inside:

- Announcing a great new Applications Pac
- Conserving magnetic tape
- A new program for software vendors
- 15 new Series 80 Solution Books
- A look at the HP-85's I/O capabilities
- Discs—You can now add 270K to 4.72M bytes of on-line storage to your system.

contents

Hardware Domain—the CPU 1
Communique—editorial 4
Software Highlight—the electronic worksheet 5
Further Reading 6
Software Domain—efficient tape storage 7
Quick Routines—toggling the soft keys 7
Users' Library 8
News 10
More New Products—three new interfaces 10
Hardware Highlight—disc memories 10

basic EXCHANGE

HEWLETT PACKARD Fall 1980 VOL. 1 NO. 2

Hardware Domain

The HP-85's Revolutionary CPU

When Hewlett-Packard entered the personal computer market with the HP-85, we brought with us 10 years of experience in personal computation. You can see it in a number of ways: the user-definable keys; the exceptionally high quality documentation; the friendliness and power the operating system provides. Have you noticed when you turn on the machine how quiet it is? The need for a cooling fan was eliminated by designing a highly efficient switching power supply and by writing firmware that has only one of the input/output devices operating at a time.

But there are many more subtle ways that this product is indelibly stamped HP. The custom CPU is a case in point. Its architecture is basically different from that of any other CPU. An accumulator, which is used often in other CPU's, is notably absent. And by one definition, the HP-85 CPU is a 64-bit machine! It has multibyte internal registers that allow direct manipulation of operands up to 64 bits in length.

We'll go on to describe it in detail for those who are interested, but let's first put some questions to rest. Why does HP use its own custom CPU? One of the most important reasons is ACCURACY. Where other computers do binary arithmetic, the HP-85 does its arithmetic in BCD (binary coded decimal). Our calculators do BCD arithmetic, and we've spent years testing and perfecting those algorithms, so we KNOW that the answers returned by the HP-85 are accurate to 12 digits. Real number calculations in the HP-85 are performed internally to 15 significant decimal digits and rounded to 12 digits for presentation.

For all the algebraic functions (+, −, ×, /, and SQR), the error is no bigger than one-half count in the 12th significant digit, with correct rounding in all situations. For some rational operations such as RMD and MOD there are no errors whatsoever, regardless of the magnitude of the arguments. The transcendental functions are accurate to within one count in the 12th significant digit, except where this specification would be impractical for any machine. There are just two such cases:

1. When y^x is bigger than 10^{200} or smaller than 10^{-200}, its error may exceed one count in the last place but is always smaller than two counts.
2. For trigonometric functions of large radian argument there may be an additional error of less than one count in the 12th significant digit. Despite this error, which is significant only when the argument is huge, both sides of the trigonometric identity SIN(2x) = 2SIN(x)COS(x) agree to all 12 significant digits when, for example, x = 52,174 radians. In general, every trigonometric identity that doesn't explicitly involve pi will be satisfied to within the rounding error of each trigonometric function that appears in it. This includes all cases when angles are expressed in degrees or grads.

The point is that Hewlett-Packard customers have learned to trust the answers their machines provide and they expect that accuracy. And remember, even if you only need three significant digits in the final answer, errors can propagate to the left quite rapidly, especially when a large number of repetitive calculations are performed. So 12 digit accuracy is important even for dollar and cent calculations.

Another effect of doing BCD arithmetic is the "perceived accuracy" of the results. The perceived accuracy comes from the avoidance of binary arithmetic anomalies, which most people are not used to. The anomalies in the base 10 system are commonplace; most people understand them and know how to deal with them. (For instance, 3 times 1/3 not equaling 1 because 1/3 is not exactly representable with decimal numbers.) In the binary system different anomalies occur. For example, 0.01 (base 10) cannot be represented exactly in the binary number system, so if 0.01 is used on a binary machine for a loop counter, an incorrect number of loops results to the frustration of a user who is unfamiliar with binary numbers.

Speed

There are a couple of ways to build a CPU—make it simple and run it fast, or make it complex and run it slow. Most manufacturers try to drive their CPU's as fast as possible. Four megahertz is typical—the speed is limited by the physical characteristics of the device, like capacitance. We have followed the second strategy, performing many operations during each clock cycle. The clock speed is 613 kilohertz!

But, execution speed is more than just a function of hardware design, and the HP-85 executes programs on the same order of time or faster than other personal computers on the market. In concert with the design of the hardware, the firmware design equally effects the speed of the system. HP-85 BASIC programs are executed by an interpreter, but the code that is interpreted is very different from the BASIC commands as they were originally entered. As the statements are entered into the HP-85, they are compiled to a form of RPN, which can be interpreted more efficiently than the BASIC source statements. One of the things that has traditionally made interpreters slow is that they maintain a table of variables which must be searched at run-time for each variable reference. In the HP-85 this problem is solved by preallocation of all variable references. During the allocation process, the variable names that occur in the internal RPN form of the program are replaced by the relative addresses of the variables. Then, at run-time, the interpreter has only to read an address and add it to the base address of the program to determine the absolute location of the variable being referenced. For traditional interpreters the time required to access any variable is dependent upon its position within the variable table. In the HP-85 all variables are accessed in exactly the same amount of time. All line number references are also replaced by the relative address of the referenced line during the allocation process, eliminating the need to search for referenced lines at run-time. This allocation process also makes possible the convenient REN command, which renumbers not only the line numbers, but all GOTO and GOSUB statements as well.

But all of this is another story. The point is that the HP-85 is a machine that is inherently accurate, fast, and affordable. You might argue, though, that there is a penalty for using our own custom CPU, that software written in machine language for the more common varieties of CPU's must be rewritten to run on the HP-85. And the task of translating these assembly level programs is not straightforward; the HP-85 relies on its unique architecture for its speed. Anything written for a Z-80, for example, translated straight across, would utilize only a small fraction of the CPU's power.

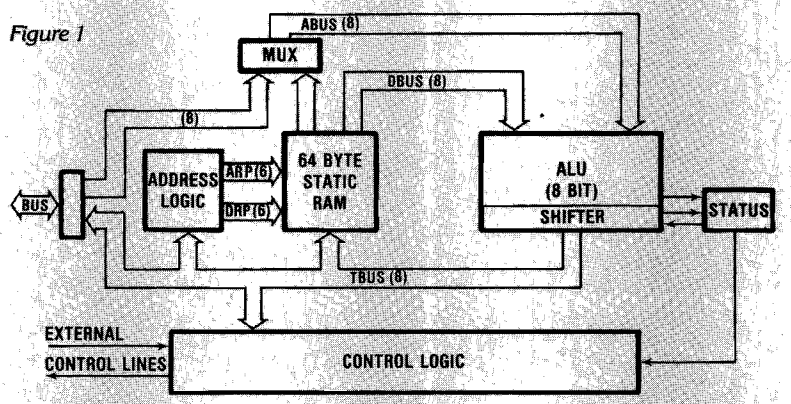
Well, even there we've got you covered! First, our application engineers have already developed a great deal of high-quality software, the Application Pacs. Next, there are the contributed programs and the new Series 80 Solutions Books available from the Users' Library. And lastly, there is the third-party software available through our Software Supplier Program. The latter two sources are fully covered elsewhere in this issue.

But really, incompatible software is a short-term problem. Most forthcoming software will necessarily have to be written in high-level language, making it independent of the actual processor used. The reason is due to increasing software costs and the desire to implement more complex programs. No one will be able to afford to develop important new applications in machine language, especially since it will be unnecessary. Because of the increased capabilities of future-generation microprocessors, coding efficiency won't really matter. Stretch it to the limit and you'll see what I mean—perhaps by the year 1999 all the software ever written will run in less than a minute. But you don't have to wait until then; forward-thinking software houses have already shifted gears.

