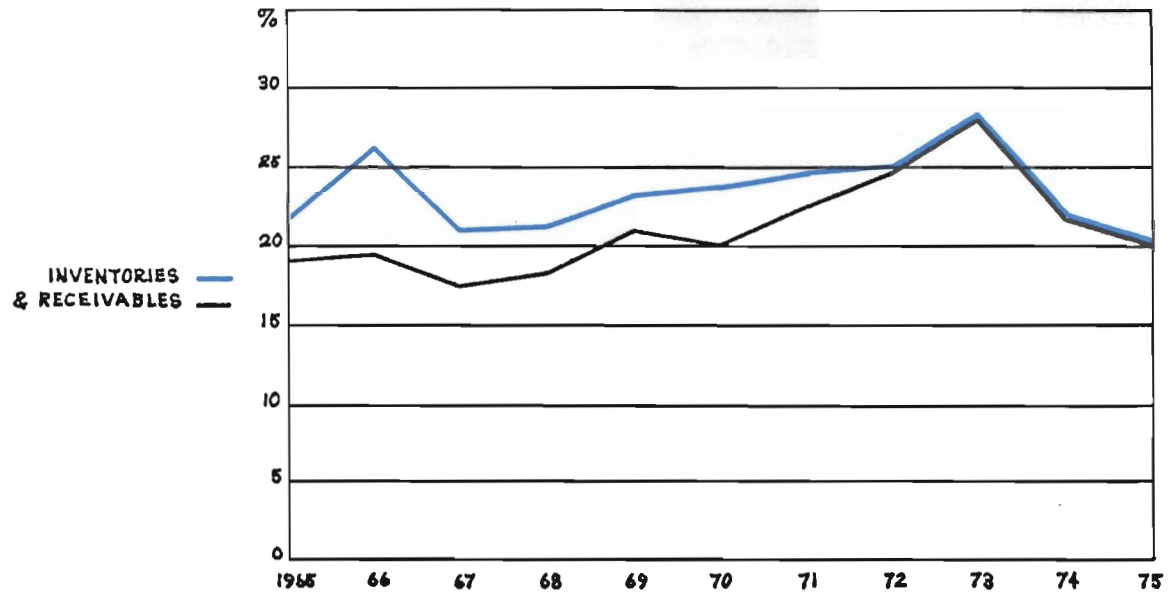
Most of the items I have discussed — fixed assets, current assets, current liabilities — tend to be related to the sales volume of the company. For some time now we have been tracking these ratios, and one can discern some interesting trends. For example, let's look at some areas of our fixed assets as they existed 10 years ago, and as they exist today. This is best shown by bar graphs:



