Keyboard

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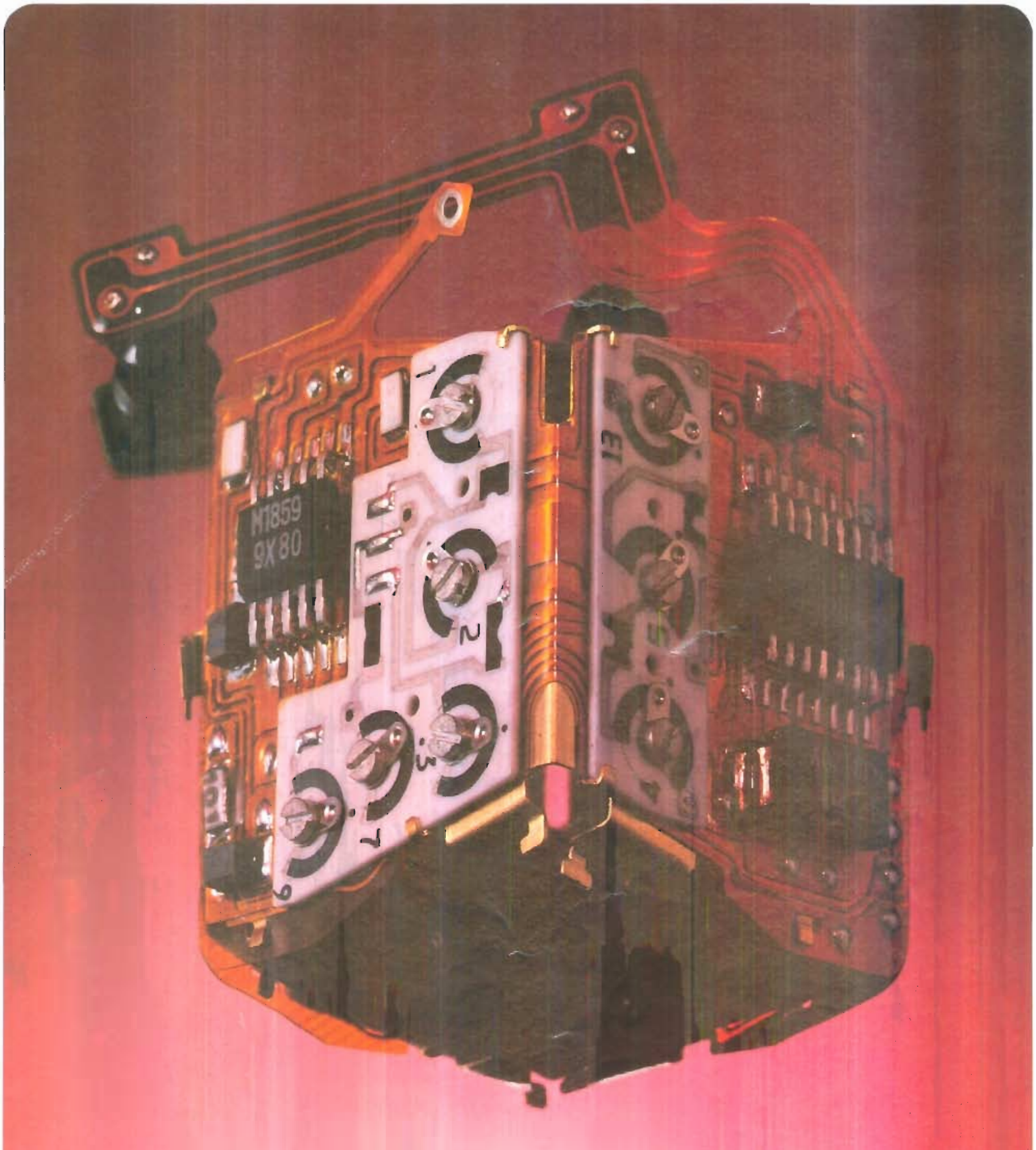


Keyboard

September-October 1980

Cover

Part of the electronic brain used in the Nikon FE 35 mm camera is shown on the cover of this issue of *Keyboard*. Testing these complex printed circuits is the job of a computer-controlled test system developed with Hewlett-Packard equipment by Nippon Kogaku K.K. of Tokyo, manufacturers of Nikon cameras. The cover article begins on page 4, and includes a short abstract printed in Japanese characters.

"Intake" also begins with an abstract, this one in French. In each case, the abstract is printed in the native language of the author.

Photo and artwork credits

cover, pages 4 and 5 lower right — Nippon Kogaku K.K.

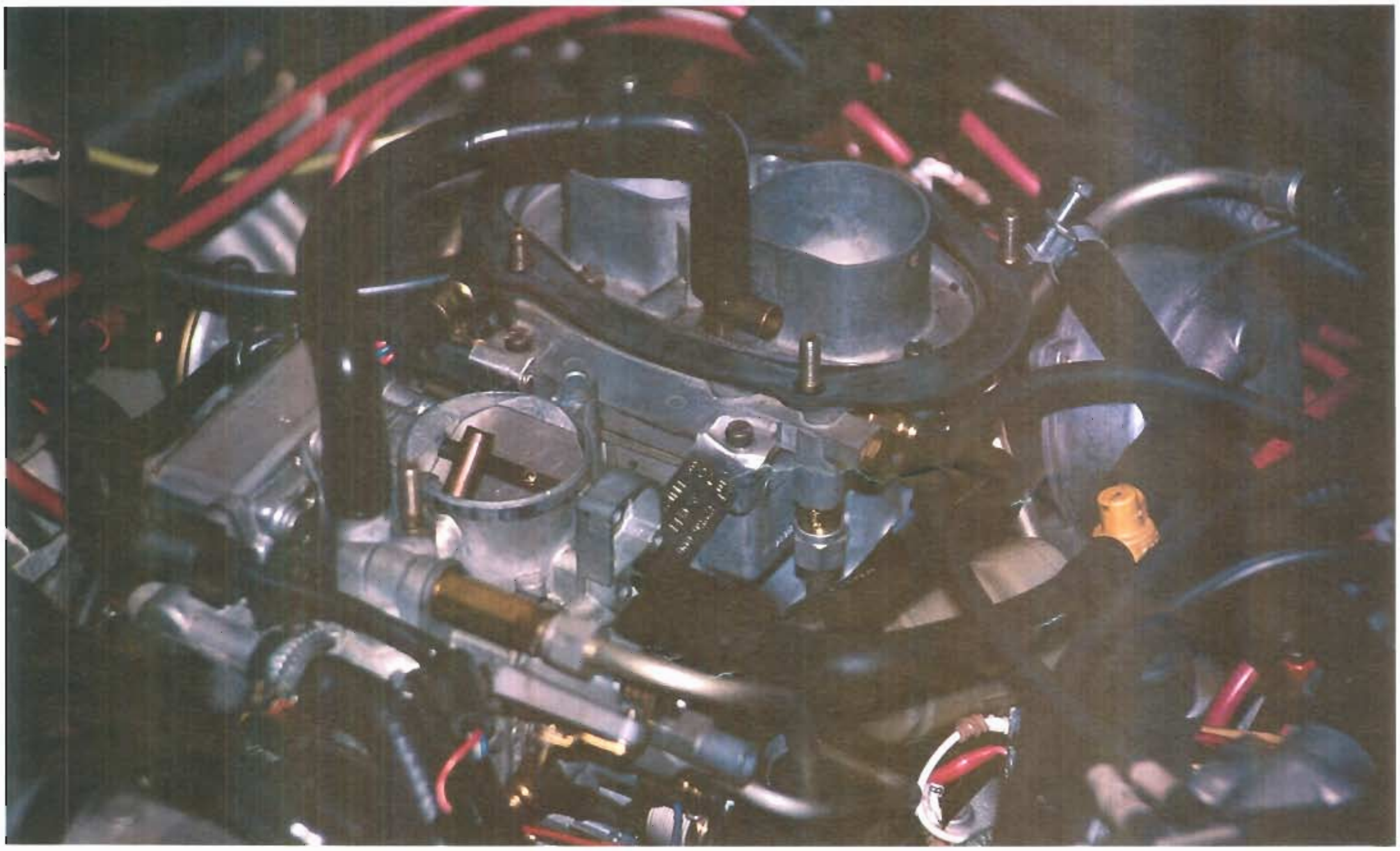
pages 1, 2 and 3 — Société des Carburateurs Solex