Architecture

The custom CPU used in the HP-85 incorporates many features currently not found in other microprocessors, such as instructions that operate on data one to EIGHT BYTES in length (simplifying multibyte arithmetic and facilitating string manipulations). It also contains features found in other microprocessors that have

Figure 1



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proven to be desirable.

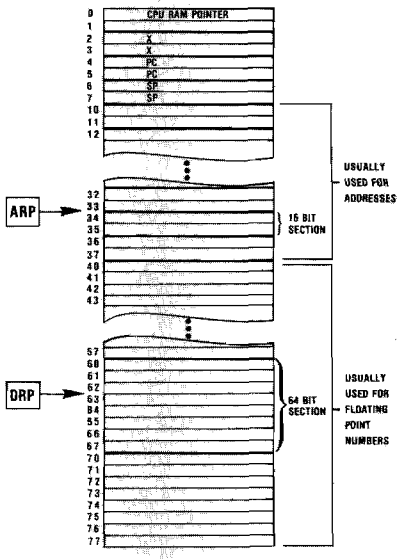
Figure 1 is a simplified block diagram of the microprocessor. Notice that the architecture is of the classical textbook variety. The three busses constitute two sources and one destination. Data for the ABUS can come from the external bus or the 64-byte on-chip memory. Data for the DBUS comes only from the on-chip memory. The ALU and shifter are in series and capable of full eight-bit parallel binary and decimal (BCD) arithmetic. Control of the entire CPU is handled by a programmable logic array.

One of the original design goals was to keep the pin count low to minimize package cost, save space, and lower the power requirements (the CPU fits into a 28-pin package). So a single, time-multiplexed, eight-bit bus is used to transport data, commands, and addresses. It turns out to be very efficient for the instruction set implemented.

When more than one byte of data is sent along the bus, an address is needed only for the first byte. The remaining data is assumed to be in consecutive locations. The memory controller and I/O units handle this by incrementing their own address registers upon seeing either a read or a write instruction. Also, the instruction-fetch sequence was designed so as not to require an updated address when fetching from some consecutive locations. As a result, the bus primarily moves data and instructions and tries to minimize the movement of addresses.

The heart of the CPU is the register bank comprising 64 bytes of RAM. The organization is shown below, with the

Figure 2



locations numbered in octal from 0 to 77. The top eight bytes are special purpose registers. Locations 6 and 7 house the stack pointer for the subroutine return address stack. Locations 4 and 5 provide storage for the program counter. Locations 2 and 3 are scratch registers used for index address calculations. Register 0 can be used as a pointer into the registers. The remaining locations are completely general purpose.

The heavy lines in figure 2 are called boundaries. In the first 32 bytes, there is a boundary every two bytes. In the next 32 bytes, there is a boundary every eight bytes. The purpose behind this partitioning is simple: 16 bits are essential for address manipulation, and 64 bits are handy for representing a floating point quantity. The register array is therefore capable of holding up to four floating point numbers and twelve 16-bit addresses. The advantage of 16-bit addresses is, of course, that page boundaries are completely eliminated—the programmer can get at any of the 2^{16} locations with any addressing mode.

The 64-byte register bank is designed as a two-read, one-write memory. Two independent locations from the memory are read at the beginning of a cycle and new information is written into one of those locations at the end of the cycle. THIS ELIMINATES THE NEED FOR AN ACCUMULATOR, WHICH IS A COMMON BOTTLENECK IN MANY MICROPROCESSORS.

Two different address pointers are therefore associated with this memory. The address register pointer (ARP) and the data register pointer (DRP) are independent six-bit locations. Both the ARP and the DRP can be used to address any of the locations in the CPU register bank.

Instructions may be either in a "multibyte" mode or in a "single" mode. As the name suggests, a "multibyte" operation involves a string of bytes rather than just a single byte. The important point is this: The string may consist of from one to eight consecutive processor locations. The actual locations involved in a multibyte operation are those inclusively between where DRP points and the next boundary. The next boundary is the one in the direction of increasing addresses.

The following examples should help explain this idea.

1. A multibyte increment with DRP set to 70 results in an increment of the 64-bit quantity stored between locations 70 and 77. Higher addresses always refer to more significant data.
2. A multibyte test with DRP set to 44 results in status being set according to the data found in registers R44, R45, R46, and R47. Location R47 is the most significant byte.

If an instruction is not in the multibyte mode, it is necessarily in the single byte mode. In this case the byte referenced by DRP is the only consideration. A single-byte negate with DRP set to 62 negates R62.

So far, only monadic operations have been used as examples. What happens if a two-operand instruction is executed in the multibyte mode? Here is where the CPU really shines! In this case, ARP points to one operand and DRP points to the other. DRP still determines the number of bytes for its operand. The other operand consists of the same number of bytes starting with the location pointed to by ARP. If data is written into a register at the end of a cycle, it goes into the register the DRP points to. For example:

1. A multibyte add with ARP set to 50 and DRP set to 60 results in the 64-bit quantity starting with R60 being added to the 64-bit quantity starting with R50. The sum is stored in R60 through R67.
2. A multibyte load with ARP set to 11 and DRP set to 74 transfers four bytes, beginning with R11, to locations R74, R75, R76, and R77.

Status Flags

There is one more thing you might like to know about. The microprocessor contains eight flip-flops and a four-bit register for program status, and some of these are quite unique.

The flip-flops serve as flags to signal the present condition of the data, while the four-bit register serves as an extended register for counting and data manipulation. A short description is given below for some of these.

- The Decimal Mode flip-flop is set when decimal operations will be performed. When cleared, binary operations will be performed.
- The Extend register is a four-bit register that can be cleared, incremented, decremented, and shifted into and out of. (This register allows for fast multiplies and divides.)
- The Left Digit Zero flip-flop is set if the most significant nibble of the result is 0000.
- The Right Digit Zero flip-flop is the counterpart of the previous flag. ■

Communique

Every now and then when I'm reading through some computer magazine, Bingo! Buried among the advertisements for the usual adventure games and accounting systems, an ad for some very unusual piece of software stops me. Some of these products may represent significant software contributions, budding new branches of computer applications. I'll just mention a few products here as examples and leave it up to the future to see what impact they will have.

There are a growing number of personal development software products on the market. Creative Computing offers the KNOW YOURSELF package, which they say "helps you investigate society's effects on your behavior, how your lifestyle affects your life expectancy, and how your attitudes are affected by society's concept of sex roles." The programs are "based on statistically valid tests and data. Using them from time to time could help you see in what direction your life is progressing." I imagine that this exercise would be particularly enlightening to anyone in a different "society," say in India or in the United States 20 years from now.

Personal Software, Inc., has six health information programs, the VITAFACTS series: Growing Up * Heart Attacks * Talking About Sex * Drinking and Drugs * Birth Control * Your Blood Pressure. They feel that "using a VITAFACTS program is like getting advice from your family doctor. Accurate, up-to-date medical information about physical and mental health is presented in a friendly straightforward way." Each program includes a manual with diagrams and a glossary, a computer cassette, and an audio cassette. The audio tape uses short dramas and straight talk to tell a story. Then computer exercises are used to test and reinforce what you've learned. Sociologists 20 years hence will probably have a field day with this one, too, but not so much because of the content. The same information can be found in hundreds of books, but the technique used may reach people much more effectively—books are static, computers interactive. It may well be that the modem way to improve your health is through personal computing!