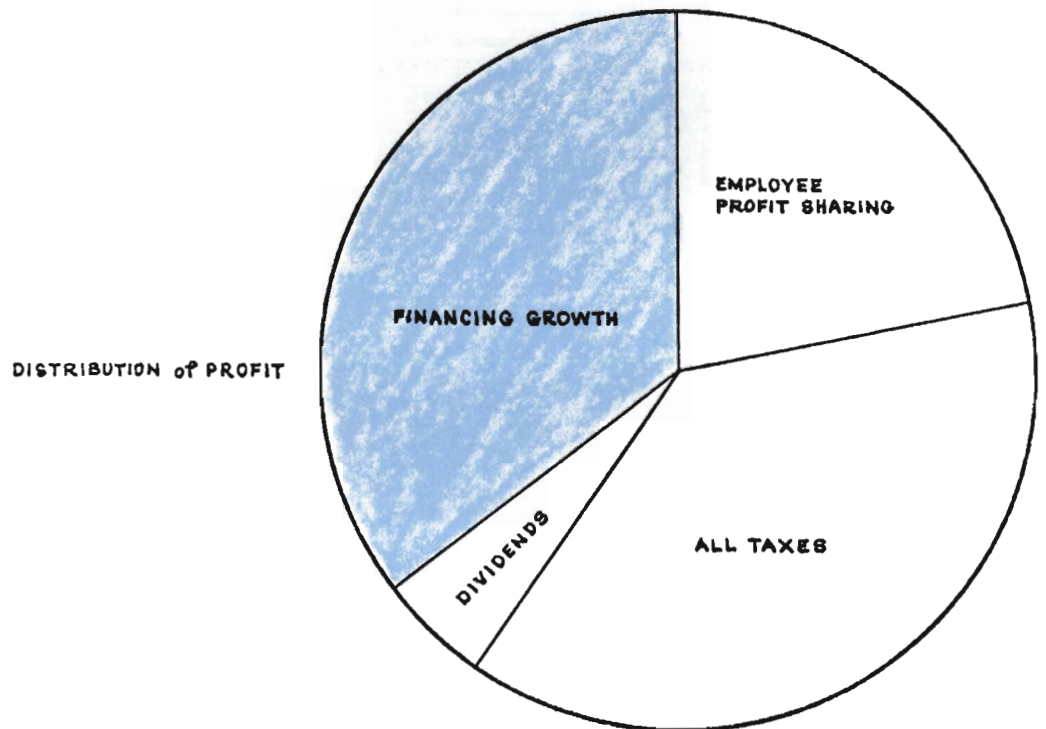
There is a significant rise for machinery and equipment, though perhaps this is not surprising as our products have become more complex. You will note the improved efficiency of our space utilization as reflected by the increased shipments per square foot of plant space. But, unfortunately this improvement in efficiency is more than offset by the tremendous rise in construction costs. As you will note, these costs have almost tripled in the past ten years. The result is a significant rise in the cost of a building to produce a given dollar of sales.

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A study of current asset trends shows very clearly what caused our concern about our levels of inventory and our accounts receivable early last year. It also shows most dramatically how effective was the concerted effort of all of you to get these two important numbers back in shape. You will note that this favorable trend is continuing through the first half of this year.



Now what happens to the money we earn? Of the approximate \$900 million earned by the company during its lifetime, about 22 percent went to employees in profit sharing and other benefits; 38 percent was paid in income taxes to state, federal and foreign governments; less than 5 percent was paid in dividends to the shareholders; and the remainder of about 36 percent was reinvested in the company to finance its growth.



Financing Growth

Before I discuss financing growth in detail, let me make a few general comments. In most large companies, particularly those whose plants are very expensive, the most common procedure is to finance such items by means of long-term debt, such as bonds or debentures. The problem is, of course, that in the long run such indebtedness must be paid off, or reborrowed, and interest must be paid on such debt. We have not used this method of financing to any extent, partially because our company needs have been modest, and partially because we have felt that financing by reinvestment of earnings was a more conservative method and made for a stronger company.

As I mentioned earlier, it is quite typical to finance current assets by short-term debt — we follow this practice when necessary.

Companies often use another indirect form of financing by choosing to lease plants and equipment rather than own them. The only case where we have leased on a regular basis is for some of our sales offices. We do this because it provides us greater flexibility in the location of such offices. For example, if a major segment of our customers moves out of a given area, we are not tied down to an unsatisfactory site, but are free to move at the end of the lease period. The fundamental reason that we do not lease more generally is that we can usually borrow money at a more favorable rate than can the person from whom we would be leasing. Not only that, but we can save ourselves the profit that he would have made on the deal.

Let me now turn from the general to the specific. Last year we earned about \$84 million after taxes and profit sharing. To this amount was added about \$31.5 million of cash flow from depreciation. The stock purchased from the company by employees is a very important source of funds to us, and last year this added nearly \$24 million. And finally some special items contributed another \$17 million. All told we had about \$158 million to work with.

I mentioned that we viewed our funds from depreciation as something special, and indeed we do. It is our policy to invest all of these funds in new plants and in modern equipment. Last year in addition to the cash flow from depreciation, we invested another \$55 million in plants, property, and equipments for a total of \$86 million. About \$5.5 million was paid out to shareholders, and the remainder of nearly \$63 million went into working capital.

