Keyboard

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Jan-Feb 1980

Cover

Far out on the waters of Florida's Lake Okeechobee, the platform of lake station 12 provides a link between computerized control centers as much as 1600 km (1000 mi) away and sensors which detect water level, rainfall and pollutants at the station site. Signals relayed by satellite conduct information from LS-12 to the people who will make decisions based on this and other information.

Photo credits

cover, pages 1, 3 and 4 — Kline Bentley and U.S. Army Corps of Engineers

pages 6 and 7 — Montres Rolex S.A.

pages 10, 11 and 12 — Hewlett-Packard Desktop Computer Division

Gathering remote resource data

by Kline Bentley

Fresh water is one of the principal resources in the state of Florida. Large areas are covered by shallow water moving inexorably toward the seas that surround the United States' peninsular state.

Citizens and all levels of government in Florida share a keen interest in the water resource. People in this state want water for recreation, agriculture and urban consumption.

Hurricane hazard

Another reason for this interest is that periodic hurricanes strike the state, creating serious flooding dangers from these same waters. Managing this resource and monitoring its condition now involves the use of computer systems from Hewlett-Packard Company to make possible safe control of this complex water network.

Responsibility for managing water in the southern part of Florida is shared by the South Florida Water Management District, West Palm Beach (a state agency); and the U.S. Army Engineers' district office in Jacksonville (a federal agency).

Following the hurricanes of 1926 and 1928, which killed 2500 people, the U.S. Congress authorized construction of a dike around the perimeter of Lake Okeechobee. Hurricanes in 1947 and 1948 led to the creation of the Central and Southern Florida Flood Control Project.

Responsibility for the installation, maintenance and operation of gaging networks to monitor water quantity and quality lies with the U.S. Army Corps of Engineers' Clewiston Area Office in Clewiston, Florida, on the southern edge of Lake Okeechobee.

Lake Okeechobee is the largest fresh water lake in the U.S. south of the Great Lakes. It is a saucer-like depression near the northern edge of the Florida Everglades, measuring about 60 km long by 48 km wide (37 miles long by 30 miles wide). Average lake depth is about 3 m (10 ft) and water surface elevation is 4.3 m (14.2 ft) above mean sea level.

Water level and rainfall data is collected on Lake Okeechobee by the Port Mayaca remote automatic platform, one of four which send data by satellite to locations in four states.

South and southeast of the lake are a vast agricultural area and three large water conservation areas.

Satellite relay

Recently, we at the Corps undertook the task of automating collection and recording of water resource parameters at key locations within the Central and Southern Florida project. We have two systems operating. The first system relays data through a geostationary satellite to government sites at Vicksburg, Mississippi, and at Wallops Island, Virginia. The satellite is jointly operated by the U.S. National Oceanic and Atmospheric Administration (NOAA), and the U.S. National Environmental Satellite Service (NESS).

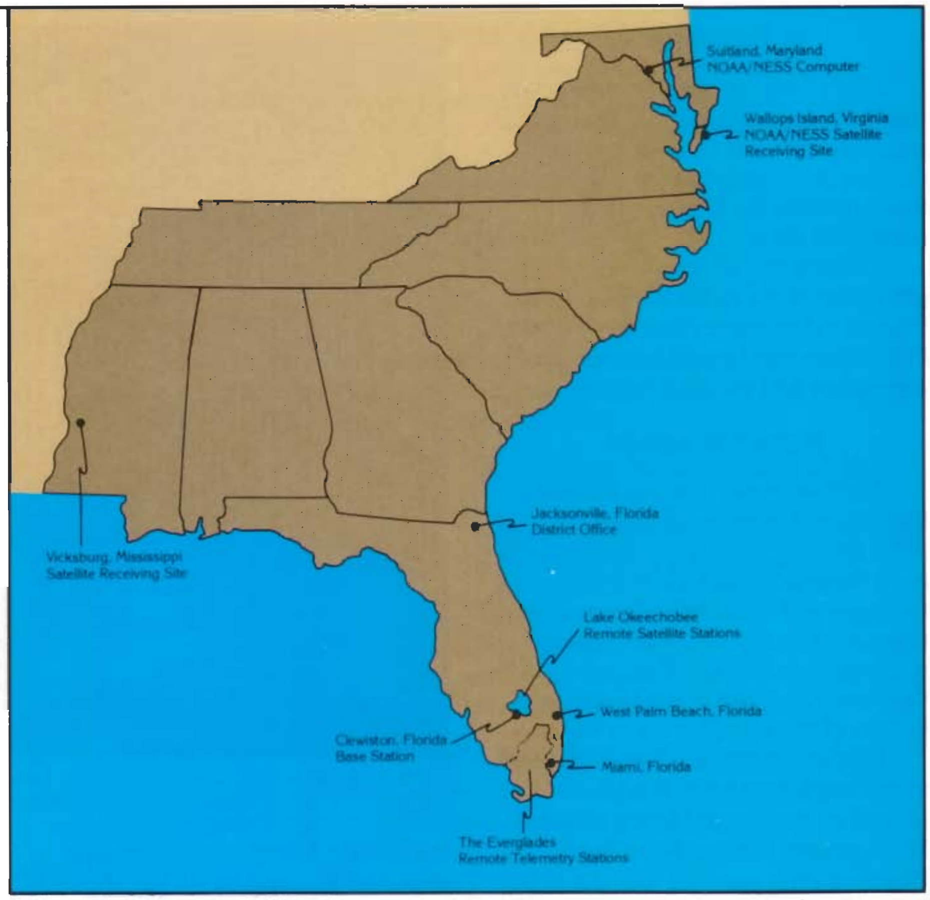
This system transfers data about water level, rainfall and water quality from four field stations to computers at the receiving sites. These computers allow user access to the data via telephone lines and standard interface equipment.

The four satellite stations on Lake Okeechobee are located on the north, east, south and west portions of the lake. Each monitors water level and rainfall using Leupold & Stevens model 7000 digital recorders and LaBarge Convertible Data Collection Platforms.

The northern-most station also has a water quality monitor which measures dissolved oxygen, temperature, conductivity and pH. Wind speed and wind direction instrumentation is planned for later.

Power supplies for all the stations are standard 12-volt batteries recharged by solar panels.

Data monitoring is controlled by the LaBarge system on each platform and occurs once each hour. The hourly readings are stored in the unit's memory and transmitted every four hours to the satellite. Shortly thereafter the data is available at the receiving sites mentioned above.