How about a MIND-MEMORY IMPROVEMENT COURSE? There is one available from Teach Yourself by Computer Software. The reviewer in the June issue of CREATIVE COMPUTING said: "I have devoted something between three and four hours to the course and I am already able to study a list of 25 shopping items for about five minutes and recall it perfectly. Not only that, I can instantly answer questions like 'What is the fifth item on the list?' or 'How many things on the list appeared before potatoes?'"

From Huntington Computing there are: OBSERVATION TEST, 30 questions to determine how observant you are; COMPATIBILITY TEST, to determine if you are compatible with the one you love; and PICKYNESS TEST/OPENNESS TEST.

It is plain to see that these applications don't fit into the standard mold. But if there is one thing we've all learned, it is that computer games can be engaging. By weaving educational material into the fabric of a game, the problem of motivation goes away.

These exceptional programs are a result of the proliferation of the personal computer. Just as cultural changes are often introduced by "outsiders" who have a different background and point of view, so too will many innovative computer applications originate. Imagine for a moment a small group nestled away in the hills of Oregon, members of est and practitioners of Primal Therapy (ref. *THE PRIMAL SCREAM* by Arthur Janov). One day, they unleash upon an unsuspecting world "THE LIFE DYNAMIC TRANSFORMATION EXPERIENCE." Perhaps they have truly discovered and developed a way to use computers in the areas of self-transformation experiences, life-awareness, and making relationships work.

Well, you don't have to stretch your imaginations very far. Their company is called Avant-Garde Creations and they are a paradigm for what I'm talking about. A column in their March 1980 newsletter is excerpted here because it crystalizes the idea better than anything I might write:

"I, like most people, greeted the computer revolution with mixed feelings: they're making life easier, more efficient, and more fun, but will we get over-dependent, too soft, let our computers do our learning and thinking for us so that we remain ignorant, and will they mechanize, depersonalize, dehumanize, and further alienate us from 'natural' lifestyles?

"Avant-Garde Creations has put aside popular, sci-fi, media, and other perspectives and beliefs on the subject of computers and has experienced, with considerable surprise and delight, computers first hand. At first our computer was utilized for the purpose of helping to create, organize, and execute each step in our study, and then it was used for data storage for our questionnaire answerers.

"However, it wasn't long before we started realizing, through our own experience, that we had at our fingertips something with a lot more potential than we had ever imagined! Data storage and processing were merely the beginning!

"Consequently, we've experimented and developed and created in the areas of self-transformative experiences via computer programs. We've come up with enjoyable but challenging, cute but thoughtprovoking programs. They're part game, part a structured learning and introspective-provoking experience.

"We know of nothing like this presently in existence in the computer world, so we're bound to receive some mixed reactions as we introduce our ideas to the more conservative members of the computer world via ads in computer magazines that will appear in the next few months. New ideas always have and always will threaten normal neurotics.

"Before experiencing computers for ourselves, we'd never realized that people who'd never even been near a computer before in their lives could actually walk into a computer store and start running a program in a few minutes, without difficulty."

What is their technique? "It was discovered that 'game-playing' was the most effective method of getting people to perceive a difficult truth. So from time to time, you're given 100 percent original games to play, games specifically designed to give you the opportunity to 'get' something challenging or elusive. The games have a symbolic level and aren't of the bang-bang-shoot-'em-up variety. The computer medium is more effective than the est or Lifespring approach (encounter groups) because people can use it when they are ready and can use it over and over, gaining something each time. Not only that, but the computer is a 'perfect' human—logical and infinitely patient."

Current offerings from Avant-Garde Creations include: The Life Dynamic Transformation Experience * The Relationship Life Dynamic * The Aliveness Life Dynamic * The Conditioning Life Dynamic * The Creativity Life Dynamic * The Environmental Life Dynamic * The Responsibility Life Dynamic * The Meaning Life Dynamic * The Normality Life Dynamic * The Physical Life Dynamic * The Sexuality Life Dynamic.

All of the above software products are mentioned only as a matter of interest and without any endorsement by Hewlett-Packard. If you're interested in obtaining listings and documentation for them, you can find addresses in computer magazines

or write to me. Curtis G. Adams, Editor/Hewlett-Packard Co./1000 N.E. Circle Blvd./ Corvallis,OR 97330/USA

Once in a while an innovative, original piece of software comes along that receives wide acclaim. VisiCalc™ is a case in point. Although the application area is not new, the program ushered in an elegant concept. With VisiCalc, you can create a two-dimensional matrix with the relationship between the rows and columns defined any way you want; the familiar balance sheet, for example, with the right hand column entries being the sums of the rows and the entries in the bottom row the sums of the columns. The beauty and power appears when a change is required—change any value and all entries related to it change too. Bear in mind that the relationships aren't restricted to being sums as in the simple example above, but might be transcendental functions or complex equations, and that a change could potentially disrupt hundreds of entries.

Hewlett-Packard has identified VisiCalc as a valuable software product, and our application engineers have licensed it, coded it to run on the HP-85, documented it, and packaged it for distribution. You can learn more about it in the Software Highlight column in this issue.

The point I want to make is this: While none of the earlier-mentioned software products will run right now on the HP-85 without modification, we watch what's going on very closely. When we spot something like VisiCalc, we waste no time in making it available to HP-85 users. ■

Software Highlight

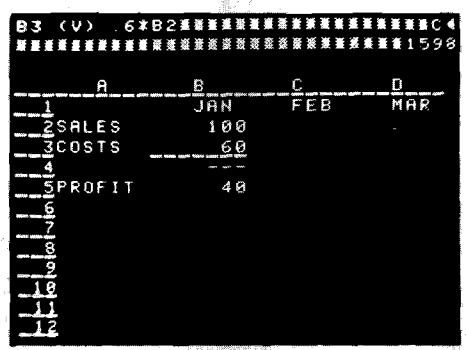
HP-85 VisiCalc™ PLUS—The Electronic Worksheet

How many times have you begun an analysis or problem-solving exercise by taking a large sheet of paper, marking off rows and columns, and then proceeding to enter titles, headings, data, and formulas? Seems like a countless number, doesn't it? When formulas are involved, you probably compute the result with a hand-held calculator and then write the resulting value on the worksheet. In many cases, entries on your worksheet depend on the values of other entries, so that you end up erasing and refiguring time and again. Sometimes you find you need to insert a row or column somewhere in the worksheet and have to squeeze it in or start all over again. And then when you've finished, you have to have it typed to make it legible. And sometimes, presentation of your work requires preparation of bar and pie charts or other graphics.

Well, now, a powerful software tool is available for the HP-85 to help you perform all these tasks quickly and easily—VisiCalc PLUS. With VisiCalc, the HP-85 display screen becomes a "window" that looks upon a much larger "electronic worksheet." You can use the cursor keys to move or "scroll" this window in all four directions to look at any part of the worksheet.

The worksheet is organized in columns and rows. Columns are designated by letters, and rows by numbers; the intersection of each column and row defines an entry position, or cell. To make an entry on the worksheet, simply move the cell cursor to the desired cell. You can enter an alphabetic title, a number, or a formula. Most significantly, the formula can contain references to the contents of other cells, so that whenever you change a cell value, all cells depending on that value are automatically changed. It's great fun watching the domino effect that often results.