A small amount of this increase in working capital was used to cover small increases in accounts receivable and inventories. But as we have seen earlier, these increases were small compared to the growth in sales. We improved our cash position by almost \$5 million, but the bulk of the amount was used to reduce our short term borrowings by almost \$77 million. But it is evident that these amounts exceed by a substantial margin the \$63 million in working capital shown above. The difference is made up through some offsetting help caused by increases in amounts due other people and to income taxes due but not yet payable. These increases were not caused by any delinquency on our part, but simply reflected the increase in business and profitability of the company.

I have now led you through those formidable pages in the back of the annual report commonly called the balance sheet, and the source and application of funds statement. I have done this because I feel it is absolutely essential that our people have a fundamental understanding of how this company is operated, and of the very firm financial position in which we currently find ourselves. It must also be evident how important a role profit plays in all of these areas. Should you wish more information along these lines or want clarification of any of the foregoing points, I am sure your division finance manager would welcome the opportunity for further discussion.

□



News in Brief

Division. Bill Foster is engineering manager, Bill Krause is marketing manager, and Matt Schmutz is manufacturing manager.

Jim Arthur, formerly general manager, Corporate Parts Center, is general manager of the new Terminal Products Division. Jim Doub is engineering manager, Ed Hayes is marketing manager and Larry Mitchell is manufacturing manager.

Dick Anderson, who continues as general manager of the Data Systems Division, has appointed Ted Doyle as marketing manager replacing McCracken. The remaining Data Systems Division staff is unchanged as are the three other divisions within HP's Computer Systems Group.

McMINNVILLE, OREGON — Bill Craven, formerly engineering manager for HP's Andover Division in Massachusetts, has been named general manager of the McMinnville Division in Oregon. He replaces Walter Dyke who has resigned to devote more of his time to a charitable trust.

PALO ALTO — Work was started last month (July) on three major manufacturing and research facilities in the U.S. Included were the medical products building at Andover, Mass., the computer peripherals plant at Boise, Idaho, and the future headquarters for pocket calculators at Corvallis, Oregon.

The medical products facility will be a two-story building located on a 110-acre site along the Merrimack River. Estimated to cost more than \$7 million, the building is scheduled for completion next August.

The 154,000 square foot Boise plant is located on 150 acres about five miles west of Boise. Cost is estimated at \$8 million, with completion scheduled next summer.

The Corvallis building will share many of its basic engineering designs with the Boise plant. Its location is a 139-acre site northwest of town. Cost of construction is estimated at \$6 million.

PALO ALTO—The machine that sparked the current revolution in sophisticated scientific and business pocket calculators just three-and-a-half years ago has been retired by Hewlett-Packard.

The HP-35, introduced on January 4, 1972, was the first of the now popular

electronic slide rules. Since then, more than one million HP scientific, business and programmable pocket calculators have been sold throughout the world.

Along the way, the HP-35 established new standards of speed and accuracy in personal computation devices.

On July 1, the HP-35 was dropped from the HP price list. In line with corporate policy, parts will be kept in stock to assure service for HP-35s for at least five years.

The HP-35 was replaced in the Hewlett-Packard pocket calculator line by the HP-21, which, thanks to evolving technology, performs more functions for a lower price. When introduced, the HP-35 cost \$395. The HP-21, introduced in February, 1975, costs \$125.

CUPERTINO — Data Systems Division will supply to the New Zealand Government, State Services Commission, a total of 41 Management/230 computer systems and 192 HP-2640A CRT display terminals.

The order will add to HP's current world-wide base of over 10,000 minicomputer systems installed.

The company competed with 23 other suppliers for the order, which is worth approximately U.S. \$3 million.

The systems are part of separate terminal networks to connect offices of the Inland Revenue Department and the Social Welfare Department with a central EDP facility, which utilizes a Burroughs B4700 computer.