page 10 — Colorado Viscomm

pages 6, 8, 9 and 13 — Hal Andersen

pages 5 upper left, 7 and 11 — Paula Dennee

Intake



La Société des Carburateurs SOLEX, premier constructeur mondial dans son domaine, cherche à informatiser la recherche et le développement de l'amélioration des systèmes d'alimentation des moteurs á combustion interne. Les efforts sont poursuivis en étroite collaboration avec les principaux constructeurs d'automobiles.

by Michael Pontoppidan

The driving force of research and development efforts in industry is the challenge of surmounting obstacles. One such obstacle is the desire for a decentralized mode of transportation: maintaining the automobile as we know it in a time of energy scarcity.

During the past several decades, many attempts have been made to develop a power plant capable of replacing the petroleum-fueled internal combustion (IC) engine for ground-based transportation.

But these would-be substitutes have thus far failed to meet tests of economy, reliability, availability and operating range. And, while the contribution of electric vehicles is likely to become significant within the next 10 to 15 years, petroleum-fueled IC engines surely will continue to dominate for now.

Continued outcry against pollutants emitted by IC engines, and the rapidly rising cost of petroleum fuel, are forcing a concerted effort to make IC engines as efficient as possible, and to reduce pollutants to a minimum.

Research and development

Our research and development efforts at Société des Carburateurs Solex, in Nanterre near Paris, France, are aimed not only at continuing to improve the performance of IC engines, but also at individually optimizing each engine family produced in the industry. A Hewlett-Packard System 45 Desktop Computer is aiding in these efforts.

Solex was founded as part of the infant French automobile industry in 1910. Today, we work primarily on air and fuel intake systems for passenger car IC engines.

Most of our research and development work is based in France. Our headquarters, and the French production plants, employ some 3 200 people, and produce 65% of the automotive engine fuel systems made in France. Outside the country, we operate in 10 nations, employ 12 300 people and produce 9 000 000 carburetors per year.

Although our product remains the carburetor, we study a range of topics related to engine intake systems, in response to public concern over fuel efficiency and pollution control. Research efforts over the past 10 years have multiplied to cover the fundamental physics, both linear and non-linear, of fluid dynamics. This work is carried out in cooperation with manufacturers who use Solex carburetors in their cars.

A product of this close cooperation has been the development of modulated carburetors and electronic fuel injection systems.

Making data understandable

Our primary application of the System 45 is to help us convert data from engine tests to a form that is easily and quickly understandable. We have 16 engine test beds, all with different engines or intake systems. From each operating engine, we collect information on up to 15 parameters. This is done manually, by technicians seated at consoles for each test bed.

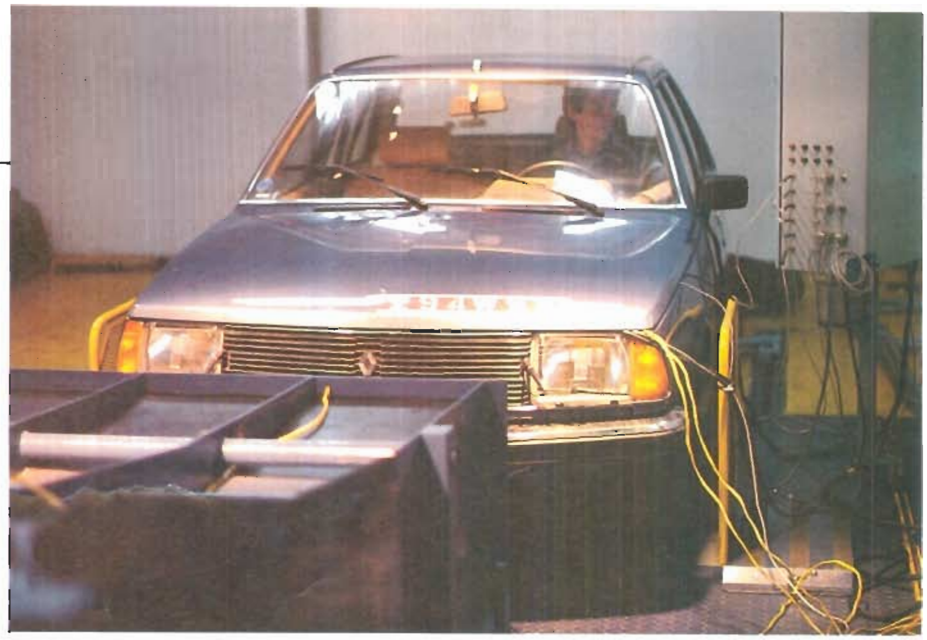
The collected data is relayed to a central location, where another technician keys it into the desktop computer. We generate a formatted table of results with the thermal printer. And, in order to meet our needs for graphic presentation of this information, we plot data in multiple colors to represent different test parameters with the HP 9872A Four-color Plotter.

Because they give us picture representations of the numbers, these plots reduce the time needed to assimilate data into plans for our next efforts. It is the fastest way to understand just what is happening inside each engine.

Optimizing each engine family

Each type of engine has its own peculiar way of operating.

Emissions are tied in a very complex way to the geometry of the engine. And, while mass-produced engines are similar, their geometric



Researchers test a Solex intake system on a dynamometer in a climate-controlled test chamber.

layouts are not identical. Getting a new engine from a manufacturer is not like getting a piece of metal.

Our objective is to develop a computerized engine testing system that can diagnose the peculiarities of each engine family and allow rapid alignment of a carburetor and adjustment of the engine to operate at its most efficient conditions.

The desktop computer is an intermediate step toward this kind of testing system. We are halfway between entirely manual and completely automated testing. And we are gathering data that will enable us to design the automated test system we want. This is the primary purpose of our desktop computer, although we have found other uses.

Digitizing

Digitizing capabilities of the computer have proved helpful in our analyses of pressure signals from engines running under full load at low speeds. These are by far the worst polluting conditions for a small IC engine.

