Keyboard

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Keyboard
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Cover

Denver photographer Charles E. Grover took the aerial photograph which shows a view looking south past Denver during the period of a study of the city's pollution. While the downtown area of the city seems almost lost in the cloud, Pike's Peak, some 70 miles to the south, is easily distinguished as the largest peak on the horizon.

Notice to European Readers

We are in the process of updating the *Keyboard* circulation list. In the March/April issue, we inadvertently gave our European readers a "final notice" to renew subscriptions, when in fact we have not yet begun to update the European portion of the list. That notice was intended only for North America and certain other areas of the world. European readers should disregard that notice; you will continue to receive *Keyboard*.

In the very near future, we will be updating the European section of the list, and we will provide you with a card to make the renewal process simple.

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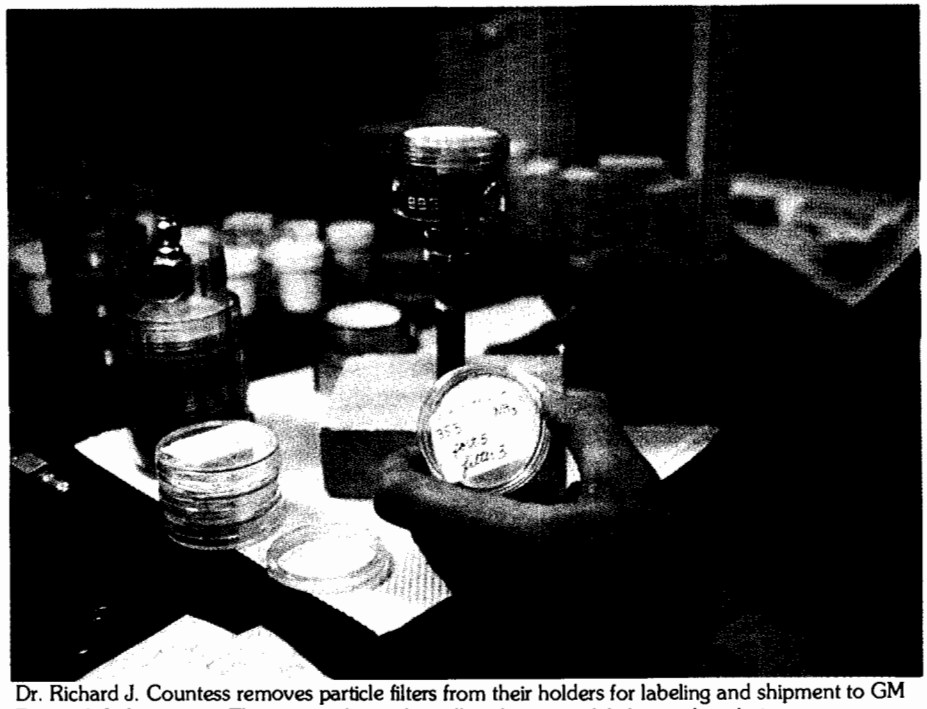
Particle analyzers probe properties of Denver's "brown cloud"



Dr. Richard J. Countess removes particle filters from their holders for labeling and shipment to GM Research Laboratories. The captured particles will undergo careful chemical analysis.

by Bill Sharp, Hewlett-Packard Company, Desktop Computer Division

The so-called "brown cloud" that often hangs over the city of Denver, Colorado, has been suspected by many researchers to be caused by particles in the air rather than by polluting gases alone. In November and December of 1978, a group of scientists joined forces to study atmospheric conditions and pollutants over Denver in order to better understand that city's weather, pollution, and, in particular, the brown cloud phenomenon.

This study brought together an impressive array of human talent and instrumentation. A wide variety of measurements was taken, and 39 stations were operated in order to describe the spatial extent of the brown cloud. In the Denver study, a data acquisition and instrument control system based on the Hewlett-Packard System 45 Desktop Computer made a contribution to the success of the project.