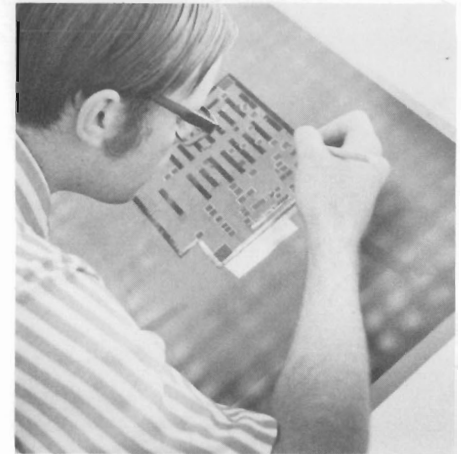
PALO ALTO — At their board meeting of July 24, HP's directors increased the semiannual cash dividend on the company's common stock from 10 cents a share to 15 cents a share. The increase will apply to HP's next regular dividend, which is payable October 15 to stockholders of record September 24.

Hewlett-Packard began paying a 10-cent semiannual dividend in 1965. In 1970, when the company had a two-for-one stock split, it retained the 10-cent rate on the additional shares created by the split. This doubled the dollar amount of dividends paid to stockholders.

President Bill Hewlett said the decision to raise the dividend was based on the company's higher level of earnings, and the significant improvement in its cash position over the past 18 months.



Instructor Lee Cozart explains Digiraster camera functions to Betty Kitajima (center), PC designer for Advanced Products Division, Ty Heglia (behind Betty) of McMinnville Division, and Paula Weir of Delcon. Teaching assistant Sue Perricone positions the printed-circuit artwork to be photographed. Below, Ty works on a light table to construct a printed circuit layer by the Digiraster method.



Multiplying a good idea

□ In the early days of Hewlett-Packard, exchanging new technologies or techniques within the company was often a matter of looking over one another's shoulders or discussing them over coffee.

But now there are 29,000 HP people in 65 countries, so such interaction is not quite so easy. And with our decentralized organizational structure, we don't share ideas as a result of some edict, but because we care enough about HP's success to want to help the other person — or the other department or division.

What makes this worthy of mention now is a recent example involving a PC board design technique called "Digiraster" — developed in Germany, adopted by HP GmbH in Boeblingen, and brought to the United States by Data Systems Division.

It took a year to implement the system, and when the time was right, Data Systems offered to pass on its knowledge and experience to other interested PC facilities. As a result, twelve divisions recently sent representatives to a Digiraster workshop in Cupertino.

Digiraster is a method of designing printed circuit boards by laying them out — almost freehand — on precise grids that disappear in the photo process. A special modification in the graphics camera makes it possible to photograph the design without the grid lines.

A team headed by Bob Jones, PC manager for Data Systems, started working on the project as a result of discussions about the technique in a corporate seminar on PC design and manufacturing standardization. Bob says that Lee Cozart and Tom Van Meter deserve much of the credit for successfully putting the method into use in the U.S.

The beauty of Digiraster is that it takes a very small capital investment to get consistently high-quality results. "We use it as a back-up to CAA," said Lee Cozart, referring to the division's computer-aided artwork system. "For divisions that don't have CAA, Digiraster is a definite step up in quality at about one tenth the investment."