For example, let's say you are preparing an earnings forecast and assume that the cost of goods sold will be 60% of sales. Your sales figure, in cell B2, is $100. When you enter the cost of goods sold in cell B3 as .6*B2 and press [END LINE], the cost of goods sold will be automatically displayed as $60. Now what if your sales forecast



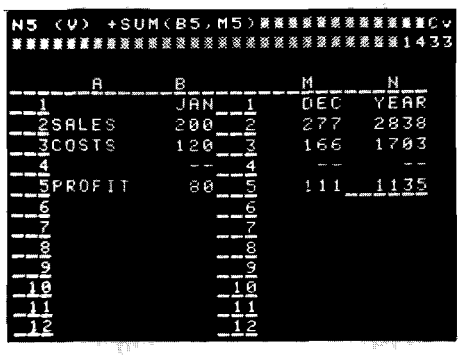
doubles to $200? Simply move the cursor to cell B2 and change sales to $200; the cost of goods sold is instantly recalculated and $120 is displayed. Each time an entry is made, VisiCalc automatically does a recalculation of all formulas on the worksheet. It is this ability to play "what if" that makes VisiCalc so widely recognized as an outstanding software tool.

The "electronic worksheet" is much larger than what you can see at any one time on the display screen. Potentially, the worksheet can have 63 columns and 254 rows. Keeping track of the number of cells remaining is very easy, by the way, since it is displayed in the upper right-hand corner of the display screen. At any one time you can see 12 worksheet rows. The number of worksheet columns you can see will vary, however, because you can control the column width. In any case, the contents of each cell held in memory may be up to 62 characters in length, so you may write complex arithmetic expressions. All of the HP-85's arithmetic, logical, and relational operators are available, as well as nearly all of the HP-85's function set. In addition, special VisiCalc functions include sum, mean, standard deviation, IRR, and NPV. The sum function is particularly useful when adding up rows or columns of numbers.

On the display screen, above the worksheet, is a three-line control block that displays important information. The top line displays the coordinates of the cell cursor—the cell where the cursor is currently located, followed by the cell contents, either the label (L) or the value (V). There is room to display the first 22 characters of the cell contents, but the Edit command allows you to examine the entire contents of the cell (up to 62 characters). With the Edit command, the cell contents are displayed on the edit line, the third line of the control block. The contents may be changed with the aid of the HP-85 editing keys. After you've finished the edit, simply press [END LINE] and the new cell contents overwrite the old contents in memory.

VisiCalc™ is a trademark of Personal Software, Inc., and designates a software product produced under license from Personal Software, Inc. and Software Arts, Inc.

Including the Edit command, there are a total of 16 VisiCalc commands. The Window command allows you to "split the screen" into two windows either horizontally or vertically. This feature is commonly used to simultaneously display the upper left and lower right portions of the worksheet, allowing you to change initial cell entries and watch the effect on the totals. For example, January sales data and end-of-year profit after taxes may be widely separated on your earnings forecast worksheet, but the Window command lets you view them at the same time.



The Title command allows you to see column and row titles on the display screen as you scroll around. This feature can be used with the Window command, so that while you are displaying data from two sections of your worksheet you can also display the labels corresponding to the data and easily interpret the data.

Display formats include general, integer, dollars and cents, and left or right justification. In the general format, VisiCalc displays as many significant digits as possible, shifting to scientific notation when necessary to display the value in the assigned column width. Formatting may be controlled globally (for the whole worksheet) or locally (one cell).

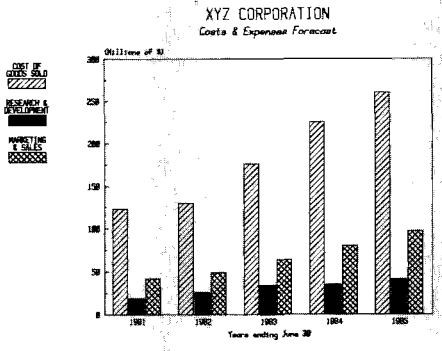
Undoubtedly one of the most powerful commands, the Replicate command allows you to reproduce the contents of a cell across a row or down a column. You can also replicate a column across the worksheet, or replicate a row down the worksheet. This command can save you hours of typing formulas into your worksheet cell by cell. For example, if you are forecasting monthly earnings for an entire year, and the cost of goods sold is 60% of sales, you would only have to enter the formula once in the cell corresponding to the cost of goods sold for January. Then you simply replicate the expression across the row into the cells for the remaining 11 months of the year.

While VisiCalc is obviously a very powerful and flexible software product, it is enhanced by the addition of the PLUS portion of VisiCalc PLUS. This is a group of four BASIC language graphics programs that use data files created within VisiCalc to generate line, bar, and pie charts, and to test sets of data for goodness of fit to a linear regression and three other standard regression curves.

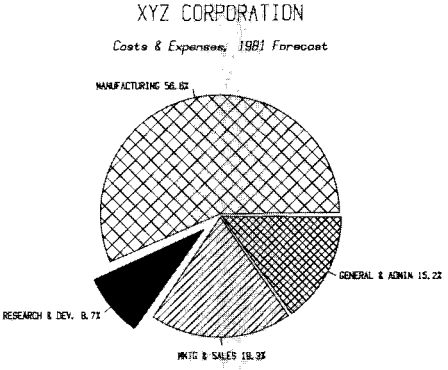
The source file for each of these four graphics programs is generated using a special feature of the Print command. After first saving your worksheet with the Storage command, you prepare the data in the proper format on the VisiCalc worksheet. This may mean moving or deleting rows or columns, changing the column width, or editing labels. Next you store the data using the Print command and exit the VisiCalc program with the RESET key.

Next, you load the particular graphics program, read the data file, answer a series of questions about titles, legends, axes scaling, etc., and then you can send your output to an external plotter such as the HP 7225A or HP 9872A. All four programs will create graphs on paper or transparencies, in up to four colors.

The line chart program graphs up to 150 data points on either linear, semi-log, or log-log axes. Linear X-axis units may be days, months, or quarters, as well as numerical. Up to six lines may be graphed per chart.



The bar chart program graphs bars in normal, stacked, or clustered modes. Up to 25 bars with up to six stacks or clusters may be graphed, having up to six different types of hatching (shading).



The pie chart program produces graphs with either one or two pies. Each pie may have up to 25 slices, either normal or exploded. Up to six different types of hatching are available.

The curve fitting program plots a data set having up to 250 points, and then fits one or more of the following regressions to the data: linear, logarithmic curve, exponential curve, or power curve. Using these curves, you can extrapolate future sales, make earnings projections, etc.

HP-85 VisiCalc PLUS will be available from your HP-85 dealer in December. It includes the VisiCalc PLUS programs on a tape catridge, a User's Guide, and a VisiCalc Quick Reference Guide. To operate the VisiCalc program and the PLUS programs, you will need an HP 82903A 16K Memory Module. In addition, to operate the PLUS programs you will need an HP 00085-15002 Plotter/Printer ROM and an HP 82936A ROM Drawer. Contact your HP-85 dealer for information about connecting peripheral devices such as a plotter, printer, and flexible disc drive. ■

Further Reading

Christopher Evans, *THE MICRO MILLENNIUM,* The Viking Press, New York, 1979. There is nothing new about bold predictions. What's unusual about the ones in this book is they're optimistic and they're made very convincingly. What's amazing is

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that Evans predicts such radical changes as the end of crime, the end of communism, the end of the work week (in fact, the end of work!), and universal affluence.

Affluence and not working may not seem to go hand-in-hand, but they did in societies that kept slaves; Evans predicts that we will all be the plantation owners. Computers will be cheap enough and smart enough to man our factories and even to a large extent be our doctors and lawyers.

Evan's long-term predictions are framed in the 1990's. Ten to twenty years may not sound long-term, but Evans qualifies that it is in event-space. His midterm predictions, for the period 1983 to 1990, paint a period of tremendous social upheaval as we try to grapple with the profound changes the microprocessor will introduce.

His long-term predictions are predicated on the appearance of UIM's. (Ultra Intelligent Machine is a term coined by I.J. Good.) If you read about them in OMNI, it's no coincidence—Christopher Evans was a contributing editor to OMNI until his untimely death last year.