An IC engine intake system tries to mix two fluids of very different densities, air with a density of about 1.3 kg/cubic meter, and gasoline with a density of about 770 kg/cubic meter. Depending on time and pressure relationships in the mixing area, the fuel/air mass flow ratio can undergo very rapid changes.

This is a very complicated system, which can really only be dealt with using a nonlinear, acoustic approach with a complex set of equations. At the intake of the engine, we can record pressure or mass flow signals. But we need to understand the physical acoustics. We have to relate the signals to the hardware of the flow system.

So we digitize a pressure or air mass flow relationship from storage oscilloscope data into the computer for Fourier analysis. We input a certain number of points, depending on the number of harmonics we want to get out. We have found that the computer conducts this analysis quite well.

Designing

Another application we have, one which falls in the area of design, is the development of the ideal shape for a moving part which controls fuel flow in a fuel injection system. We have to relate the instantaneous fuel/air ratio in the engine to the


Technician enters manually collected data into System 45 to generate plots.

mechanical movement of a lever linked to a potentiometer in order to translate the fuel/air ratio into an electrical signal.

We developed a program that models shapes for the moving part and computes the best position of mechanical contact on the curve of the part for each possible set of conditions. Once that is known, the best single position can be selected by the computer. The locus of the ideal shape can either be drawn on our 9872A Plotter or stored for later reference.

This is very important, because normally, if we want to know this relationship, we have to put the car on a dynamometer and measure the exhaust gases at all engine speeds, which requires about a week of work. The desktop computer can provide the desired shape in one minute.

System configuration

Our System 45A is equipped with 48K bytes of memory, plus the thermal printer and the graphics ROM. We use it along with the 9872A Plotter.

Due to the flexibility of the language, programming this computer is a rather easy task; we prefer this because we try to invest as little time in programming as possible. We use computers as tools, and this is possible with the 45.

Our desktop computer is accessible for someone who has not been trained with computers. The conversational language has been helpful in learning to use the system.

If you consider a computer with Fortran, the method of making your desires known to the computer is sometimes rather tedious. Fortran requires you to stick to a strict layout of data format, whereas, there is much more latitude with the desktop computer.

Plotting

We were able to develop graphs of our data in several colors using the plotter. Our previous practice had been to employ several highly skilled people to produce these charts manually. We generate 25 plots per day.

It is not easy to estimate the amount of time or money saved by using the plotter, instead of people, to do this work. What is more important than the savings, however, is that we are avoiding the errors humans tend to make.

We now have a standard plot that represents the data in the same manner to all the manufacturers with whom we work. Also, we no longer have to employ skilled workers to correctly read the data and produce the plots. We've been able to move these technical people to other important work.

When errors do occur, they are much easier to spot if they arise in the computer system, because they are likely to be large and obvious mistakes. Humans tend to make smaller errors, but rather frequently. These human errors can be far more damaging because they are so much harder to detect.

Looking ahead

Borrowing the phrase of a well-know humorist, "To forecast is a very difficult task — especially when speaking of the future."

The goal of industrial research should be to provide a maximum of functional improvements to a specific product. We are trying to do this with the petroleum-fueled IC engine.

Experience has proved over and over that it is difficult to create a low-cost alternative power plant with better efficiency than that of the IC engine. The encouragement given by greater understanding of atomization and combustion processes indicates that substantial improvements in the fields of pollution abatement and fuel economy are possible.

This suggests that the internal combustion engine should survive in recognizable form through the year 2000, assuring for at least the present that personal transportation will persist. And our research is intended to make IC engines as efficient and non-polluting as possible.

Michael Pontoppidan graduated from the Technical University of Denmark in 1973. Since 1974, he has been responsible for a Solex research and development group working with fundamental aspects of fluid mechanics in IC engines.

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Testing Nikon quality

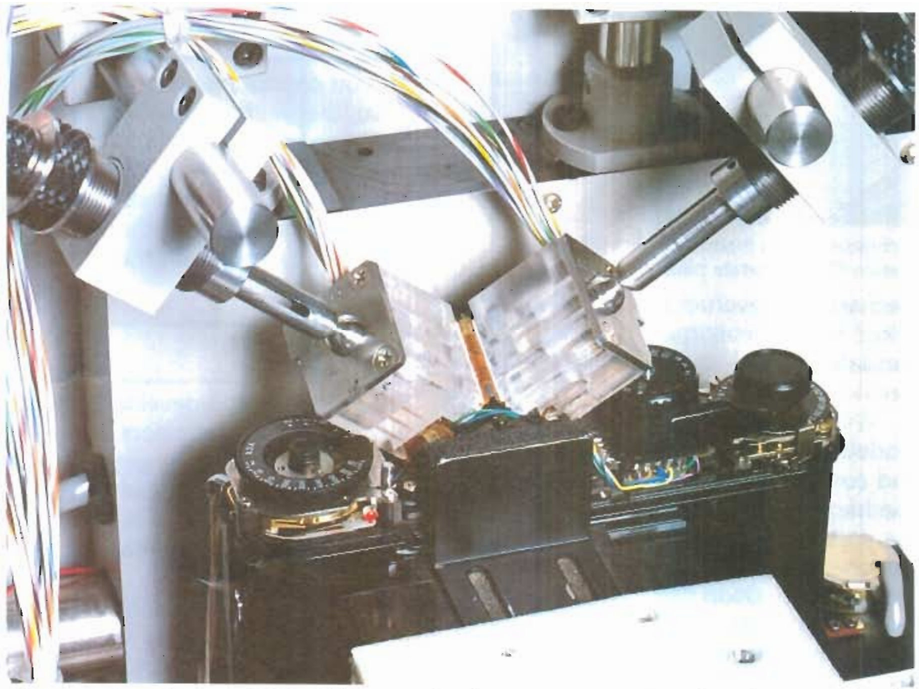
この記事は日本光学工業株式会社のカメラ製造工程における電装部分の事故（断線，コード外れ，半田ブリッジ等）を自動的に探し出す診断システムの紹介をします。

村上　敦

by Atsushi Murakami

As cameras become more automatic, they become more dependent on electronics, with the result that the proportion of electronic components, such as printed circuits, is increasing.

Nippon Kogaku K.K. of Tokyo, Japan, the maker of the renowned Nikon camera, has a vested interest in developing computer-controlled systems for production line testing of these printed circuits.



Once a worker places each Nikon FE camera into the test system, testing takes place automatically, including checks of iris control, film winding, shutter release and power on/off.

Detecting faults

Although the number of faults in PCs is not high, the reasons they occur are myriad. In fact, discovering the source of a failure in a PC may take much longer than correcting the problem itself.

However, Nikon has developed a diagnostic system for its FE camera that has enabled the company to detect 95% of all faults on the production line. This has saved considerable time in repairing these failures, and contributed to the general quality of the finished FE model cameras.

Our equipment includes the Hewlett-Packard System 45 Desktop Computer, interfaced to HP's 6940B Multiprogrammer and 9885M Flexible Disc Drive.

System configuration

Figure 1 shows the system configuration. The 6940B controls the potential detector and camera jig. The former instrument, with a given iris setting using a standard light source, tests the automatic shutter speed operation. Control over the light source, plus data acquisition, is performed via the HP 98032A 16-bit Parallel Interface.