Both very-high-frequency (VHF) radio waves and satellite relay signals are used to distribute information collected by the Corps-operated system to local, state and federal offices.

Radio relay

The second system consists of a very-high-frequency (VHF) telemetry system and ten stations in the water conservation areas. These stations use Leupold & Stevens recorders to monitor water level and rainfall. Electronic telemetry equipment for each remote station, as well as the base station at the Clewiston Area Office, was manufactured by Engineered Systems, Inc., Phoenix, Arizona.

Each remote station can automatically sample and store data at 30-minute, 1-hour, or 4-hour intervals, selectable from the base station. The stations provide 48 hours of data storage at the 1-hour sample rate, then dump the data to the base station on interrogation demand via the VHF radio system.

Data access

Interrogation demands may be made manually or automatically from the base station using a Hewlett-Packard 9825 system which includes two flexible disc drives, a 2631A Printer, bit-serial interfaces for the base telemetry unit, a Bell 103A data set, and a real-time clock.

As mentioned above, the purpose of the 9825 is to control remote station interrogations and sample rates through the base station telemetry unit. In addition, the 9825 records all received data on discs for permanent storage and serves as host computer for remote users desiring access via the Bell 103 data set.

Operating modes

The real-time program runs in local, automatic and remote modes. In local mode, the 9825 responds to keyboard entries to communicate with the telemetry system and perform utility functions such as initializing a new disc and printing summaries of current disc usage. In automatic mode, the system will either relay data, or record received data hourly. It can also record data at 8:00 a.m., 12:00 p.m., and 4:00 p.m., depending on the automatic mode selected.

In remote mode, the 9825 serves as host to remote users who need access to the data. Remote mode is initiated by an interrupt from the Bell data set and may occur while the system is in local or automatic mode, unless overridden by a local operator.

After the remote session ends, the program always returns to local mode, then defaults to automatic if no keyboard entries occur within a reasonable length of time. We use two passwords to gain access to the system, one password for the Corps of Engineers District Office in Jacksonville, Florida, and one for other users.

With the District Office password, communication with the telemetry

Data frames are reversed, and each character coded at the receiving site. For System 45 string functions, this is no problem, but most Fortrans would require carefully-written code.

Collected data is sent by VHF signal from remote station 1-8C to the base station at Clewiston. A total of 10 such stations monitor water level and rainfall in water conservation areas of the Everglades.

system itself takes place through the 9825. With the other password, data previously recorded on disc, and conversational messages between remote user and local operator are the only functions allowed. We leave the 9825 on line in automatic mode most of the time. The field storage capability of the telemetry system comes in handy in freeing the 9825 from strictly a controller function to allow other programs to run.

District system

In the Jacksonville District Office, we have a System 45 which is the central part of our Reservoir Regulation Center. Besides gathering data to use as a basis for decision making in the reservoir regulation process, we generate monthly operating reports that serve as records for regulation activities.

The installation consists of the System 45, two flexible disc drives, a 9872A Plotter, a 9874A Digitizer, a 2631A Printer, a Leupold & Stevens paper tape reader for recorder tapes to fill in missing data in the near-real-time record and an Anderson Jacobson acoustic coupler for telephone communications. We have HP's terminal-emulator software for general communications with host computers but found that the 45's I/O ROM and Enhanced BASIC made developing our own programs easy.

BASIC vs. Fortran

In fact, when we were in the planning phase, we received a lot of advice on the pros and cons of BASIC vs. Fortran as applied to our applications. As it turned out, I think we're much better off with the Enhanced BASIC. For example, data frames retrieved from the satellite receiving site are reversed, and each character within a frame is coded. For the System 45 string functions, this is no problem, but most Fortrans would require some carefully-written code to handle it.