To make the possibility of UIM's credible, Evans had to deal straight on with the subject of artificial intelligence. Here is where the book shifts from making cheap predictions to squarely facing some difficult questions, and here is where it shines.

"Can a machine think?" He brilliantly answers some classical stumpers. "At this point in the argument, most humans ask the question which every computer scientist has come to dread: 'But a machine's intelligence, if you must use the word, is purely automatic. Surely it can only do what you have previously programmed it to do?' The answer to this is unexpectedly simple: the same is true of animals and humans."

And remember, he points out, computers don't have to develop any intelligence for or devote any resources to eating, locomoting, maintaining themselves, or reproducing themselves. We do all that for them. So if evolution does favor them with becoming the grandest tiger in the jungle, it looks at least that humans will be carried along in a symbiotic relationship.

Once you reach the point where you agree that computers might be intelligent, he's got you. Because, then, machine intelligence can move ahead in quantum leaps to ultra-intelligence. The first task given a computer that is even just a little smarter than a human is "design a machine smarter than yourself," and it leapfrogs along from there. Evans doesn't comment about whether these machines will, like Raggedy Ann, be endowed with a candy heart.

Christopher Evans' style is charming. If you're interested in computers from their beginnings to where they're headed, you'll like this book a lot. ■

Software Domain

You may be interested to know that there is a way you can squeeze more programs onto a tape cartridge. You can store a program using significantly fewer records, say 15 instead of 20, by using a COM (common) statement in your program.

As you know, one of the first things that happens in your HP-85 when you press RUN is that storage is allocated (set aside) for all variables in the program. Each real variable is given eight bytes, short variables four bytes, and integers three. Dimensioned variables gobble up space according to the size of the array.

By putting variables in common, space is still reserved for them in the system RAM, but no corresponding space is set aside on tape when the program is stored. The variables are stored unallocated.

As an example, type in the following program:

```
10 DIM A(40,40)
20 PRINT "THIS IS A TEST"
30 END
```

Then store it on tape: `STORE "DTEST"`.

Now, change the first line to `10 COM A(40,40)` and store it on tape: `STORE "CTEST"`. Type `CAT` to see the storage requirements—the display looks as follows:

```
NAME     TYPE   BYTES    RECS FILE
DTEST    PROG     256      53    1
CTEST    PROG     256       1    2
```

Here, a storage compression of 53:1 was obtained just by putting the variable A in common. ■

Quick Routines

Toggling the Soft Keys

The HP-85 has eight soft keys (user-definable keys), on the keyboard. A clever technique that has been used in the Financial Decisions Pac doubles the function of these keys and helps make the user instructions simple, logical, and convenient.

For example, rather than use one key to set a 360-day-year mode and another a 365-day-year mode, the technique permits one key to be toggled back and forth, alternately selecting one mode or the other. The key labels at the bottom of the screen reflect the changes by underlining the mode in effect, 360/365 or 360/365 in this example.

To see how it works, try running the following demonstration program:

```
10 K1$="1ST/2ND"
20 K1=1 @ CLEAR
30 ON KEY# 1,K1$ GOTO 6
40 KEY LABEL
50 GOTO 50
60 IF K=1 THEN 100
70 K1=1 @ K1$="1ST/2ND"
80 DISP "FIRST MODE"
90 GOTO 30
100 K1=0 @ K1$="1ST/2ND"
110 DISP "SECOND MODE"
120 GOTO 30
130 END
```

Getting this program into the HP-85 is tricky in itself. First, enter the following program:

```
10 L=0
20 K1=1 @ CLEAR
30 ON KEY# 1,K1$ GOTO 60
40 KEY LABEL
50 GOTO 50
60 IF K=1 THEN 100
70 L10
80 DISP "FIRST MODE"
90 GOTO 30
100 L=0
110 DISP "SECOND MODE"
120 GOTO 30
130 END
```

Then add steps one through five, below. Refer to your owner's manual, page 292, if you don't follow what is happening.

```
1 CLEAR
2 DISP "10 K1$="&CHR$(34)&CHR$(1
77)&CHR$(211)&CHR$(212)&"/2ND"&C
HR$(34) @ DISP
3 DISP "70 K1=1 @ K1$="&CHR$(34)
&CHR$(177)&CHR$(211)&CHR$(212)&"
/2ND"&CHR$(34) @ DISP
4 DISP "100 K1=0 @ K1$="&CHR$(34
)&"1ST/"&CHR$(178)&CHR$(200)&CHR
$(108)&CHR$(34) &DISP
5 STOP
```

Run the program. The CRT should look like this:

```
10 K1$="1ST/2ND"
70 K1=1 @ K1$="1ST/2ND"
100 K1=0 @ K1$="1ST/2ND"
```

Replace statements 10, 70, and 100 in the program with the statements above by moving the cursor up to each line number and pressing END LINE. Finally, delete statements one through five:

```
DELETE 1,5.
```

To see the results, press RUN and then press special function key k1 a few times. ■

HP Computer Museum
www.hpmuseum.net

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Users' Library

The amount of software available for Series 80 Systems (HP-85 and future systems) is skyrocketing, and it's all described in the new Series 80 Software Catalog. You can see a copy of this catalog at your local HP dealer, or you will receive your own copy if you are a member of the Users' Library. It will replace the HP-85 Users' Library Catalog.

The Catalog comprises a collection of data-sheet style summaries in a loose-leaf notebook, organized with dividers and an index. This format allows the Catalog to be updated to include new summaries and keep existing summaries current. The Catalog contains summaries of software from three different sources: Software Supplier Software Pacs; Users' Library programs, including the new Series 80 Solution Books; and HP-written programs and Application Pacs.

The Software Supplier Program

This new program will encourage software vendors to make products available for Series 80 Systems. The primary incentive for them to do so is the marketing channel open to them through the Series 80 Software Catalog itself. Of course, potential suppliers must meet the standards established under the software supplier program. This insures that products included in the Catalog are well supported and maintained.

It is the software suppliers' responsibility to sell their products directly to dealers and end-users. This may involve demonstrating programs to dealers, answering customers' questions, and fixing bugs. So HP screens suppliers based on their marketing and support capabilities, business experience, and expertise in their application area.

A qualified vendor's software products will be described in the Series 80 Software Catalog, reaching thousands of potential customers. No supplier will have exclusive rights to any market segment, leaving opportunities open for other third-party suppliers and providing users with a number of software solutions with different capabilities and at different prices.

Series 80 Solution Books

The Users' Library has published 15 new Series 80 Solution Books. Each book is a collection of programs in a specific application area (the details are highlighted below). These books are similar in format to the popular solution books available for HP calculators. Any of the programs they contain are also available individually from the library. And the best news is—the Series 80 Solution Books are only $10* each. They should be available from your local HP dealer.

New Services

You'll be happy to know that typing Users' Library programs into your machine from listings is no longer necessary. All Users' Library programs are now available on magnetic tape cartridges and 5¼-inch flexible mini-discs. The following prices* include the program listing and complete documentation:

	Members
Cartridge	$20 for first program, $6 for each additional program until cartridge is full.
Mini-Disc	$12 for first program, $6 for each additional program until disc is full.
	Non-Members
Cartridge	$25 for first program, $10 for each additional program until cartridge is full.
Mini-Disc	$18 for first program, $10 for each additional program until disc is full.

So you see, you now have several new sources of high-quality software, conveniently available in several media.