The camera jig manipulates various camera functions, including iris control, film winding, shutter release, power ON/OFF and current detection.

In this configuration, the System 45 directs all data acquisition functions, except the setting of shutter dials. This data is validated by Nikon-written software which incorporates data-checking algorithms. Results are then displayed on the System 45's CRT.

Measurement programs

All information is gathered under the control of an interactive diagnostic test program, which prompts the operator (on the CRT) to initiate the next step of the testing procedure.

The only actions required of the user are mounting and dismounting the camera on the jig, positioning the potential measuring probes and verifying the shutter dial settings. The user must also set the shutter release timer and press one key when prompted by the program. It takes about one minute to acquire all of the 130 or so measurements.

Diagnostic algorithms

The Nikon test system differs from most others in that its purpose is not to accept or reject cameras, but instead to locate the reason for failures in cameras that are known to have faults.

For this reason, specialized software that incorporates a sophisticated algorithm for fault analysis is employed. The software deals exclusively with electronic failures; those of a mechanical nature are excluded.

If, therefore, a camera suffers an electronic fault, the symptoms must

Using this system, Nikon can identify the source of failure in a camera within one minute, and rectify the fault quickly.

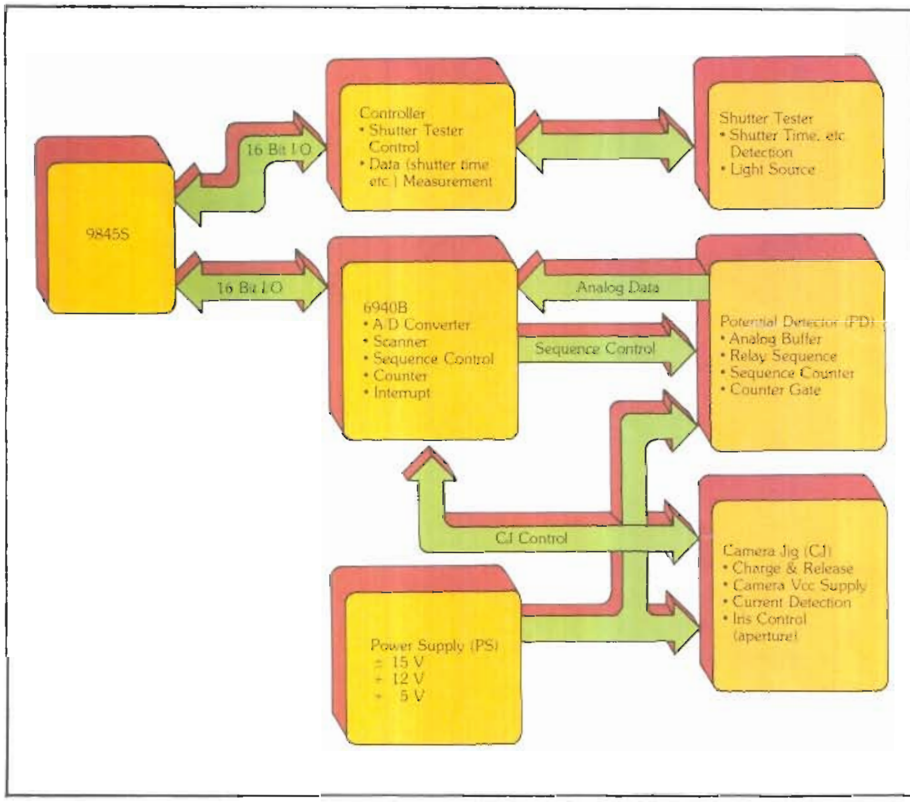


Figure 1.

be various trimmer resistors that were misadjusted during production. As a result, the data read at the test points in the camera circuits has no meaning in its raw form.

In light of this, Nikon takes a sample of ten cameras, each meeting required specifications at test points on the circuit, and records their average readings and distribution. A value within four standard deviations of the standard values will be assured to be acceptable.

Next, known faults are introduced into the control cameras, and readings compared with standard values. A range error table is created for each fault and each test point. It shows whether the data now being read is high (H), low (L) or in the range (M) as judged by the four standard deviation criterion. The graphics capability of the System 45 permits the table to be displayed on the CRT or printed for examination.

Failure algorithm

An algorithm is now developed to use this data base to determine the cause of the failure. While each source of failure manifests itself in a unique way, the sheer volume of range error data makes it impractical to compare each test value against all data. For various reasons, then, the potential voltage that controls shutter speed is chosen as the starting point in the search for the cause of any camera fault.

The program selects a search subtree based on data acquired from tests performed under condition A (Auto exposure at light level 9) and condition D (one-half second manual exposure at light level 14). Design of the tree-search conditions is "cut and dry," and is not based on theoretical conditions.

In addition to conditions A and D, conditions B (Auto, light level 14) and C (Auto, light level 14, using shutter release timer) also are measured. All tests are performed at ASA setting 12, and with aperture setting f5.6.

The diagnostic program runs automatically after data acquisition is completed, and results are displayed on the CRT without requiring futher operator intervention.

System benefits

By using this system, Nikon can identify the source of failures in its cameras within one minute, and rectify the fault quickly. This contributes to high efficiency on the part of the service people on the production line, where some of the world's finest cameras are made. K

Atsushi Murakami, who holds a degree in electrical engineering, is a production engineer in the camera production research and development department for Nikkon Cameras at Nippon Kogaku Kogyo K.K.

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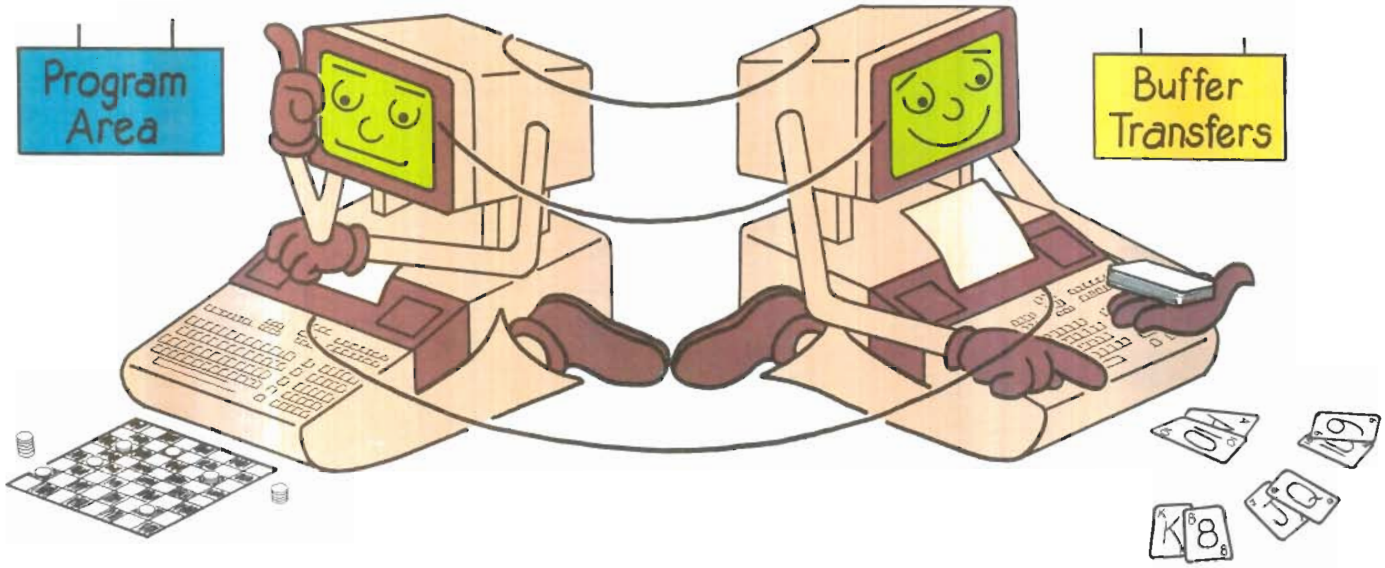
Interrupts and buffers