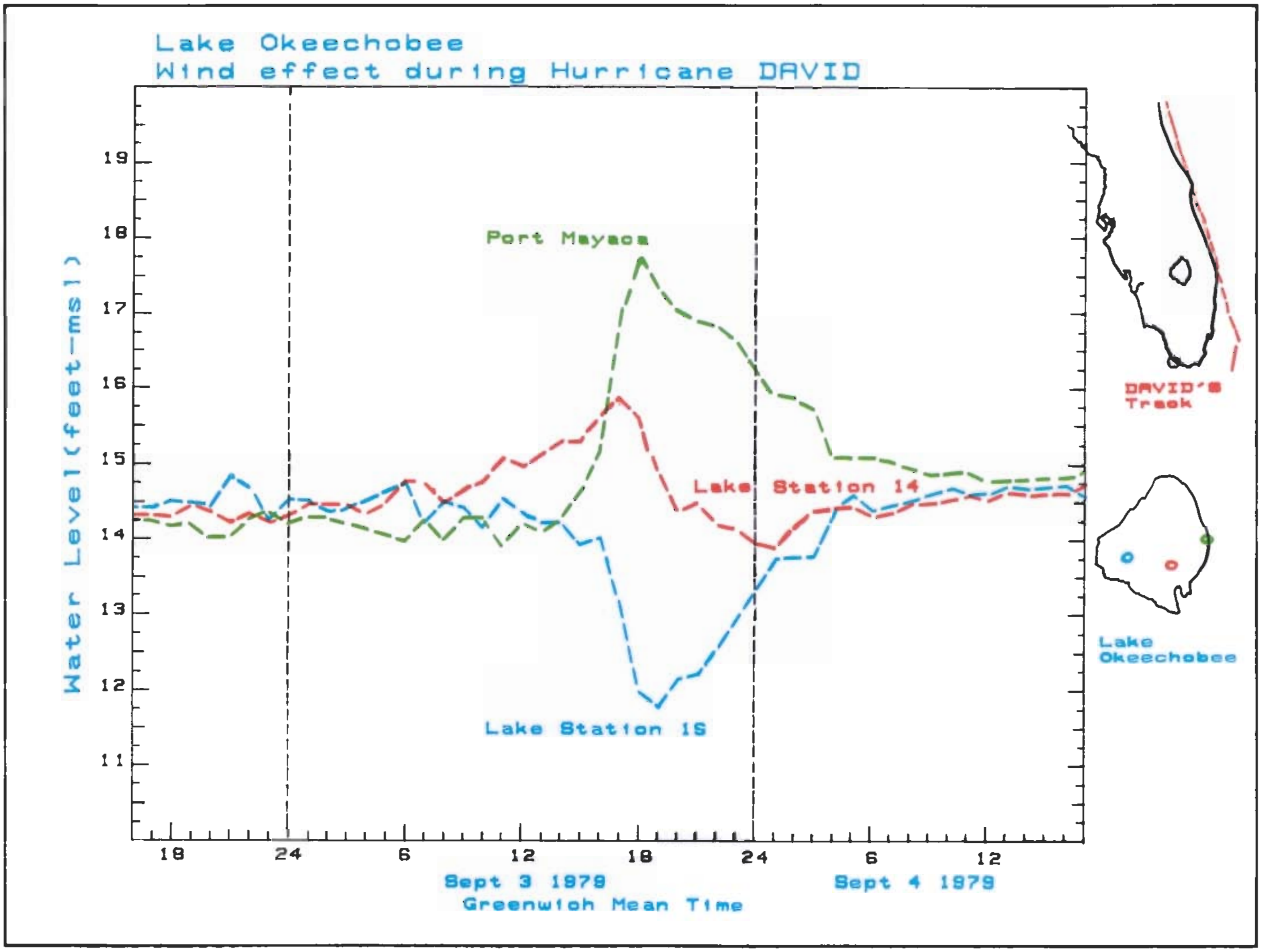
Typical morning

A typical morning at the Reservoir Regulation center and Clewiston Area Office proceeds as follows: using the System 45, we call the computers at the Vicksburg Division office of the Corps or NOAA/NESS to get the latest readings from our remote stations. Although the 9825 can retrieve the data from the Vicksburg Division or NOAA/NESS directly, we generally leave the 9825 to run the telemetry system and act as host to remote users.

After we receive the satellite data in Jacksonville and prepare a lake-station status report, we send a lake-station summary to Clewiston and receive the latest data from the telemetry system in return. Then we call the South Florida Water Management District and get data from the state's key stations.

Meanwhile, the state can call the 9825 at Clewiston and retrieve the latest data from Lake Okeechobee and the water conservation areas. Usually by 10:00 a.m., both federal and state water managers have data from field stations needed in making decisions on releasing water for various uses.

We have plans to implement water resource models on the System 45 to improve our forecasting for use in



During last year's Hurricane David, which brushed Florida's eastern coastline, winds on Lake Okeechobee reached 88.5 kph (55 mph). Data from three of the four lake stations shows the power of the storm, as reflected in the water level differences between stations.

operations. Of course, such models will depend heavily on the weather. So the approach we'll take is to have models flexible enough to provide a forecast based on a wide variety of "what ifs."

Reliability

One of the hardest things to find on the gaging equipment market is devices that will endure conditions on Lake Okeechobee and in the Everglades. Besides the natural perils of lightning and wind during frequent storms, a gaging site is often a tempting target to some hunters with high-power rifles. Although we have what we think is some of the best gaging equipment available, we know we'll have stations down from time to time.

With field station problems to contend with, we can't afford additional down time caused by computer failure. So far, total down time for both the 9825 and System 45 is zero.

Will our lake and telemetry stations survive a hurricane when the need for information is critical? Clewiston Area Office personnel have put a lot of effort into installation — now, only time and Lake Okeechobee can tell.

K

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Programming Tips

Merging and weaving programs on the System 45

Being an ardent 9830 fan for many years, I missed the MERGE statement on the System 45.

Although the manual doesn't mention merging, this operation is available, and in an even more flexible form than on the 9830. Merging is done with LINK or GET, but the program segment to be merged has to be prepared using PRINT# instead of SAVE.

The important detail is that the first line in the DATA file to be merged must have a higher number than those following it. The LINK or GET statement must give at least a first line identifier. As usual, any old lines with this number or higher will be deleted. However, any subsequent program lines in the DATA file will be treated as if they had been entered from the keyboard (except that a renumbering will be made first if the first line number in the DATA file does not agree with that indicated by the LINK (GET) statement). Thus, new program lines can be inserted anywhere among the old ones or may replace old lines.

If it is desired to merge a complicated program segment, the most convenient way is to SAVE it into a temporary file and let an auxiliary program READ# and PRINT# the final version.

EXAMPLE: Suppose the lines below are to be merged.

```
110 Z=2^(-ABS(X))
120 RETURN Z+1
```

Begin by SAVE-ing them in a temporary DATA file "TEMP". CREATE another DATA file "MERGE" which should be large enough to admit these lines and the line

```
9999 !
```

Now enter and run the following program:

```
10 DIM S$[160]
20 ASSIGN #1 TO "TEMP"
30 ASSIGN #2 TO "MERGE"
40 ON END #1 GOTO 90
50 PRINT #2;"9999 !"
60 READ #1;S$
70 PRINT #2;S$
80 GOTO 60
90 ASSIGN #2 TO *
100 END
```

After this, "TEMP" may be PURGE-d, and "MERGE" is ready to be merged.

For instance, suppose the program below is in the memory:

```
10 X=FNA(0)
20 PRINT X
30 LINK "MERGE",9999
40 Y=FNA(0)
50 PRINT Y
60 END
100 DEF FNB(X)
110 RETURN X^2
190 FNEND
200 DEF FNA(T)
210 B=1/(1+T)
220 RETURN T+FNB(B)
230 FNEND
```

If you run the program, the printout will be:

```
1
1.5
```

If you list it after running it you will obtain:

```
10 X=FNA(0)
20 PRINT X
30 LINK "MERGE",9999
40 Y=FNA(0)
50 PRINT Y
60 END
100 DEF FNB(X)
110 Z=2^(-ABS(X))
120 RETURN Z+1
190 FNEND
200 DEF FNA(T)
210 B=1/(1+T)
220 RETURN T+FNB(B)
230 FNEND
9999 !
```

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Biocurve and bionumbers on the 9815

For those readers who believe biorhythm information can be helpful, here are two programs you may want to try. Both programs produce information related to biorhythms.

The first program takes your date of birth, as well as a second date of your choice, and calculates your values for three factors on that second date. These factors are:

man rhythm = M
woman rhythm = W
intelligence rhythm = J

The second program prints a + or − in each of the above categories for each day of a month you specify.

For a listing of these programs, and brief instructions, please write to *Keyboard* at the address given on the back page, and request listings of the biocurve and bionumber programs.

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Guarding Rolex quality

by Edmond Zaugg,
Rolex Electronics Department Manager

Millions of watches riding on the wrists of people around the world owe their existence to a business venture begun in 1905 by the founder of Rolex. It was Hans Wilsdorf who first sucessfully marketed the wristwatch.