The overall study

In cooperation with the Colorado State Department of Health, the Motor Vehicle Manufacturers Association sponsored this large-scale study. Following analysis of the data collected, those interested in improving the quality of Denver's air will have available an up-to-the-minute picture of the city's atmospheric conditions.

The principal contractor for the study, Environmental Research and Technology, Inc., Westlake Village, California, was responsible for coordinating the measurement program and making the measurements not performed by the subcontractors. Other participating groups performed various functions: measured the optical properties of the atmosphere (University of Washington, Seattle, and Lowell Observatory, Flagstaff, Arizona); determined the three-dimensional distribution and nature of the brown cloud by aircraft sampling (Meteorology Research, Inc., Altadena, California, and the National Oceanic and Atmospheric Administration, Boulder, Colorado); measured the meteorological variables (local meteorologist Loren Crow); and provided measurements at a background site (Rockwell International, Rocky Flats, Colorado). The Environmental Science Department of General Motors Research Laboratories, Warren, Michigan, participated both by providing project management through the Motor Vehicle Manufacturers Association, and by operating the most comprehensive ground-based sampling station used in the study.

This large and comprehensive effort was necessary because of the complex terrain and meteorology of the Denver area. The total study required the following array of sampling sites:

- 2 comprehensive ground-based monitoring stations
- 2 aircraft
- 2 rooftop sampling stations
- 1 background sampling station
- 22 meteorological data stations
- 10 ground and aerial photography sites

The GM monitoring station

The Environmental Science Department of GM Research Laboratories has performed field measurements of air quality since 1960 using its Mobile Atmospheric Research Laboratories. Since 1972, the second generation of this effort, ARL-2, has toured the continental U.S., making air pollution measurements with sophisticated equipment and techniques often unavailable to local governments.

For this study, however, the capabilities of ARL-2 for measuring gaseous pollutants and meteorological variables were not enough. To fully understand the brown cloud, the measurements of the gaseous pollutants had to be supplemented with filter collection of the particulate matter, followed by extensive laboratory determinations of chemical composition. In addition, instruments were required to measure visibility, particle mass and particle size distribution.

The volume of data to be gathered made a data acquisition and instrument control system mandatory.

Meteorological variables

The facilities of ARL-2 allowed continuous measurements to be made of hundreds of different constituents in Denver's air. These facilities also made it possible to continuously monitor all the necessary meteorological parameters. The following lists the wide variety of measurements made with the equipment of ARL-2.

Gas measurements

Carbon monoxide
Methane
Total hydrocarbons (C_2 to C_{10})
Nitric oxide
Nitrogen dioxide
Sulfur dioxide
Ozone

Meteorological parameters

Wind speed
Wind direction
Dew point
Rainfall
Ultraviolet radiation
Barometric pressure
Inversion strength and height

Filter samples and analyses

Three parameters were considered necessary to describe atmospheric aerosols: the amount, the chemical composition and the size distribution. The amount and the chemical composition were determined by collecting samples of the aerosol on special filters. The sampling equipment used in the study collected a new specimen of aerosol every four hours, 24 hours per day.

In addition, two samplers were operated simultaneously. One collected particles of all sizes, the other collected only small particles. Research has shown that particles smaller than about two micrometers are especially important in understanding atmospheric visibility and atmospheric chemistry.

Once the particles were collected on the filters, the filters were returned to GM Research Labs where the chemical composition of the particles on them could be determined. Among the measurements made on these samples were total mass, sulfate, nitrate, ammonium, vanadium, elemental carbon and volatile organic compounds. About one hundred filter samples were acquired per day during the study, assuring months of work for analytical personnel at GM.

Choosing the System

The Denver study was the first field study undertaken by General Motors which involved extensive instrumental determination of particle properties and effects. Dr. Peter J. Groblicki is a GM Senior Research Scientist who developed the particle measurement system taken to Denver. He has been engaged in laboratory studies of particles for the past 13 years.

The volume of data to be gathered made a data acquisition and instrument control system mandatory. Dr. Groblicki had previously made limited particle measurements during a field study by recording data on strip charts and later preparing the data for computer entry using an HP 9820 Desktop Computer with a digitizer.