by Steve Leibson
Hewlett-Packard Company
Desktop Computer Division

In our discussions about I/O hardware, we considered the needs of a wide range of peripheral devices. Some devices are much slower than internal computer processes, some are about the same speed and some are faster than the computer can comfortably handle.

We discussed the three hardware handshakes associated with these three classes of peripherals. Slow devices are best handled by interrupt (see Jan/Feb 1980 issue). Only when the device is ready for another data transfer is the processor interrupted so that it can service the peripheral.

Medium-speed devices can interact with the processor directly, since they will not degrade system performance. High-speed devices require special hardware for Direct Memory Access (DMA) because the processor alone is not fast enough to service them (see Mar/Apr 1980).

The hardware to perform interrupt I/O and DMA is useless unless there is software to support the capability. In the previous article, we discussed formatted I/O and referred only to the simpler handshake or programmed I/O. Most computers support this type of I/O even if it is only by using the PRINT statement.

Hewlett-Packard desktop computers support interrupt I/O in two ways: user interrupt service routines and buffer transfers. DMA is supported only through buffer transfers.

Processor interrupts

High-level languages frequently have subroutine capabilities. In HPL, subroutines are invoked with the "gsb" statement. Return to the main program is accomplished using "ret". BASIC uses the corresponding statements GOSUB and RETURN.

User interrupt service routines are a variation of the subroutines. After interrupts are enabled, the subroutine is invoked because a peripheral interrupts.

The subroutine is written in the high-level language of the computer and is terminated with an interrupt return statement such as "iret" in HPL. The following HPL program fragment illustrates how user interrupt service routines are written:

```
10: 1→I
11: oni 6, "send"
12: eir 6
•
•
•
87: "send": wtb 6,A$[I,I]
88: I+1→I;if I<=len(A$);eir 6
89: iret
```

Line 10 sets a counter that points to individual characters in string A$. Line 11 directs the program to line 87, labeled "send", when an interrupt occurs. Line 12 enables the interface hardware and software to accept interrupts.

Line 87 sends a single character from string A$ each time the user interrupt service routine is called. Line 88 increments the counter I to the next character and re-enables interrupts if there are more characters to transmit. Line 89 forces a branch back to the main program.

Getting bitten

There are several things to note from this example. The "eir 6" enables the interface. The meaning of an interrupt is that the interface is not busy. The first interrupt will occur immediately after the computer executes line 12.

Novices at interrupt routines are always bitten by this the first time they write one. If the interface has not been made busy by sending it a character before interrupts are enabled, interrupt is immediate.

Note that a counter must be kept by the program to keep track of where the next character will come from in A$. Also note that interrupts must be re-enabled in the interrupt service routine if the transfer is not finished.

This is necessary because the "eir" is canceled when it is invoked. That prevents the interrupt service routine from being interrupted.

Buffers are better

High-level-language program lines are slow compared to the processor's machine code speed. Only low data rates can be supported with user interrupt service routines. Buffer transfers are a much better choice for data transfers, leaving user routines to service special situations.

Buffers are blocks of computer memory allocated for I/O (see Figure 1). Data passes through the buffer on the way into or out of the computer. Enabling of interrupts and character counters is automatic.

Data transfers can be terminated on a count as in the above example or by a character match for buffered input. The following example performs the same task as the first, but uses buffered I/O.

```
10: buf "OUT",100,1
11: wtb "OUT",A$
12: tfr "OUT",6
```

As you can see, this is much simpler. Line 10 creates a buffer of 100 characters, line 11 fills the buffer with the contents of string A$ and line 12 sends the data to the peripheral. The 1 at the end of line 10 specifies an interrupt buffer.

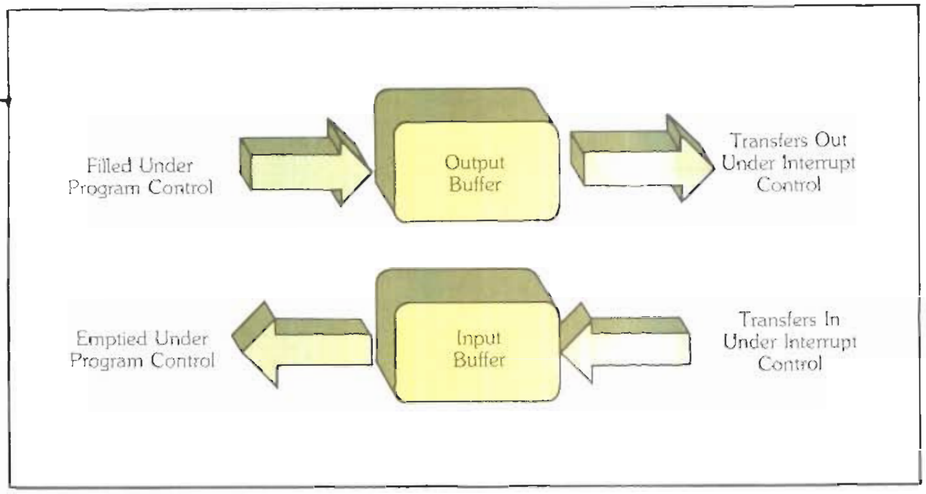


Figure 1.

Why is this technique superior to simply writing out the data directly to the peripheral? Line 12 only initiates the data transfer. After that process is started, the program will continue with line 13. When the peripheral interrupts, it will automatically be given the next character. Meanwhile, the computer is executing the rest of the program.

End of the line

Interrupt buffers are faster than user interrupt service routines for one primary reason. The only safe place to interrupt a high-level language program is at the end of a line. In the execution of a line of high-level language code temporary locations are set up, addresses are calculated and a whirl of activity is taking place.

An interrupt routine must be able to return to where the program left off after the interrupt is serviced. If the user routine accesses variables being used by the main program, or worse yet, changes them, there could be disastrous results.

That is why high-level language interrupts are restricted to the end of a line. Things are safe there.

Conversely, the routines used by the buffer transfer interrupt service routines are in machine code and are restricted. Their affect on the system is well known because all they are allowed to do is data transfer.

Buffer interrupts are allowed any time they are enabled. Thus, interrupt buffer transfers can be much faster than user interrupt service routines for data transfer. They are also easier to use.