Rolex also introduced the first waterproof wristwatch in 1926, and became known for manufacturing timepieces of the very highest quality.

Our watches featuring quartz-linked movements require nearly a year to manufacture, and are accurate to within seconds per month. We produce watches used by professional divers whose lives depend upon accurate timing of deep dives. One Rolex watch is guaranteed for accurate timekeeping underwater to a depth of 610 meters (2000 feet).

The demands made upon these watches have reinforced the need for us to give our watches stringent quality control tests before they can be sold. Rigid performance evaluation of each finished watch is required to assure continued accuracy during the life of the watch.

We determined that a computerized system was needed to perform quality control checks. We had specific requirements for the system we wanted. And when no suitable system was found, we decided to build our own around a Hewlett-Packard 9825A Desktop Computer.

Data had to be collected without taking watches from the production area. At the same time, however, data processing had to be performed in a laboratory several floors above the production area.

Unattended operation

Operation of the system had to be automatic to allow non-technical personnel to run it. And not only would the computer have to run the tests, but it also had to be available for general computational use by workers.

We test the watches in an environmental chamber built to simulate conditions anticipated during normal use of the watches. Up to 1000 watches are placed in the chamber at one time. This takes place in the production area after the watches are calibrated. The chamber then is sealed and is not opened until the test is completed.

Inserting a cartridge into the tape drive of the 9825 and activating the computer initializes the system for automated operation.

A digital clock switches the system on at the proper time, and the 9825 conducts a system test from its remote location several stories above to make certain that all is functioning normally. The system then begins its tests.

It takes just 10 minutes for the computer to analyze data from all watches in the chamber and group the results into calibration categories.

Magnetic pulses

Within the environmental test chamber, watches are positioned in shallow trays stacked atop one another. The electronic watches each generate a magnetic pulse once every second. It is the precision of this pulse timing that determines whether the watch has been correctly calibrated.

Transducers built into the trays of the chamber detect the pulses of the watches. On command from the 9825, a scanner selects the magnetic pulses from the first watch. The pulses are relayed to an HP measuring system which includes an HP 5312A HP-IB Interface and an HP 5308A 75-MHz Timer/Counter.

An external atomic clock simultaneously feeds pulses to the counter at precise, one-second intervals. The counter compares the standard reference pulse intervals from the atomic clock with the intervals measured from the watch. The difference between these intervals, measured in thousandths of a second, is output to the HP-IB interface and relayed to the 9825. The computer then stores this data on tape.

Data in 15 minutes

The system takes data on the performance of each watch in the chamber in turn, and empty positions on the trays are noted. The data acquisition process for a chamber full of watches takes less then 15 minutes. We repeat the procedure once each day for a week and construct a performance record for each watch.

We wrote our own software to enable the 9825 to analyze the collected data. From the comparative readings taken daily, the computer determines whether each watch is performing normally, gaining time, losing time, or running irregularly.

It takes just 10 minutes for the computer to analyze data from all watches in the chamber and group the results into calibration categories. Watches that fall outside our stringent requirements for accuracy are singled out.

The 9825 makes a printout on its internal printer indicating the characteristics of the watches which fall outside acceptable performance limits. We return these watches to workers for adjustment, and forward accepted watches for finishing touches before they are shipped.

We also derive other information from the data using the 9825. The desktop computer calculates individual watch performance curves and plots them on our HP 9871A Impact Printer. The computer also provides feedback to workers calibrating watches by producing a distribution curve on the 9871 that shows the accuracy of original calibration against the total number of watches tested. It also prints reports of any hardware malfunctions that occur during the test period.

The watch test system is used only part of the time, which allows personnel to use the computer for other tasks during most of the day.

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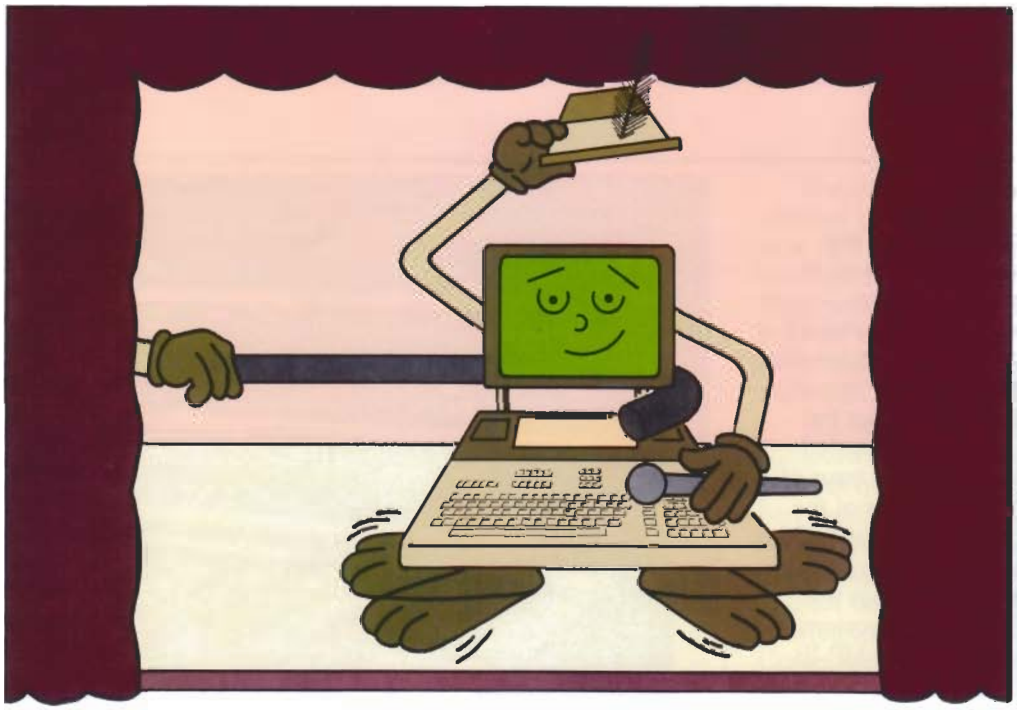
Leibson on I/O Part VII

Interrupt I/O: getting the attention of the processor



by Steve Leibson,
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Desktop Computer Division

What do you think is the most important part of the telephone? The dial? The receiver? The cord?

I submit that it is the bell. If the telephone had no way to summon you when a call came in, you would have to check it periodically to see if there was someone on the line.