* *U.S. price only. For information outside of U.S., please contact the sales office or dealer nearest you. Regional addresses appear on the back page.*

Series 80 Solution Books

Math

Complex Trigonometric Functions—Performs trigonometric functions for complex arguments. *Spherical Triangles*—Solves spherical triangles with the apex at the north pole. *Parabolic Equation*—Finds the equation of a parabola passing through three given points. *Area Under a Curve*—Computes area under a curve using Simpson's Rule. *Linear Equations—Gaussian Reduction*—Solves simultaneous linear equations using Gaussian reduction. *Polygon Area*—Computes the area enclosed in any polygon. *Bessel Functions*—Calculates Bessel functions of the first kind. *Complex Determinant*—Computes the value of a complex determinant. *Simultaneous Linear Equations*—Solves simultaneous linear equations using the CROUT algorithm.

Stock & Bonds

Stock Value and Evaluation Report—Determines whether a stock should be invested in, depending on chosen input conditions of market growth. *Bond Price Analysis*—Computes the price and accrued interest for a bond, given its coupon, redemption data, yield, and maturity date. *Warranty Price Calculation*—Computes 'normal' warrant price given the common stock and exercise prices, the number of shares per warrant, the previous year's high and low prices, the months remaining before warrant expiration, the current stock yield, the number of options, and the common shares outstanding. *Exponential Smoothing as a Stock Guide*—Uses exponential smoothing on past price data to provide a guide for timing buy/sell orders of a given stock. *Stock Incentive Program*—Prints a table of stock incentive estimates for the merging of two companies. *Bond Switch Analysis*—Calculates the effect of a bond switch and provides a sensitivity analysis on various inputs. *Price/Earnings Ratio Calculation*—Calculates the theoretical P/E ratio for a given firm. *Bond Yield Analysis*—Computes after-tax yield to maturity of a bond, given its coupon, redemption price, maturity life, price, and the tax rates applied to interest and capital gains. *Stock Returns Report*—Computes a matrix of returns for a stock investment and an average return under various buy/sell conditions.

Decision Analysis

Analysis of Variance and F-Ratio—Computes an analysis of variance table and F-ratios for a simple Graeco-Latin square design. *Kruskal-Wallis One-Way ANOVA*—Produces a one-way analysis of variance using the Kruskal-Wallis technique. *Three Factorial Analysis of Variance*—Computes an analysis of variance for an experiment with 3 factors. *Regression/Correlation*—Performs simple regression and correlation analysis on a series of observations of the values of two variables. *Analysis of Covariance*—Computes an analysis of covariance table, F-ratio, and adjusted means for groups of unequal size. *Basic Statistics*—Calculates basic statistics for grouped and/or ungrouped data. *Confidence Limits*—Determines the confidence limits for a population proportion based on the exact binomial distribution. *Correlation Coefficient*—Computes the correlation coefficient for two sets of data having an equal number of elements in each set. *Pooled Mean and Standard Deviation*—Calculates the pooled mean and standard deviation for up to 30 groups of data. *Least Squares Fit, Multiple Y's Per X*—Does a least squares fit for groups having more than one Y per X.

Games

Qubic—Tic-tac-toe on a 4 × 4 × 4 cube. *Biorhythm Comparison*—Computes the biorhythm compatibility of two people. *Pro Football*—Pro-style football where you are the quarterback and the defensive signal-caller for your team. *Radioactive Decay Game*—Simulates the radioactive decay of playing chips with a half-life of 10 minutes. *Hunt the Hurkle*—Find the hurkle hiding in the 10 × 10 grid. *Bagels*—A number guessing game where the computer thinks of a three-digit number and you try to guess it. *Roulette*—The computer spins the wheel and you place the bets. *Stock Market Game*—You are given $10,000 and can buy and sell stocks according to information given you in the program. *Golf Game*—Simulates an 18-hole championship golf course.

Management Science

M/M/1 Queueing System—Calculates all the necessary information for a queueing system with a single server, poisson input, and exponential service times. *M/M/S Queueing System*—Calculates all the necessary information for a queueing system with 'S' servers, poisson input, and exponential service times. *Linear or Quadratic Program Problem Solving*—Solves either a linear or quadratic programming problem. *Shortest Route Using the Method of Dynamic Programming with Successive Approximation in Functional Space*—In an 'N' node network, this program will find a path from node 1 to node N such that the total cost (or distance) is minimized. *Linear Trend Forecasting*—Computes a simple linear trend forecast with seasonal adjustments for monthly data. *First Difference, Percent Changes, Percent Difference*—Calculates first difference, percent difference, percent changes, average changes, variance, standard deviation, and Durbin-Watson statistic for up to 1000 time periods. *Critical Path Analysis*—Performs a critical path analysis on any complex project capable of being represented as a network of individual tasks. *Network Flow Determination*—Finds the feasible minimum or maximum cost flow through a network.

Real Estate

Loan Amortization—Amortizes a loan using arbitrary monthly payments entered by the user. Reports are generated indicating payments to interest and principal. *Mortgage Analysis*—Will find the missing parameter of the following four, given the remaining three: interest rate, life (years), amount borrowed, and monthly payment. *Capital Investment Analysis*—Evaluates capital investment alternatives. Cash flows are determined and the rate of return is calculated using discounted cash flow analysis. *Mortgage Plan Comparison*—Permits the user to easily compare and evaluate mortgage payment plans simultaneously. *Investment Return*—Calculates internal rates of return and present values for sets of cash inflows and outflows over a given period of time. *Discounted Return on Investment and Payback*—From initial investment and cash flow information, depreciation, taxable income, taxes and cash flow after taxes are predicted. Three depreciation methods can be used for the calculations. *Real Estate Investment Analysis*—Calculates the critical financial information for a real estate purchase. *Cash Flow Analysis*—Calculates present value of up to four cash flows, implicit rate of return, and period in which payback occurs. *Annuity Analysis*—Performs the calculations necessary for determining both payment and withdrawal annuities.

Budgeting & Finance I

Proforma Income Statement and Balance Sheet—Provides a listing of a simple proforma income statement and balance sheet. *Sales Commission Report*—Computes a monthly planning table for a salesperson, with their base salary, incentive dollars, and prospective billing totals. *Financial Ratios*—Uses income statement and balance sheet data to compute various financial ratios. *Lease Income*—Calculates annual lease income from (U) units at sales price (S) leased at lease rate (R) for lease period (L). *Make-Buy Decision Analysis*—Calculates the present value of the cost saving incurred by making a product as opposed to buying it. *Loan Amortization*—Amortizes a loan using arbitrary monthly payments entered by the user. Monthy reports are generated indicating payments to interest and principal. *Mortgage Analysis*—Will find the missing parameter of the following four, given the remaining three: Interest rate, life (years), amount borrowed, and monthly payment. *Cost of Equity Capital*—Computes the cost of equity capital by computing the dividends and the share price for future periods, and finds the discount rate by equating the present value of the stream to the current share price. *Depreciation Method Comparison*—Computes and prints the monthly depreciation of a given investment by four methods: straight line, double declining balance, sum of the years digits, and 150% declining balance. *Simple Loan Analysis*—Calculates the monthly interest charges and outstanding balance of a loan that must be paid off in one year or less.

Budgeting & Finance II

Income Statement—Prints a simple income statement and allows a sensitivity check on various input parameters. *Mortgage Plan Comparison*—Permits the user to easily compare and evaluate mortgage payment plans simultaneously. *Capital Investment Analysis (Discounted Cash Flow)*—Evaluates capital investment alternatives. Cash flows are determined and the rate of return is calculated using discounted cash flow analysis. *Exponential Smoothing on Price Data*—Uses exponential smoothing to forecast data which is thought to have a trend and/or season effect. *Cash Flow Analysis*—Calculates present value of up to four cash flows for a given cost of capital, implicit rate of return, and period in which payback occurs. *Compound Interest*—Calculates the amount of money that would accumulate after N years at an annual interest rate. *Lease Analysis as Determined by the Lessee*—Compares the advantages of leasing vs. purchasing equipment. Investment tax credit is considered and a cash flow table is available. *Annuity Analysis*—Performs the calculations necessary for determining both payment and withdrawal annuities.