Limit: one DMA

Once you understand interrupt buffer transfers, DMA buffers are easy because they work the same way. A buffer is set up, filled and transferred. The syntax is the same too. The only parameter that changes is the buffer type.

Only certain interfaces can support DMA transfers and only certain devices require DMA service. Since DMA requires special hardware, Hewlett-Packard desktop computers have one set of DMA hardware. Thus, only one DMA transfer may be active at one time.

Buffered I/O is a real convenience. It is another way of taking I/O hardware such as interrupt and DMA circuitry and making the capability available in an easy-to-use form. ◼

A fast draw in Colorado

by John Monahan
Keyboard feature writer

Printed circuit board designers, who once used materials such as mylar tape to draw their PC boards, now use drawing systems as modern as the PC boards themselves.

But depending on their complexity, full drawing systems can cost several hundred thousand dollars. This can represent a heavy investment in a field which is continually changing.

Hewlett-Packard's Colorado Springs division, which manufactures oscilloscopes and logic analyzers, foresaw several years ago that future PC boards would have to be "denser" — that is, more circuits in a smaller area.

Computer Assisted Artwork (CAA) was the only way the necessary tolerances for achieving this overriding goal could be realized, according to Brad Beall, PC shop and design manager at the Colorado HP facility.

Digiplot

Having decided on CAA, Beall enlisted the services of Nicholas Jensen, who wrote software to enhance a CAA system for another HP division. Jensen is a software engineer in PC manufacturing.

Key to the system, called "Digiplot" internally, is the HP 9825 Desktop Computer interfaced to an HP 9872A Four-color Plotter through HP-IB. A track-ball device is attached to the plotter to enable a designer to place the plotter pen at any point on any predefined grid quickly and easily. The HP 98032 16-bit Parallel Interface connects the track-ball to the plotter.

Five systems are shared among seven designers, with two more computers on order.

Mel Lester of the PC manufacturing group operates the 9872A to generate a drawing. Controls for the track ball device added to the 9872 are visible at the far side of the plotter.

PC structure

PC boards made at Colorado Springs typically consist of two to eight stacked layers. Each layer has two sides, which may include a pad side (to convey electrical impulses out of the board), a component side, circuit or solder side, inner layers and solder masks. The Digiplot cassette, however, may contain data on as many as nine layers.

The more layers, the more complicated life becomes for the designer trying to locate traces on a crowded board. Traces are equivalent to wires between components, although they are only 7 mils wide.

When working with mylar tape to depict the traces, designers were limited by the inaccuracy of the tape — they couldn't put traces as close together as desired on an integrated circuit. Consequently, the manually rendered boards were not dense enough.

Digiplot, however, solved the problem. Where once tolerances for laying down tape were .005 inches, Digiplot has reduced them to .001 inches. The reduction has allowed designers to accurately place two traces, .009 inches apart, between pads. The distance between each trace and the pad is .0095 inches.

As Jensen points out, increasing density ultimately leads to more portable instruments with more useful features.

Designing boards

Designing PC boards, which more accurately might be described as getting them on paper after the engineers decide what they want, is by appearances a lugubrious task.

The desktop computer has made the chore somewhat easier. The designer types into the HP 9825 the

"Moving a section of a PC board used to take as long as two days; with Digiplot, it's done in a few minutes."

X-Y coordinates of the pads, holes or the board edge. The plotter then draws them to the tolerances related above, filling in the traces. The data is stored on tape in the 9825.

The track-ball is used to locate a pen over a particular point, since the pen moves just .025 inches at a time. This comes in handy when making minute changes to a PC board.

Saving time

While Digiplot has increased designers' accuracy, it has also saved them time in certain areas, PC design supervisor Pat McMullen points out. For instance, moving a section of a PC board used to take as long as two days; with Digiplot, it's done in a few minutes.

Also, since the grid coordinate data is stored on cassette tape, it can be transferred to the drilling shop where numerical control tapes can be made. This practically guarantees that the holes will be drilled accurately into the various PC boards. Previously, an optical programmer was used.

Designers have noticed that different engineers frequently ask for boards of a similar design. When this happens, it's simpler to find an old design on the cassette tape and make changes than to draw an entirely new board.

Along these lines, Digiplot saves time (and ennui) because it permits designers to make multiple images of duplicate or dissimilar sections appearing several times on the same PC board. Moreover, designers can rotate an image to a new section without having to redraw the image.

Much of this is accomplished using Special Function Keys on the HP 9825. Pushing a key allows the designer to change the scale or delete sections or layers.

Of course, it's the soldiers in the trenches — the designers themselves — who ultimately decide the desktop computer's value.

Designer Karen Rhodes says that once she learned how friendly the system was, she began seeing its potential. Now, she says, designers jealously guard their alloted time with Digiplot.

"It's made life easier for us," she says. "I don't think anybody could go back to mylar tape. It seems like the Dark Ages."

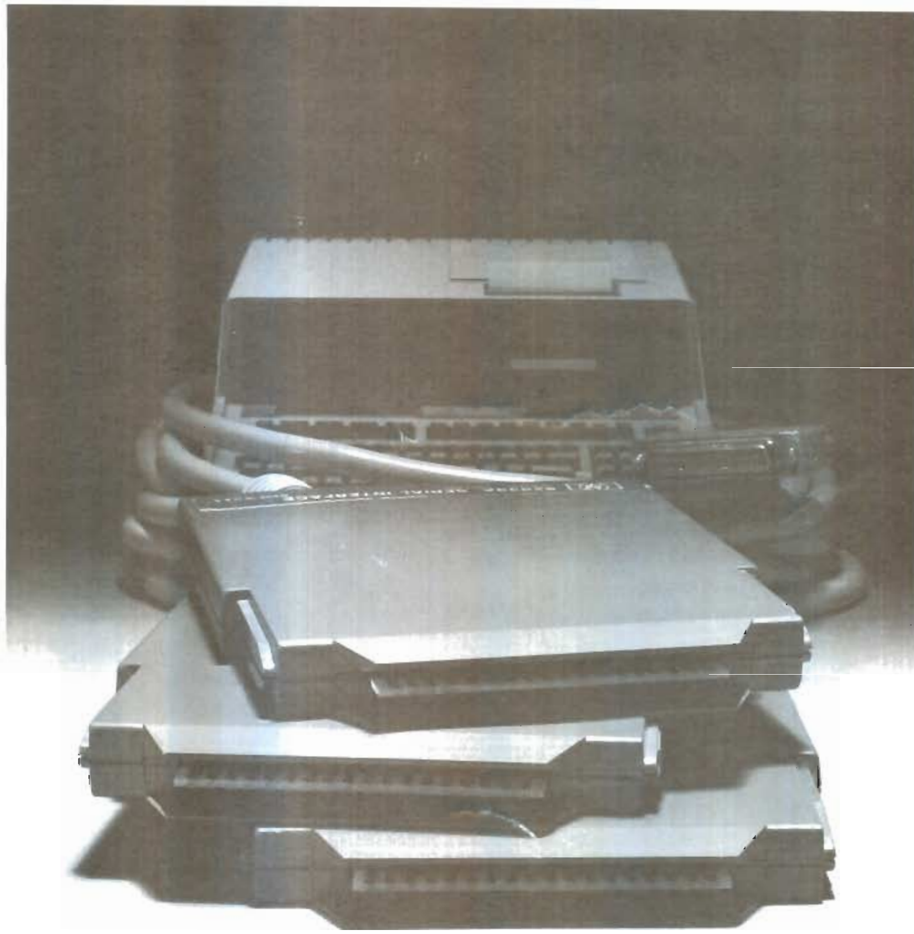
Manager Beall points out that Digiplot represents only the first step in adding automation to the design and manufacture of PC boards. He says he's looking for even faster turnaround time and a system that can cut out completed boards automatically.