The inconvenience of lifting the receiver every few seconds would quickly make the instrument seem very irritating. Fortunately, telephones do have bells, which interrupt you when someone calls.

Waiting for peripherals

Early in this series we discussed the relative speeds of computer processors and peripheral devices. The mismatch in speeds necessitated the creation of handshake lines that the processor could check to see if the peripheral was busy. Without these lines, the speedy processor would inundate the poor peripheral with data.

The use of these handshake lines is the simplest form of I/O. The computer spends much of its time patiently waiting for the peripheral to get ready for the next transaction.

Interrupting

The above situation is quite satisfactory if there is nothing else for the computer to do. Frequently, however, there are many other things the computer could be doing, and the use of handshake I/O is inefficient. Fortunately, an alternative exists in most modern computers. It is interrupt I/O.

First, let's decide what it is that we will be interrupting. The computer is continuously executing a program in its memory. If there is no user program currently running, then at least the operating system is executing.

Thus, we have two levels of programs in the computer. The highest level is the user program, usually written in a high-level language such as BASIC.

Microprocessors currently cannot run a BASIC program directly, and so have a second, lower-level program which interprets the BASIC statements. This lower-level program is written in machine code, instructions that can be directly executed by the processor. This program is called an interpreter.

Interrupts are hardware mechanisms for forcing the processor to leave the part of the program it was executing just before the interrupt and start execution at a different location in memory. This interruption takes place at the machine-code level. It is a very useful mechanism for synchronizing external events with the computer program, but it must be used carefully. Let's take an example.

Suppose that a user program asked the computer to compute the value of 2.5+2.5, print the answer on a teletypewriter and then compute the value of 3+3. The computer would first execute the routine in the BASIC interpreter that performs floating point addition to produce the result: 5.00.

This creates a total of six characters to print: 5,.,0,0, carriage return and line feed. We can assume that the addition takes two milliseconds. Teletypewriters print ten characters per second, so the printing of six characters will take approximately 600 milliseconds (actually a little longer because the carriage return requires extra time).

Handshake I/O requires the computer to wait out the full 600 milliseconds before performing the second addition. The alternative

BASIC programs do not require an interrupt service routine for HP desktop computers, because the routine is in the interpreter.

offered by interrupt I/O is that the characters to be printed can be placed in memory somewhere, in an area designated as the I/O buffer.

Interrupting machine code

The first character to be printed then is sent to the teletypewriter, causing the interface to the peripheral to "go busy," transferring the character to the printer. Now the computer can proceed to the next BASIC statement, confident that when the teletypewriter has finally printed the first character it was given, it will become ready for the next one. At that time the interface will interrupt the processor and ask for another character.

Note that it is the machine code interpreter that is interrupted and not the BASIC program. The flow of execution of the BASIC statements is not changed, but the interpretation of the program into machine code is stopped while the computer outputs another character. This illustrates the use of interrupt for buffered I/O.

The writer of the BASIC program does not have to write an interrupt service routine for Hewlett-Packard desktop computers because the routine has been provided in the interpreter. This is quite convenient because many factors must be carefully handled in such a routine. The interrupt forces a branching in the machine code program to a different location.

If the processor does not remember where it was before the interrupt, it cannot return and will be "lost," unable to continue operating properly. Most processors automatically save the address of the location being executed before the interrupt, and a return from the interrupt is sufficient to restore that address.

If the interrupt service routine uses any of the internal registers in the processor, it must first carefully save the contents of these registers and then restore them at the end of the interrupt service routine. This must be done, because it is difficult to tell what information in these registers was important to the program that was interrupted. By saving and restoring the registers, the processor is left as it was found and the interrupted program will not be affected.

Interrupting BASIC

Sometimes, the buffered I/O routines are not sufficient for handling the problem. Some problems require more complex action from the computer than the transfer of a piece of information. In these instances, it is necessary to interrupt the BASIC program itself and branch to an interrupt service routine written in BASIC.

Interrupting the BASIC program is considerably more complex than interrupting the machine code program. BASIC statements can affect large portions of memory such as those used to store the values of variables. If a variable is being changed just as the interrupt comes in, and the BASIC interrupt service routine also uses that variable, the wrong value or a garbled value may be used in the interrupt service routine.

Waiting for the end of the line

To prevent such problems from arising, Hewlett-Packard desktop computers force BASIC-level interrupt service routines to wait until the end of the current line has been reached before the actual branching occurs. This is called end-of-line branching. The interrupt can be logged in at any time during the execution of a BASIC statement, but the granting of the interrupt is withheld until the end of the line.

Machine code, or low-level interrupts, are generally called hardware interrupts because the processor hardware performs the interrupt request granting and the subsequent branching. Interrupts of the BASIC, or high-level program, are called software interrupts because several instructions in the operating system are required to log in the low-level interrupt, request the end-of-line branch and then take control of program flow at the end of the line.

Finally, let's consider what is actually meant by the interrupt. A classic example of misunderstanding interrupt occurs whenever a first-time writer of interrupt service routines tries to use interrupt for input. The typical programmer will enable the interface to interrupt and expect that when the interrupt comes, the interface will have the desired piece of data.

Unfortunately, the interface actually interrupts whenever it is not busy. Since the interrupt service routine did not make the interface go busy by requesting acquisition of the data before enabling the interrupt, the interface interrupts immediately, as it had nothing to do.

The interrupt service routine then ends up with no data or old data. The key is that to properly use interrupts, the first data transfer is performed before enabling interrupts, and subsequent transactions are performed under interrupt. K

Our new HP-85 the basic BASIC computer

by Martin Nielsen,
product marketing engineer,
Hewlett-Packard Company,
Desktop Computer Division

A low-cost, lightweight desktop computer which takes the essential components of larger computers and integrates them into one compact unit is now available from Hewlett-Packard: the HP-85A Desktop Computer.

The HP-85 comes in one case which combines a central processing unit, keyboard, cathode ray tube display, 200K-byte tape drive and hard copy printer.

BASIC language

This new desktop computer brings BASIC language, graphics and, in the future, powerful I/O to the low-cost range of the HP computer product line. It allows a starting point for upward growth into the BASIC-language HP technical computer family, which now includes the HP-85, System 35, System 45 and the HP 1000.

The HP-85 is the smallest and lowest-priced desktop computer which features graphics in the HP product line. And, as small as it is, the HP-85 still provides many of the graphics features found in much larger computers, such as the System 45. It can dump alpha or graphics information to its internal printer with a single keystroke.