Lee went to Germany about two years

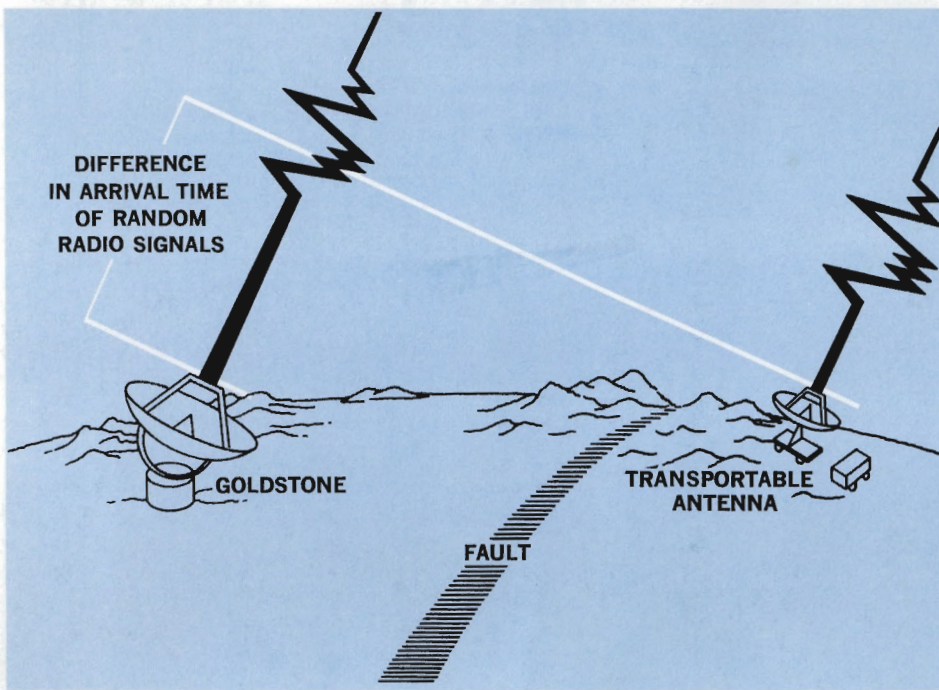
ago to investigate and learn the Digiraster method, and it was at his recommendation that the Cupertino project was begun.

He went back to Germany last year. "Originally, Digiraster was a metric system," he explained. "Of course, HP will eventually go metric, but all our component design aids are in English measurements, so I wanted the grids to be compatible. On my first trip I was too busy just learning the method to look into this, but when I went back I encouraged the printing of English-based grids." The materials are now readily available in both metric and English measurements.

Training seems to be no obstacle either; the twelve representatives from other divisions acquired a good working knowledge of the system in four days of well-planned sessions involving a lot of "hands-on" work at light tables and in the camera room.

It may not be as easy as it was when HP was small, but good ideas *do* get around. Perhaps it's because we can still think small. □

Do earthquakes signal their coming?



By virtue of their accuracy and ruggedness, the atomic clocks manufactured at HP's Santa Clara Division get involved in some pretty far-out experiments. They are essential tools in many types of advanced research conducted at the Jet Propulsion Laboratory of the National Aeronautics and Space Administration in Pasadena, California.

One JPL project of significance is dubbed ARIES, for Astronomical Radio Interferometric Earth Surveying. By a technique originally developed for navigating spacecraft, ARIES makes use of radio signals from quasars several billion

light-years out in space, but for the very down-to-earth purpose of testing a geological theory of earthquake prediction.

The theory says that some earthquakes are preceded by swelling of the Earth's surface. The change is very slight. "We're trying to measure a distortion of only a few centimeters over distances of hundreds of kilometers," explains Peter MacDoran, the NASA scientist who heads the project.

Making such a measurement requires two sensitive radio telescopes, now located 200 kilometers apart in Pasadena and at Goldstone in the Mojave desert.

Between them lies the San Andreas fault, main channel of the earth fracture system in California. The antenna at the Pasadena end is transportable, and plans call for all parts of the fault system to be surveyed from several locations.

Through a complex system that includes HP's 5065A Rubidium Standard, exact times are recorded showing when the quasar signals arrive at the two stations. "It's possible to discern the difference in time of arrival of identical wavefronts with an accuracy of one tenth of a billionth of a second," says MacDoran. By monitoring this energy at two distant sites, the NASA research team can perceive any small change in the Earth's crust.

If the ground-swelling theory proves valid, it could lead to accurate forecasting of earthquakes. But what then? How should the news be given to the public? Could it cause wholesale panic as devastating as the earthquake? The agency will attempt to answer questions such as these in a socioeconomic study being conducted jointly with a leading university. "Handling society at large is likely to be an even more challenging problem than the technological development of the instrument itself," MacDoran concludes.

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