Still, in an industry changing continually because of new technology, Beall's present CAA system serves its purpose well.

Digiplot has been submitted to the HP Calculator User's Club by the PC Manufacturing Group. If you own or use a 9825 Desktop Computer, you can join the CUC by submitting a program of your own, and in return get Digiplot or other programs available from the club. For information, write to Anneliese Schafer, HP Calculator User's Club,Hewlett-Packard GmbH, Postfach 1430 7030 Boeblingen, West Germany.

Once the Digiplot program has been completed, data is relayed to the department's Model 33B Gerber Photoplotter, which produces the high-accuracy negatives used in producing PC boards.

Adding I/O to the HP-85



by John Nairn
Hewlett-Packard Company
Desktop Computer Division

A major reason for the popularity of desktop computers is that they are designed to make computing easy for people — human interfacing is optimized.

The HP-85 may be the best example of this concept. It is compact and powerful, yet provides all of the necessary human interface devices (keyboard, CRT display, printer and tape cartridge) for solving a variety of computational problems (see *Keyboard*, Jan/Feb 1980).

For a great many tasks, this self-contained configuration is all that is needed (see Figure). But there are two areas for which this scheme must be altered. Such changes in human interfacing are the reasons for adding external input/output (I/O) to the HP-85.

Augmenting human interfacing

One of these two groups of tasks requires peripheral devices with more powerful characteristics than those inherent to the HP-85, such as a page-width multiple-copy printer, or a full-size graphics plotter with multi-color capabilities. Other applications may require that the HP-85 be able to communicate with other desktop computers, minicomputers or full-size mainframe computers.

Adding external peripherals to supplement internal peripherals augments the ability of the computer to interact with people.

Eliminating human interfacing

A second group of tasks makes elimination of the human interface desirable. In data acquisition applications, some measurement instruments can communicate directly to the computer, eliminating the need for manual data entry through a human interface.

Communicating directly with instruments, not only acquiring and performing data analyses, but also making decisions and providing feedback to modify operation of the system, is the definition of a controller, or I/O computer. This requires a different type of I/O, one not optimized for human interaction.

In order to add I/O capability to the HP-85, two distinct elements are required. First, a piece of hardware known as an interface card is required to provide electrical, mechanical and timing compatibility with the device to be connected to the desktop computer.

Second, a piece of firmware (microprocessor program) known as an I/O ROM is required to add new statements to the BASIC language. These statements give the applications programmer access to the interfaced device.

In the back of the HP-85 are four slots which allow add-on ROMs, add-on RAM (user read/write memory), and interface cards to be connected to the internal memory bus (see Figure 1). A single ROM

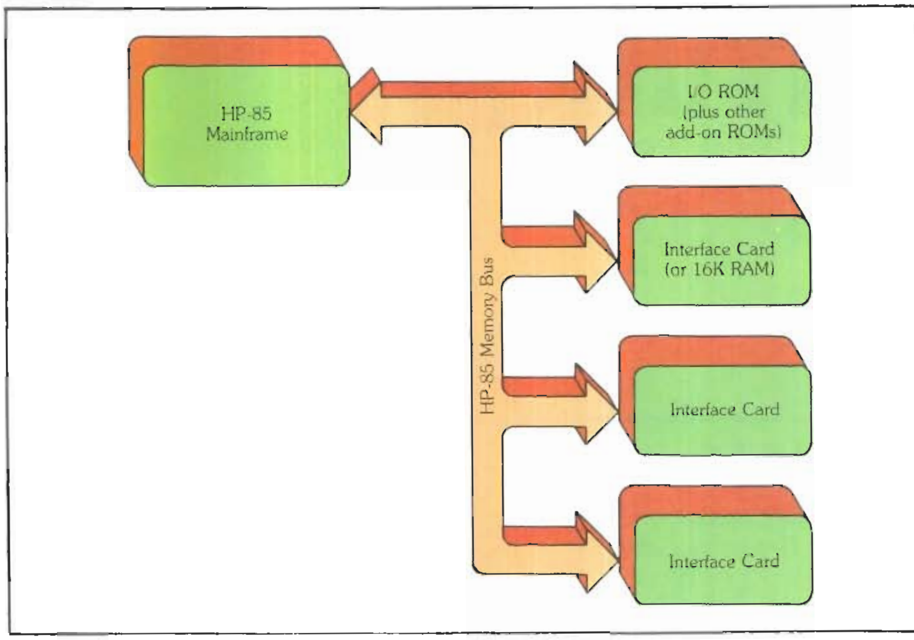


Figure 1.

drawer plugged into one of these slots can contain the I/O ROM and up to five other add-on ROMs. Thus, a typical interfacing configuration can include a ROM drawer and three interface cards or the add-on RAM module and two interface cards.

I/O cards

The most general-purpose interface card is the 16-bit GPIO card (parallel). Sixteen TTL-compatible input lines and 16 open-collector output lines, plus a variety of status, control and handshake lines make this card a workhorse. A variation of the card, with input lines organized into four-bit nibbles, is called the BCD card. It will allow interfacing devices whose data is encoded in binary-coded decimal format.

A third type of interface card is designed to connect the HP-85 to serial I/O devices using either RS-232C or 20 mA current loop configurations. This card will also allow the HP-85 to be connected to terminals, modems or a host computer.

A fourth interface card, and the first to be introduced, is the HP-IB card, the HP-85's implementation of the IEEE-488 instrumentation bus standard. Using this card, the HP-85 may be used to control up to 14 IEEE-488 compatible instruments in data acquisition and control applications. With HP-IB systems, applications such as gathering and analyzing measurement data, production line monitoring, and product testing can be automated easily.

The HP-IB card itself contains an 8049 microprocessor which makes possible a complete and powerful implementation of the bus standard. This card can act as either the controller of all the other HP-IB compatible devices on the bus, or as a non-controller responding to the commands of another controlling device on the bus.

A bidirectional interrupt capability makes it possible not only for the card to interrupt the HP-85 to inform it of events occuring on the bus, but also for the HP-85 to interrupt the card to obtain bus status information or abort a process, even when the card is busy performing bus operations.

I/O ROM

Making the capabilities of the interface cards available to the BASIC language program in the HP-85 is the task of the I/O ROM. The HP-85 itself provides such statements as PRINT, DISP and INPUT for accessing the internal peripherals.

When external peripherals are added, their wider range of capabilities requires more extensive BASIC language statements. The I/O ROM expands the BASIC language by increasing the number of statements and functions that can be recognized and executed.

Almost all computers provide language extensions for the output of data to a device or the input of data from a device. These BASIC language OUTPUT and ENTER statements are usually sufficient for communicating with external peripherals.