Cooler

The HP-85 does not generate enough heat to require cooling fans because it uses only as much power as a 40-watt light bulb. And, like many other desktop computers in the HP line, the HP-85 uses the friendly, interactive BASIC language.

Standard hardware

Standard HP-85 hardware includes:

- Extended BASIC programming language (a superset of ANSI Standard BASIC).
- A full ASCII keyboard with separate numeric keypad, ten system control keys and four Special Function Keys that can be assigned up to eight tasks.
- A 12.7-cm (5-in.) CRT with both alpha and graphics capabilities, including a screen alpha capacity of 16 lines of 32 characters and graphics resolution of 256 x 192 dots.
- A 32-column, bidirectional scanning head thermal printer with a maximum speed of 2 lines per second for making hard copies of alpha or graphics displays, listing programs and printing data.
- A built-in, 200K-byte cartridge tape drive which uses 98200A Data Cartridges.
- Four I/O slots at the back of the HP-85 for interface cards, additional read/write memory, and an optional ROM drawer which holds up to six ROMs.
- 16K bytes of standard read/write memory, expandable to 32K bytes (using one I/O slot).
- Three programmable timers plus a system clock.
- Intensity controls for both CRT and thermal printer.
- Programmable variable tone beeper.

Sample software

The HP-85 is shipped with a Standard Pac which includes a sampling of programs for math, graphics, games and education. Additional software pacs include: BASIC Training, Games, Math, General Statistics, Basic Statistics and Data Manipulation, Regression Analysis, Linear Programming, Financial Decisions, Waveform Analysis, Circuit Analysis and Text Editing.

Now, for a look at how the HP-85 might be used, consider some sample applications.

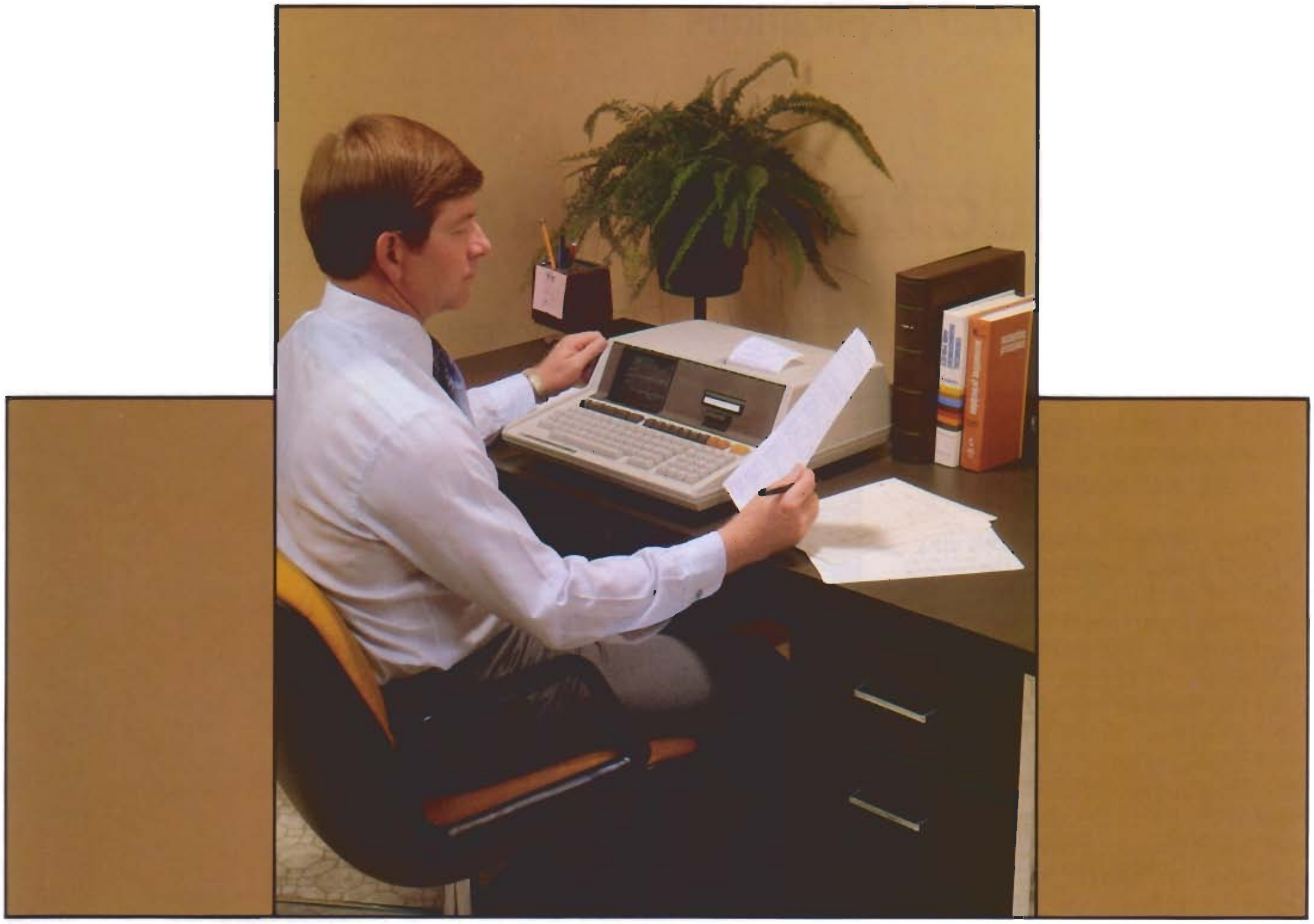
Quality control

A quality control supervisor on a large assembly line tests a random sample of products coming off the line for performance. When failures occur, he uses the HP-85 to correlate these with factors such as the vendor of the parts, individual assembly technicians, day of the week and environmental conditions within the plant, to name a few.

He can isolate and test individual failure factors for correlation with product failure data. Graphs easily generated on the HP-85 can be used, instead of columns of numbers, for easier and faster interpretation. Statistical variables can also be computed to verify visual impressions from the graphs.

By using the HP-85 BASIC Training Pac and user mauals, he teaches himself to program the computer. Statistical analysis is aided by HP-supplied software.

The desktop computer helps him



perform his tasks better and faster to avoid the problems which cause product failures.