"It took us months to digitize the data for the computer. I decided never again to try that kind of project without a data system," said Dr. Groblicki.

For the studies of particles in Denver air, he decided to use HP's System 45 Desktop Computer to acquire data from all the instruments, and to control two of them.

"We chose the 45 because it is so easy to use, so friendly. Software was also available to control the data acquisition hardware. The hardware came, we cabled it together, and it worked. We were able to integrate the computer into our instrumentation system with essentially two to three person-months of effort. We did not need a construction crew or two full-time electronics engineers to help design the system.

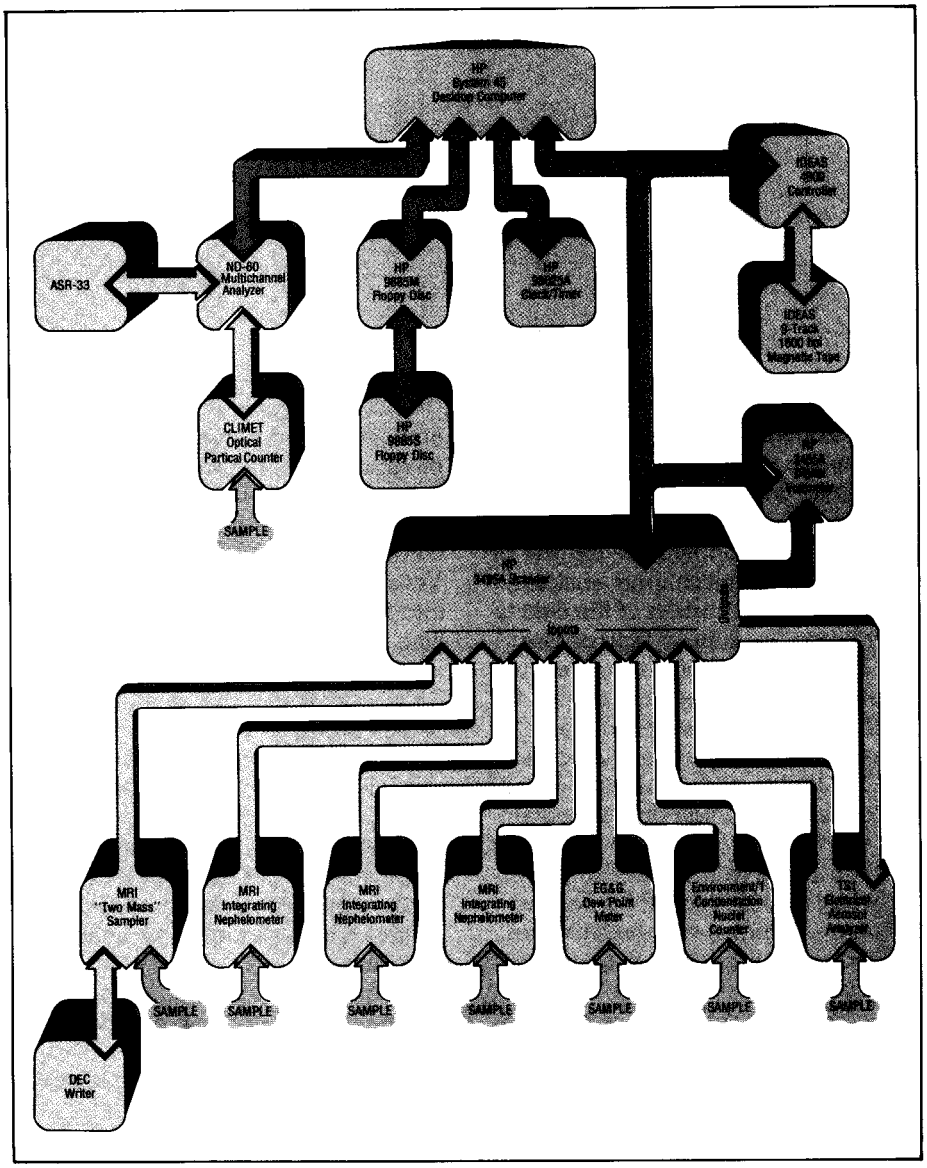
"I did trade off some capabilities for this friendliness. The system is a bit slow, for example. And I have a system that I can't work with at the component or machine language level. That is the tradeoff that I made, and I am willing to live with it."