Control applications, however, may require other methods of transferring data and control information. This is important where timing is critical and the speed of the external devices and instruments may not be well matched to the speed of the computer.

For example, considerable time may be wasted waiting for data from a slow device. The HP-85 I/O ROM provides a mechanism to interrupt the program when data is available, freeing the computer to perform other tasks.

Typical applications would be the analysis of data from relatively slow activities such as traffic control, chemical titrations, environmental control or production line monitoring.

At the other end of the time scale are applications which require capturing a burst of data from rapidly changing events. Normally, each data point is entered into the computer and converted to the internal format before the next data point is read.

The HP-85 I/O ROM provides a fast read/write mechanism in which a bust of data may be placed in a buffer and the conversion to internal format delayed until the data capture is complete. In burst mode, data may be transferred at rates in excess of 20K bytes per second. Typical applications include examination of data from fast real-time events and waveform analysis.

Thus, the HP-85 makes available for the first time in a low-cost unit the same kinds of powerful interfacing and control capabilities previously found only in more costly desktop computers. ■

Programming Tips

Recovering PURGE'd files (System 35A/B and 45A/B/C)

It is possible to recover a file which has been accidentally PURGE'd from a data cartridge. This method relies on two characteristics of the tape file system:

1. A PURGE'd file is removed only from the directory, not from the actual tape.
2. There is a time lapse between directory access and file read/write while the tape moves to the appropriate position.

For example, suppose file "A", which began at record number 72 on a tape, has been accidentally PURGE'd. The only other file on the tape is "B", which ends with record number 50. To recover the file:

A. Fill the empty space on the tape: CREATE "C", 21

This forces the next tape access to begin at record number 72.

B. Re-enter A's name into the directory. You need to be familiar with and react to tape movements very carefully during this step. Practice on a spare tape.

Use STORE or CREATE, depending on whether A is a program or data. If A is a data file, CREATE must specify enough records to cover the entire data set. Now watch closely as the entry is made into the directory.

VERY IMPORTANT — As the high speed search to record 72 is made, immediately press CONTROL-STOP.

C. PURGE "C"

D. Access A as you normally would.

E. Programs should be RE-STORE'd and data file lengths checked to ensure correct future operation.

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Input editing routine (System 35A/B and 45A/B/C)

Software developed for use by individuals other than the programmer has one universal problem: ensuring that the user can easily interact with the program without making mistakes.

A way to avoid operator or user errors is to have an input editing system which will trap errors as they occur and help the operator to correct them before they become part of the stored data. An input routine can be added to any program which requires interaction with non-programmers.

Just such an input editing subprogram is available to any interested customers at no cost. A copy of the listing is available from *Keyboard* magazine by writing to the address on the back page, and requesting a copy of the input editing routine. For additional information on the program, please write to the author at the address below.

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Inverse video plotting (System 45A/B)

Inverse video is not available for plotting operations with the System 45A/B. Yet it is sometimes desirable to plot with black on green rather than with green on black. If your desktop computer is equipped with a Graphics ROM, inverse video plotting is possible by using the GLOAD statement. The following subprogram gives the same results as GCLEAR, but in the inverse video mode:

```
10 SUB Ginverse
20 INTEGER Figure(0:468)
30 MAT Figure=(-1)
40 FOR I=0 TO 34
50 Figure(0)=-(468*I+1)
60 GLOAD Figure(*)
70 NEXT I
80 SUBEXIT
90 SUBEND
```

The Figure array is initialized at line 30, and is used to fill the graphics memory in lines 40 through 70. The value −1 lights the 16 dots of each addressable cell in the CRT screen. Keep in mind that, in this mode, PEN −1 draws and PEN 1 erases lines already drawn.

We have experimented with various values in the Figure array. For example:

30 MAT Figure = (0) acts like GCLEAR, and
30 MAT Figure = (21845) gives a "grey" screen.

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Go for the rainbow

This portrayal of System 45C color capabilities is the creation of *Keyboard's* art director, Hal Andersen. It was used as the May 10 cover for *Electronic Design* magazine.

HP System 45B owners wishing they could have color graphics now can. Any System 45B can become a System 45C through the on-site addition of an upgrade kit.

The upgrade kit, part number 98771, converts any 45B configuration into its 45C equivalent, complete with light pen. The kit includes conversion of the 45B to a 45C, as well as a complete set of manuals, utilities, training and demonstration programs for the 45C.

HP System 45A owners also can grow with color, but they must first upgrade their 45A to a 45B with either the 98401A or 98402A Upgrade Kit. All upgrades require returning replaced parts to Hewlett-Packard. 🅺

Maxi

HP customers who want the most powerful System 45 available now can order a fully-configured computer more easily. It's called the "Maxi," option 190.

When ordered with the 45B, option 190 provides:

- 449K bytes of memory
- Graphics ROM
- I/O ROM
- Mass Storage ROM
- Advanced Programming ROM
- 2nd tape drive
- Graphics subsystem
- Basic Data Communications ROM
- Data Communications Interface
- High-speed Asynchronous Terminal Emulator
- Data Base Management
- Thermal Printer

When ordered for the System 45C, the option includes the same equipment, with all the additional attributes of the System 45C.

The Maxi options include a standard thermal printer. They can also be ordered with a metric printer (option 061), Katakana standard printer (option 040) or Katakana metric printer (option 041).

Local language keyboards also are available. 🅺

Update

Flexible mass storage multiplied

The desktop computer user who clamors for "more" and "faster" now has access to 2.36 megabytes of personal mass storage with HP's new double-sided, double-density flexible disc drive.

The HP 9895 Flexible Disc Memory enhances the range of HP mass storage devices available, offering the user four times the storage capacity of the HP 9885 single drive without the expense of a hard disc.

Featuring the HP-IB Interface, the 9895 expands the memory capabilities of the System 35 and 45 Desktop Computers and the HP Series 1000 Minicomputers by offering an additional 2.36 megabytes of mass storage on its 8-inch diameter discs.

A built-in controller enables the 9895 to handle its own two drives, plus two drives in an optional dual-drive slave, for a total of 4.7 megabytes of memory.

Data stored on 9885M or 9885S Discs can easily be converted over to the new 1.18-megabyte discs through the controller. The 9895 recognizes if a flexible disc has data on one or two sides, so it can read and copy discs from the 9885.

And, for users who need to read data from or exchange data with an IBM mainframe, the 9895 can recognize if a disc is written in IBM 3740 single-density format or HP's double-density format. Software utilities available for the System 35 and 45 enable the 9895 to read and write data in the appropriate format.

The 9895 is patterned after the flexible dual drives used in HP business computers: the HP 250, 300 and 3000 Series 33.

3-D Graphics Utilities

Displaying three-dimensional images on desktop computer CRTs, viewing those images from different angles, scaling and rotating them are all made easier by the new Three-Dimensional Graphics Utilities pack.

The pack is available for use with System 45B or 45C Desktop Computers equipped with 187K bytes or more of user-available Read/Write memory and a graphics ROM.

A versatile data base and routines for entering, manipulating, viewing and displaying three-dimensional objects are included in the pack. Using the documented routines and subprograms provided can significantly reduce software development time. K

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