Technical services

A person running a technical service, such as a consulting engineer, would use his HP-85 primarily for computation and design. But he might also use the computer for recordkeeping. For this application, he could write the program himself, or contract with a software house to supply the program.

In an architect's office, personnel not trained in computer programming can use a Special Function Key to access information on selected customers, vendors or building designs. The person can then type in a specific inquiry to get a full readout of the needed information in seconds.

For example, he may want to know the status of the billing for the new downtown office building he designed for Doctors Morgan and Adams. He presses the Special Function Key marked "CUSTOMER," and keys in the name of either doctor. The HP-85 lists the start date of the project, hours spent in work on the project, original estimates of costs, final costs and a list of payments made to date.

Abundant I/O planned

These applications provide only a suggestion of what can be accomplished with the HP-85, particularly in the area of data acquisition and control. To aid customers in these areas, a full range of interfacing cards is planned, including 16-bit parallel, HP-IB (IEEE 488), BCD, RS232-C and an I/O ROM.

These I/O enhancements will make it possible to use the HP-85 as a low-cost and cost-effective controller. A future article in *Keyboard* will deal extensively with I/O on the HP-85.

Engineering design

An engineer designing supermarket freezer cases for a large manufacturer might use his HP-85 to help determine temperature variations within a new freezer case prototype.

Control and data collection could be performed automatically by the HP-85, using software written by a company programmer. The HP-85 would scan measurements from eight sensors placed in the prototype freezer case, making it possible to obtain an accurate temperature profile during long-term, unattended tests.

The information gained would tell whether the design is acceptable. One of the HP-85's built-in timers could generate interrupts for the tests once each minute, and signal the HP-85 to take another set of readings. Data would then be stored on the internal tape cartridge for a permanent record.

Charts or graphs of the data could be generated later on the CRT screen and dumped to the internal thermal printer for a hard copy to use in management consultations.

Peripherals aplenty

The HP-85 will be plug-compatible with existing HP-IB peripherals, including the 7225A Plotter and the 2631A Printer.

The HP-85 will be sold by HP's Technical Computer Sales Force, and by selected computer stores and office equipment dealers. K

Magnetic tape fools NC controller

by Brenda Hume
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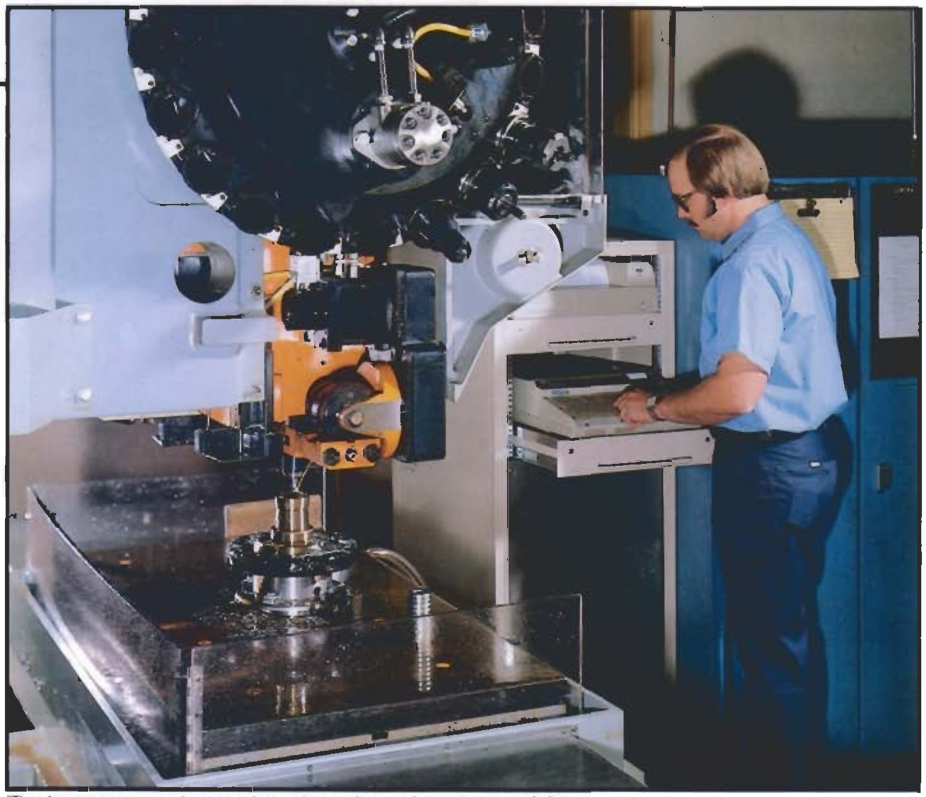

The large numerical-control machine shown here is one of the tools at HP's Loveland Instrument Division now run by a 9825 set up to simulate paper tape input.

In the 1950s, machine shops and tool rooms were equipped with numerical-control (NC) mills and lathes. The input medium was a punched paper tape that "talked" to the machine. Today, the machines are faster and produce high quality work, but the input medium is the same.

Technicians have developed an alternative in the machine shop at Hewlett-Packard's Loveland Instrument Division, Loveland, Colorado. Using an HP 9825 Desktop Computer, software has been developed over the last five years to fool the mills and lathes into acknowledging data from magnetic tape cartridges. Thirty cartridges store 500 different jobs and require ½ cubic foot of storage space. The traditional punched paper tapes storing 500 jobs would take up 54 cubic feet of space.

Standard I/O cable

The interface between the computer and the NC machine is a standard I/O cable (98032A). No modification is required because the tape reader is paralleled with the computer. The machine thinks it is being controlled by punched paper tape, but the computer is feeding it data simulating the tape.

A part program is required to operate the NC machine. The 9825 software takes part-program data, manipulates it and transmits it back to the controller.

Prompting format

The program image from the tape cartridge is manipulated through user-definable keys and the software is written in prompting format (succeeding displays tell the operator, step by step, what to do). Thus, there is no need for a computer programmer to operate the system.

When the NC machine "asks" for data, the computer must respond within 25 milliseconds. The controller has a fail-safe circuit that will create a read error if this requirement is not met. The 9825 satisfies this 25-millisecond response.

One of the advantages of the fast computing time of the 9825 is the ability to compute machine data during a machine cycle. For example, if a part has a constantly decreasing elliptical axis contour, points can be computed in a subroutine. If the formula for this contour is

$$\left(\frac{x}{\text{minor ellipse}}\right)^{2.5}+\left(\frac{y}{\text{major ellipse}}\right)^{2.5}=1$$

the formula itself is a subfunction.