Dr. Peter J. Groblicki designed GM's particulate studies around a System 45.

Groblicki added, "On the other hand, choosing the System 45 made it possible for us to get the system up and running in the field within two months. And the data acquisition software for the HP 3052 Data Acquisition System made our job much easier.

"I am saying all of this from the standpoint of a chemist who has to go out and get a job done, not as an electronics expert. I could have started with a mainframe minicomputer, worked a lot harder and longer, and had exactly what I wanted. But I traded some of that for the ability to walk up and turn it on and start working."

Throughout the planning of the system, Dr. Groblicki emphasized redundancy so that the odds were good that he would bring back data in some form from the field. He had a choice of storing data on nine-track magnetic tapes, on twin flexible discs, on two System 45 tape cartridges, or as printed output or strip charts. If the whole computer system failed, he still would have strip charts that could be digitized back in the laboratory.



The flowchart provides some details of how the components of the particle analysis system were linked together. Dr. Groblicki's group developed the software for the instrumentation.

Measurement of particle properties

The instrumentation feeding data to the System 45 performed three types of measurements. First were instrumental measurements of visibility. The second category included size distribution information. The third category was information necessary to understanding the performance of the whole system.

Instrumental measurements of visibility were made with integrating nephelometers. These instruments measured the amount of light scattered by particles in the air, which is related to visibility. Two identical instruments were operated — one measuring properties of air at ambient temperature and the other measuring air which was dried by heating. A large difference between the two measurements indicated the presence of fog. A third nephelometer was the same model as those used at other monitoring stations in the study.

The particle size distribution data was to be used with theoretical modeling to gain a better understanding of the visibility reduction. The atmosphere contained a very wide range of particle sizes, making many instruments necessary in order to get a complete size distribution picture.

A simple separation of the particles into two size classes (at 3.5 micrometers) was done in the Two-Mass aerosol monitor. The material in each size fraction was deposited on filters. A source of beta particles was located on one side of the filter, and a nuclear detector was on the other side. The reduction in the number of beta particles which penetrated the filter and reached the detector could be related to the mass of the particles on the filter.

A condensation nuclei counter provided readings of the total number of particles. The total particle measurement was heavily dominated by the smallest particles. This small size range of particles is produced by recent combustion.

Slightly larger particles in the 0.005 to 1 micrometer size range were measured with an electrical aerosol analyzer. This instrument converted the neutral particles into charged particles, or ions. The ions then passed through an electrical mobility analyzer, which was set to measure all ions with diameters larger than 0.0056 micrometers. The voltage applied to the mobility analyzer then was changed, passing all ions with diameters larger than 0.01 micrometers. The difference in signal was proportional to the number of particles between 0.0056 and 0.01 micrometers.

By changing the applied voltage 11 times, a ten-interval size distribution was obtained. The System 45, through a relay actuator card in the 3495A Scanner, issued the reset and advance commands used to apply voltages in the electrical aerosol analyzer.

Particles measured by this analyzer originated from combustion sources, and also from processes which convert atmospheric gases into particles. The particles from 0.1 to 1 micrometers were considered the most important in determining visibility reduction.

Particles in the 0.5 to 10 micrometer size range were measured with the optical particle counter, which pulled the particles through a small beam of light. Scattered light then was measured by a photomultiplier tube. The impulses were counted by a multichannel analyzer. The microprocessor-based multichannel analyzer was controlled by the System 45 through an RS-232C port. Data also flowed back to the desktop computer via the RS-232C connection. These larger particles

were due to mechnical processes. Typically, soil and dust would be in this size range.