Securities & Investment Analysis

Securities Earnings Per Share Growth—Finds the number of years of constant growth in earnings per share required to justify the current price of a stock; provides the present values of the dividends and terminal share price for one less year of growth. *Present Value—Stream of Cash Flows*—Calculates the present value of a stream of cash flows. *Securities Portfolio Analysis and Determination*—Traces the relationship between minimum non-market risk and market sensitivity for portfolios. A portfolio is found which gives the minimum amount of non-market risk for a given level of sensitivity. *Extended Risk Analysis*—Determines the advantages or disadvantages involved in making certain financial investments. The output is in the form of average cash flows per future period, the expected payback period, the expected rate of return, and the probability of various rates of return. *Capital Investment Analysis*—Prints the gross cash flow, annual depreciation, annual tax, net cash flow, and discounted cash flow for a long term capital investment. *Discounted Return on Investment and Payback*—From initial investment and cash flow information, depreciation, taxable income, taxes and cash flow after taxes are predicted. Three depreciation methods can be used for the calculations. *Investment Return (Cash Flow)*—Calculates internal rate of return and present values for sets of cash inflows and outflows over a given period of time. *Efficient Corner Portfolios*—Finds the set of 'efficient' corner portfolios from a given set of securities.

Science Learning I

Photosynthesis Experiment—Investigates changes in rate of photosynthesis when carbon dioxide concentration and light intensity are varied. *Young's Double Slit Experiment*—Young's Double Slit Experiment is simulated. *Lens Problem*—Solves lens problems involving focal length, object distance, image distance, image size, or object size. *Snell's Law*—Presents Snell's Law pictorially. *Photoelectric Effect*—Simulate an experiment involving the photoelectric effect allowing students to improve their understanding of the phenomenon. *Optical Absorption Spectra Simulation*—Computes and plots simulated optical absorption spectra for up to five equilibrium mixtures of a system of two interconvertible chemical species. *Propagation of Error*—Computes the precision of a quantity computed from imprecisely measured quantities. *Natural Selection Experiment*—Studies a population of pepper moths over a period of 30 years and observes the consequences of altered environmental conditions. *Cloud Formation*—Tests students ability to solve problems on cloud formation.

Science Learning II

Electronic Configuration—Derives the electronic configuration of any element. *Empirical Formulas*—Calculates the empirical formula from the atomic mass and percent composition. *Projectile Motion*—Calculates the coordinates, vertical and horizontal velocities, and speed of a projectile for equal time intervals. *Instantaneous Velocity*—Computes instantaneous velocity at points on a graph of distance vs. time for an accelerating body. *Einstein Distortions*—Calculates the relativistic effects on a 'twin' traveling some percent of the speed of light. *Atomic Weight*—Calculates the atomic weight of an element. *Sum of Two Waves*—Finds the sum of 2 waves, one provided by the student and one by the computer. *Avogadro's Number*—Calculates Avogadro's Number. *Nuclear Decay*—Will find the half-life and mass of an element at a given time.

Math Learning

Solution of First-Order Differential Equations—Solves a set of first-order differential equations using the Runge-Kutta-Gill algorithm. *Arithmetic Mean, Median and Standard Deviation*—Finds the arithmetic mean, median value, and the standard deviation of a set of numbers. *Trigonometric Solutions of Triangles*—Given three parts of a triangle, the program will determine the remaining three parts and graph the triangle. *Properties of a Straight Line*—Finds the slope, midpoint, and length of a line segment between two points. The resulting line is graphed. *Quadratic Equation Solver*—Solves all cases of the quadratic equation and provides a graphic representation of the function and its roots. *Approximating the Derivative Using Secant Slopes*—Approximates the value of the derivative of a function by calculating the slope of the curve. *Area of a Surface of Revolution*—Calculates the area of a surface of revolution formed by the rotation of a curve about the X-axis. *Volume of a Solid of Revolution*—Computes the volume of revolution generated by rotating a curve around the X-axis. *Length of a Curve*—Approximates the length of a curve between two points by summing the lengths of a number of secants to the curve.

Electrical Engineering

Low Pass Filter Design—Uses constant-K-prototype-T-section and M-derived-termination-L-section low pass filter designs. The program will give high attenuation at specified frequencies in the stop band by adding up to nine additional M-derived-T-sections. *Ladder Network Analysis*—Analyzes circuits with a "ladder" topology comprising R-L-C-networks or lossless transmission lines. *Active Filter Design*—Designs Butterworth or Chebyshev filters with roll-offs of 12,24 or 36 db per octave (48 for Butterworth). *Frequency Plot of Poles and Zeros in a Complex Plane*—Lists and plots the frequency response given the poles and zeros in the complex plane. *Passive Filter Design*—Calculates the element values for matched Butterworth or Chebyshev filters. It will operate for low pass, high pass, or Cohn structure band pass filters. *Mixer Spurious Response*—Applies the general equation for mixing to each converter and calculates the frequency of the spurious response; the harmonic numbers and frequencies involved are printed so that filter requirements can be determined. *Microwave Parameter Conversion*—Conversions include signal separation, theoretical noise level, and Smithchart. *AC Circuit Analysis*—Computes node voltages by inverting an admittance matrix created from a nodal description of an electronic circuit containing resistors, inductors, transformers, independent current sources, and voltage-controlled current sources.

General Probability

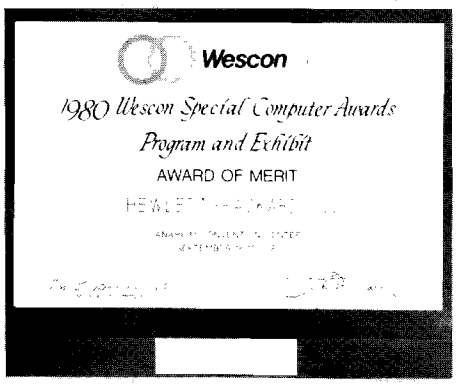
Least-Squares Fit—Performs a least-squares curve fit to various functions. *Probability Distribution Comparisons*—Produces a comparison of probability distributions. *Probability of Chi-Square Values*—Computes the 'exact' probability of a chi-square value with specified degrees of freedom. *Expected Value of Perfect Information*—Computes the expected value of perfect information. *Chi-Square Test*—Applies a chi-square test to several sample proportions. *Exact Probability of an F-Ratio with Degrees of Freedom*—Computes the exact probability of an F-ratio with degrees of freedom. *Binomial, Poisson and Hypergeometric Probabilities*—Computes Binomial, Poisson, or Hypergeometric probability. *Fisher's Exact Probability Test*—Analyzes discrete data from two independent small samples which fall into one of two mutually exclusive classes. *Subjective Probability Distribution*—Determines a subjective probability distribution given the minimum, maximum, and most probable values.