This function sends the computer to a subroutine that calculates xy coordinates. One of the unknowns is incremental; the computer solves for the other unknown. The points are then transmitted to the NC controller which simply follows the commands.

Software triggers

The 9825 software can also be written to trigger other devices. For example, if the computer reaches a program line containing the letter "A", the 9825 will inhibit the NC controller and branch to a subroutine causing another device to function. This could be releasing pump coolant to a predetermined level or moving the indexer on the machine to a specific position. Upon completion of this task, the computer continues with the part program where it left off.

Interrupts

The computer also responds to interrupts. In cycle-time data acquisition, the controller sends an interrupt to the 9825 at the end of each part cycle. The computer services

Technicians found their greatest time savings with single character editing. What used to take 1/2 hour manually now is done in 10 seconds.

this interrupt request by reading the time from a 98035A Real Time Clock. After calculating statistical cycle-time data, the computer continues with the part program.

With each data line, the 9825 sends a sequence number consisting of the character "N" and four digits to the NC machine. The machine uses line sequence numbers, the computer does not. Thus, in a 500-line program, 2500 characters of memory are saved because the 9825 doesn't store sequence numbers. The computer generates them as they are needed and prints line numbers on hard-copy printouts for the user.

Editing features

Several editing features permit quick changes in specifications when required. The EDIT key allows the operator to view part-program lines. Any character or line in the display may be edited, inserted or deleted. The DUPLICATE function enables a user to duplicate several lines of data and move them elsewhere in the part program. The MOVE key moves multiple lines of data from one section of the part program to another.

A COMMENT key lets the user program reminders or explanations of program functions and sequences. The PRINT TIME function prints out actual, average, minimum and maximum time required to cycle a machine part. This information is valuable to management for scheduling NC machine run times and for budgeting.

The CONTINUE DATA key adds lines to the end of the program. For example, if you have a program with 500 lines and need to add 20 lines to the end of it, this editing key implements the change quickly.

Other special editing keys include INSERT, LOAD, STORE and RESTART.

HP technicians found their greatest time savings with the single-character editing function. If characters need to be added, deleted or changed on a punched paper tape, the user has to splice the tape and reassemble it. With the computer, the only action necessary is one keystroke. In other words, what used to take ½ hour manually is now done in 10 seconds by computer.

Machine simulator

When new software is developed or current software changed, it is not tested on the NC machine. Software implementors Don Kedrowski and George Risley have developed a simulator to act as a machine controller. When the 9825 executes a program, the simulator responds with the same actions as would the NC controller. To conduct tests in a real situation would be costly at a minimum of $50/hour.

Central controller

In addition to the current hardware, HP will soon install a System 45T as a central controller interfaced to the 9825s. As tooling specifications (part-program data) are updated, a part programmer will make changes in the central controller instead of in each 9825. The controller will transfer the updated information to the 9825 software where it will replace previous specifications.

Besides instant update of information, real-time data will be available to management for figuring production costs and machine run times. The System 45 will also eliminate the use of cartridges. However, cartridges will still be utilized as a backup when the 45 is needed for other applications.

Although there will be a central controller, the 9825s will be independent of it. The System 45 will act only on a request from the 9825s for information. No constant contact will exist between the 45 and the 9825s.

The prime advantage of a central controller is explained by current 9825 user Don Kedrowski. "The System 45 will eliminate paperwork. With each production part is a set-up sheet for the NC machine. When a change is made, these sheets are distributed to various departments. By the time the changes reach my desk, new changes have already been made. To eliminate this time lag, we will make on-line changes daily and each department will have the most current specifications."

Improved reliability

The reliability of punched paper tape is low in comparison to the current hardware. The computing functions of the 9825 have not failed in five years of use at HP's machine shop. The only problem has been the keyboards. Because of the hostile environment, heavy oils and flying metal chips can damage contacts under the keys. This problem has been alleviated by placing Mylar covers over the keyboards. In addition, a fan with a negative air flow, built into cabinets housing some of the 9825s, blows particles away from the computer.

Just as technology improved the output quality of numerically controlled machines in tool rooms, the HP 9825 and System 45 are meeting the challenge of an improved input medium. As software writers Don Kedrowski and George Risley have explained, "the possible functions of the 9825 in this application are limited only by the user's imagination." K

Update

Principal components and factor analysis

The statistical software offerings on the System 45B were recently extended with the release of the Principal Components and Factor Analysis package. The package represents the most intensive statistical analysis software ever offered on an HP desktop.

Principal Components and Factor Analysis will be especially useful to scientists who deal in multidimensional data. The purpose of the package is to reduce complex multivariate data to a more understandable form. The technique is becoming very popular with chemists, social scientists, biologists and even with electrical engineers.

The package includes routines for computation of principal components, factor extraction (principal axes or maximum likelihood), and orthogonal or oblique factor rotations. It features graphical presentation of case scores, component plots and factor plots. Principal Components and Factor Analysis contains the Basic Statistics and Data Manipulation routines which provide a data base for all the statistical packages on the System 45.

The package requires the System 45T configuration.

Free tape cartridge or magnetic card

In order to reduce errors and key-in work required in preparing Programming Tips for publication, *Keyboard* is making you this offer: If you are sending us a Programming Tip, please send your Tip already stored on a tape cartridge or magnetic card designed for your desktop computer.

As a gesture of our appreciation for saving us the work of keying the program into computers here and helping us eliminate errors, we will send you a tape or card in return for every tape or card containing a Programming Tip which we publish. This means we will return your original tape or card, plus a new, blank tape or card for your desktop computer. Even if your Tip is not published, your original tape or card will be returned.

By sending us your Tip already recorded, you will help us publish your Tip sooner.

Programming Tips book

Keyboard's compilation of Programming Tips published in past issues will soon be ready for distribution. You will be able to leaf through one volume for Tips you can use on 9810, 9820, 9821, 9815, 9825, 9830, 9831, and System 35 and 45 Desktop Computers. Tips are organized by mainframe to make them easy to peruse. The book also contains an index to shorten your searches.

The Programming Tips book is available to owners and users of HP 9800 Series Desktop Computers at no charge.

NOTE: If you took part in *Keyboard's* 1978 survey on the Programming Tips book, you may rest assured that we have your name on file. You will receive your copy of the book as soon as it is available, which should be around February 1.

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The Programming Tips book is *Keyboard's* 10th anniversary present to you.

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