Finally, the system recorded temperatures and test voltages throughout the station. The size of the aerosol could be affected by humidity, so a dew point meter also was included to provide this data.

Developing the software

One of the reasons for using the HP system was the short lead-time available to acquire, program and test the system.

Just after Labor Day last year, Carolina Ang, a research technician in Dr. Groblicki's group, began working with the System 45 manuals, although she and Dr. Groblicki did not yet have the computer itself. Becoming familiar with the system through the manuals became her full-time job at that point. Dr. Groblicki started a long list of tasks the system had to perform. He had some good ideas about how they could write a program that would do these tasks and yet be organized to simplify the writing, understanding and debugging of their programs.

That program eventually required a 180-way "IF" statement. The reason they wanted such a large branching routine was that every 15 minutes the real-time clock provided an interrupt which initiated one complete measurement cycle. Every five seconds, the clock provided another interrupt which caused branching to a labeled section of the program.

Each section specified exactly what actions were to be taken during each of the 180 five-second intervals. For instance, during the first five seconds, all the arrays where data were to be stored were initialized; sources of continuous data were scanned; the electrical aerosol analyzer was reset and the multichannel analyzer was reset and started.

At 10 seconds, the system only read continuous data. At 300 seconds, it read continuous data, computed five-minute averages and stored the data. Data was acquired for 14 of the 15 minutes. The last minute was available for computations, transfer of data from the multichannel analyzer, data display and transfer of the data to the storage medium — tape or disc.

The advantage of this program was that by simply looking at a counter, Dr. Groblicki could tell where in the program he should be at any moment.

"If I had to add something, I could go to the right section of the program and put it in."

The speed with which Dr. Groblicki was able to get his System 45 up and running was evident from the fact that he received the desktop computer in the first week of October, and before November the system was controlling instruments and acquiring data. The moving van came to transport the computer and instrumentation to Denver on November 3. On November 8, the system was up and running in Denver.

"Field operation of the data acquisition system pointed out areas where our programming needed to be improved," said Dr. Groblicki. "The data system crashed about once per week during the study. All but two of these were immediately explainable."

"Twice out of about 10-million readings, the digital voltmeter (DVM) did not return a reading when requested. And although I had a routine to correct these errors and restart the system, the error-correction routine was in the main program, while the DVM read was in a subprogram.

"So the system did crash a few times. But you have to remember that we came here [Denver] with no long-term operation of the computer. For the present development of our system, it was good performance.

"I am the developer of this system, and I designed the program and understand it. I was able to babysit it and get it through the test. But the program needs further development before I can turn it over to a technician and have the system automatically correct 99% of the problems that arise. Yet all the needed capabilities are built into the desktop computer, and with a little more development time, we'll have everything we want."