Numerical Analysis

Quadratic Equation—Analyzes a quadratic equation. *Interpolation of Non-Linear Functions*—Provides for interpolation of non-linear functions by Newton's formula. *Vector Exponentiations*—Raises a complex number to a real or complex power. *General Fast Fourier Transform*—Finds the Fourier transform of a function. *Real to Complex Fast Fourier Transform*—Performs a real to complex Fourier transform. *Complex to Real Fast Fourier Transform*—Finds the time function given a complex line spectrum. *Roots of Polynomials*—Finds the roots of polynomials. *Definite Integral*—Computes a definite integral. *Vector Arithmetic*—Performs the four basic operations (+, −, *, /) with vectors. *Roots or Fixed Points of Non-Linear Functions*—Finds the roots or fixed points of a non-linear function. ■

News

A competition among personal computer manufacturers was held at the recent high-technology engineering show, Wescon "80." The manufacturers' support documentation was judged by a panel drawn from science, industry, business, and the news media, and Hewlett-Packard received this award for outstanding quality.



More New Products

The HP-85 is now endowed with a complete complement of interfaces: HP-IB, serial, GPIO, and BCD. Simply plug in the ROM drawer (containing the I/O ROM) and the interface module or modules in any of the four slots in the back, and the HP-85 becomes a full-featured I/O controller.

The HP 82939A Serial Interface is the RS-232C compatible interface, providing bit-serial, asynchronous data communication. The RS-232 standard for serial interfacing is extremely versatile. It is the common means of communicating between a computer and peripherals such as printers, but because of the aforementioned versatility, it is difficult to give a simple procedure for interfacing all printers. To help in this regard, we have developed two new Application Notes, one for the Centronics 730 dot-matrix impact printer, and one for the NEC Spinwriter full-character impact printer. These notes provide specific instructions for getting these printers up and running on your HP-85 via the serial interface. They discuss the hardware required, the installation, and the instructions required in your programs to drive the printers. You may get a copy of these Application Notes from your local HP dealer or sales representative. You can also expect more Application Notes from us in the future.

Other common uses of the serial interface are connecting two computers together via direct connection or dial-up phone lines (using a modem). The interface supports operation with the HP-85 acting as the computer or as the peripheral. It also supports current-loop operation, used by teletypes for example.

The HP 82940A GPIO Interface (parallel) is a general purpose byte or word (16-bit) oriented interface. Parallel interfacing is used in applications where a simple, wide data-path interface is important. Common uses include interfacing peripherals such as printers, paper tape devices, card readers, etc. It is also very useful for interfacing custom designed devices.

The HP 82941A BCD Interface (binary coded decimal) is a special purpose digit-parallel interface. All data is presented simultaneously on a set of 48 wires. This interface is designed for use with BCD instruments that present digits on a set of parallel lines— counters, voltmeters, scales, and medical equipment, for example.

All four interfaces have a common bond, the I/O ROM. The I/O ROM gives the HP-85 30 BASIC commands that are necessary to perform I/O operations or that greatly simplify the task.* These provide for data transfers, data conversions, interface control, interrupts, and end-of-line branching.

For example, the ENTER and OUTPUT commands allow for both formatted or free-field input and output of data. Quite prosaic. Well, the CONVERT command allows you to set up character conversion tables for ENTER and OUTPUT. The conversion can be an indexed table or a pairs-lookup table.

ENABLE INTR sets up an I/O card to interrupt on a specified condition. ON INTR specifies where to go in the BASIC program when an event interrupt is received.

Other features include bit manipulation, base conversion, and keyboard masking. Note that these latter capabilites are generally useful and not specific to I/O. For example, BINAND returns the logical AND of two 16-bit values; ENABLE KBD prevents unintentional keystrokes by disabling sections of the keyboard.

In all, the I/O ROM adds 8K bytes of read-only-memory to the operating system. For the details about it and all four interfaces, ask for the data sheet "HP-85 I/O ROM and Interface Specifications," either from your dealer or from Hewlett-Packard. ■

** Only the Plotter/Printer ROM is necessary for interfacing most printers and plotters using the HP-IB interface.*

Hardware Highlight

HP 82900 Series Flexible Disc Drives

As of August, from 270K to 1.08M bytes of on-line storage can be added to your HP-85 using 5¼-inch removable flexible discs. The HP 82900-Series comprise single and dual units available as masters (with controllers) and add-ons (that must be used with a master).

- HP 82901M Flexible Disc Drive—two drives and a master controller providing 540K bytes of on-line storage, expandable to a maximum of 1.08 M.
- HP 82902M Flexible Disc Drive—one drive and a master controller providing 270K bytes of on-line storage, expandable to a maximum of 810K bytes.
- HP 82901S Flexible Disc Drive—two drives providing 540K bytes of additional storage, for use with either of the master controllers.
- HP 82902S Flexible Disc Drive—one drive providing 270K bytes of additional storage, for use with either of the master controllers.

These units provide double-sided, double-density storage. There are 35 tracks on each side of a disc. Data is stored in records on a track, a record comprising 256 bytes. If you were told that there are 16 records to a track and you cared to do the mathematics, you would calculate 286,720 bytes of total storage. Well, space for a disc catalog, formatting, and four tracks reserved for bad-track identification leaves about 270K of user storage capacity, as advertised.

The records are soft-sectored, that is, there is no hardware indication of where a record (or sector as it is sometimes called) starts. Instead, two fields are used, the ID field, and the data field that actually holds the information. This permits records to reside in physical locations that can be optimized to give the greatest system speed. You can specify an interleaving factor that minimizes the number of revolutions required to get and store your data. That interleave factor depends on the nature of your data and is most easily determined experimentally. But you don't have to worry about the physical location of a record, the controller does that for you. If speed isn't

important, you don't even have to specify an interleaving factor; the default value is used. The controller also takes care of bad tracks—the ID field of each record is given a value that effectively makes the track invisible.

The disc controller handles the I/O communications between the HP-IB and up to four drives. It interprets the commands received on the bus and controls the operation of the drives, providing timing and control signals, and transfering data.

And, as if the controller wasn't already smart enough, it can also perform an extensive self-test. All self-test functions can be initiated manually (switches) or by using commands. The controller performs a subset of the test functions each time the unit is turned on; a flashing drive light would indicate that the disc is not working properly.

With these discs, large data bases can be quickly stored and read. Also, very long programs can be stored on disc and "chained" into the HP-85. Data can be transferred at 350 bytes per second and programs at 1.5K bytes per second. Average access time is 187 msec.

The Mass Storage ROM adds over 30 BASIC statements to your system that allow powerful disc management capabilites; the PACK command, for instance, removes null files for more efficient disc utilization; a read-after-write operation can be selected to provide an extra level of reliability; a TRANSLATE command allows programs written around tape cartridge storage to run using the disc instead; 12 error messages pinpoint problems in disc usage. With the Mass Storage ROM, the disc operating system is ready to go when you turn on the HP-85, the disc memory totally integrated into the system.

The HP 9895A

You may be thinking small if you write-off large data storage requirements as unlikely. The HP 9895A is the next progressive step following the HP 82900 Series, providing from 1.18M to 4.72M bytes of mass storage, depending on the configuration.

The HP 9895A single-master drive can store 1.18M bytes of formatted data. The standard HP 9895A has two drives for a total of 2.36M bytes. Optional single-drive and dual-drive add-ons give an extra 1.18M and 2.36M bytes of storage, respectively. These options can be added to your system at a later date it you choose.

The HP 9895A uses a double-sided, double-density format on 8-inch flexible discs. You can get approved media directly from Hewlett-Packard. Through extensive testing, selection, and control, these HP qualified flexible discs provide the most reliable performance possible.

As in the HP 82900 Series, the extensive self-test capabilities of the HP 9895A are accessible to the HP-85. A hardware self-test is initiated and reported on the HP-IB at powerup. Read/write tests can be initiated manually by the operator or remotely via the HP-IB.

When you're planning your system, you'll be taking into account your future needs. Remember that until relatively recently, you probably didn't even think you would own a personal computer. So don't think small. ■

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HEWLETT PACKARD

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