Using the data

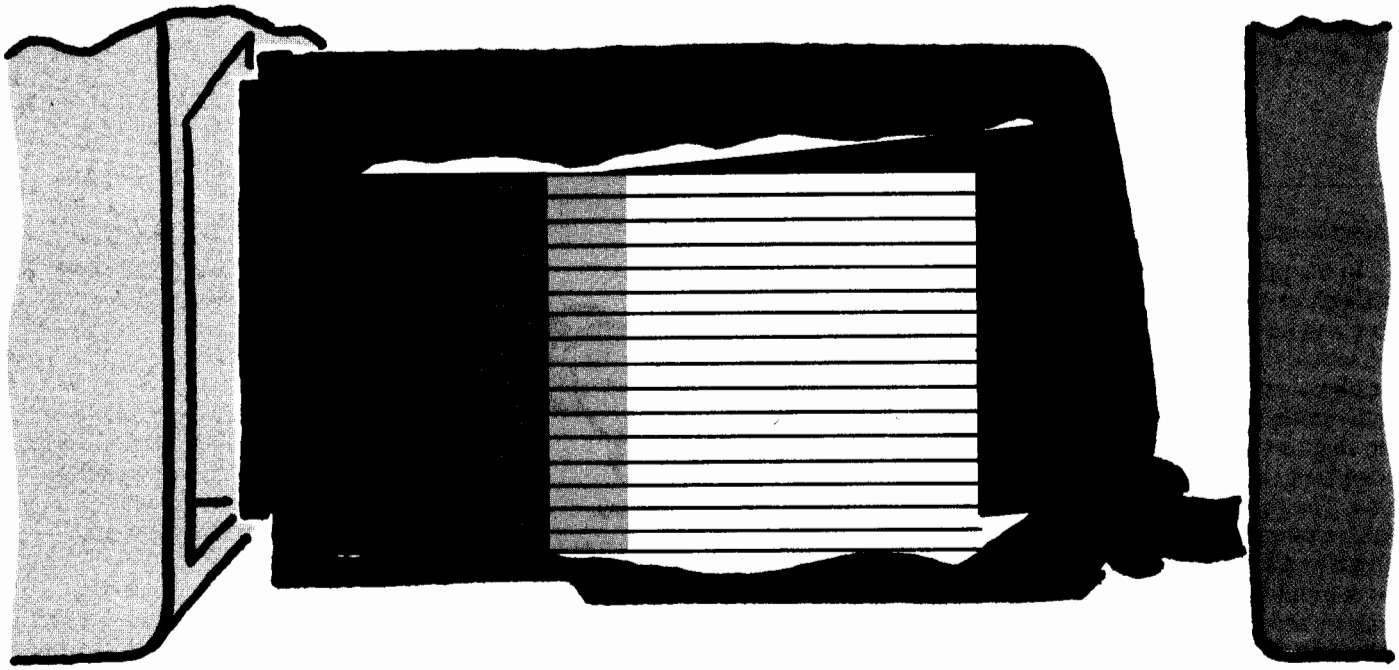
The data from the GM site will provide a comprehensive picture of air quality at one ground location in the Denver air basin. It fits together with the data from the other ground stations and with data from the aircraft, to give a total picture of air quality in Denver.

Scientists involved in the study were fortunate. While measurements were being taken, a severe temperature inversion lasting several days caused the second worst pollution episode in Denver's history. Because of the varied weather, samples ranging from very dirty air to very clean air were available for analysis. During the 40 days of the field study, more than 6,000 filter samples were taken, requiring months of laboratory analytical work. The final data base will incorporate millions of measurements of gases and particles in Denver's air, and detailed analyses of their physical and chemical properties.

Dr. Groblicki concluded, "The whole aim of this study is to assemble a data base on the chemical and physical characteristics of the atmosphere over Denver, including its brown cloud. Once this is done, the facts will be available upon which to base a strategy for improving air quality.

"There have been a number of previous studies that have looked at parts of the picture. In this study, we have tried to measure as many pertinent air quality parameters as possible so that the public can do constructive decision-making."

The parallel interface



by Steve Leibson, Hewlett-Packard Company, Desktop Computer Division

Computers are information processing machines and thus require paths for raw data to enter and for processed information to exit. In modern computer design, a very common technique is to create one universal path that leads both into and out of the processor. That path is the I/O bus.

This concept simplifies computer design but brings a complication: whatever the design of the I/O bus, the computer will be incompatible with a large number of peripheral devices. Some will be too old and use different signal levels, some will have varying data formats and most will be slow enough to seriously degrade the computer's performance if it must wait on every data transaction.

The complication is solved through the use of interfaces which act as transformers of voltage levels, data formats and transaction speeds, thus allowing a computer to communicate with a vast array of peripheral devices.

Data lines in parallel

A very simple peripheral will often have interface requirements which are very similar to the I/O BUS. Data is transferred over a set of data lines using a signal line to indicate when the next chunk of information is ready. The peripheral indicates its readiness to accept another piece of data on another signal line.

This type of interface is a parallel interface, so-named because the data lines are in parallel and data is transferred several bits at a time. The HP 98032A is a parallel interface designed for the 9825A, System 35A/B, and System 45A/B desktop computers. The I/O bus described in the Mar-Apr, 1979 issue of *Keyboard* is the I/O bus of the above-named computers, so we will be using the 98032A 16-bit Interface as the model for our discussion of parallel interfaces.

The I/O bus has 16 bidirectional data lines. Data is handled in 16-bit chunks and flows over these lines either into or out of the computer, but not in both directions at the same time.

The 98032A splits the I/O bus into two sets of data lines: 16 output lines and 16 input lines. The configuration is more compatible with unidirectional peripherals. Unneeded lines are left unconnected. Out of 32 data lines only eight might be used by a unidirectional, eight-bit peripheral.

As mentioned above, interfaces are sometimes used to transform voltage levels used on a computer I/O bus to those required by a peripheral. Our I/O bus uses "TTL" levels meaning that a low level is represented by a voltage between 0 and 0.7 volts and a high level is between 2.0 and 5.5 volts. Since the input lines of the 98032A parallel interface are built using TTL integrated circuit logic, these voltages are required on the data inputs of the interface to represent high or low logic levels.

The data outputs have been built with transistors, however, and can withstand 30 volts for a high level. The low level is still around zero volts. Remember when discussing logic signal lines that only two signal levels are allowed, one designated high and the other low. If the high level corresponds to a logic one, the signals are said to be positive-true logic. If a low level signal corresponds to a logic one, it is called negative-true logic. Logic zero would correspond to low or high levels respectively.

We have now established:

1. The I/O bus data lines, which are the conductors used to transfer data between the computer and the interface.
2. The interface input and output lines, which are the conductors used to transfer data between the interface and the peripheral.

Handshake lines serve to synchronize the interface and the peripheral. The meaning of each line depends on the direction in which data is flowing.

Register architecture

In the previous article, we established that each interface would have a unique address on the I/O bus and would be selected via the peripheral address lines of the I/O bus. Each interface was further subdivided into registers which could be individually addressed by a register code. The register model contains eight registers. Four of the registers are output registers, receiving data from the computer. The remaining four registers are input registers, supplying data to the computer. Each register has a special function which is defined by the interface. The 98032A Interface makes the following definitions:

Input registers

Register code	Function
R4	Data input
R5	Interface status
R6	High byte data input
R7	(Not used)

Output registers

Register code	Function
R4	Data output
R5	Interface control
R6	High byte data output
R7	Data transfer trigger

The R4 registers are the primary means of data transfer in the interface. The R4 OUT register is directly connected to the interface output data lines and the R4 IN register is connected to the interface input data lines. When the computer places information into the R4 OUT register of a 98032 interface, the data pattern appears on the data output lines. A reading of the R4 IN register provides an image of what is in the interface's R4 input register which may or may not represent the current state of the interface's input data lines.

Note that the R7 OUT register is called the data transfer trigger. When used in conjunction with the R4

The peripheral handshake

registers, the R7 OUT register forms a handshake mechanism which effects data transfer between the fast computer and the slower peripheral.

Before discussing data handshake however, four more registers need to be discussed. The R5 IN register contains several pieces of important information. Only the lower eight bits of this register have been implemented. The meanings of these numbered bits are as follows:

Interface status (R5 IN) register

7	6	5	4	3	2	1	0
INT	DMA	1	0	IID	IOD	STI1	STI0

The INT and DMA bits are used for I/O operations called interrupt and direct memory access respectively. These are advanced I/O techniques and will be discussed later in this series.

Bits five and four are interface identification bits. The 10 pattern identifies the 98032A interface as a type two interface, 10 being two in binary notation. Software in the computer uses the interface identity to decide how to communicate with the interface.

The IID and IOD bits are also used by the computer software. IID stands for invert input data while IOD stands for invert output data. These bits allow the computer-interface combination to communicate with peripherals using either positive-true or negative-true logic on the data lines.

It is important to note that the data inversion occurs in the computer and not in the interface, and that the computer may choose to ignore these bits in certain classes of I/O operations.

Another two bits

The two remaining bits of the interface status register, STI1 and STI0 are directly connected to two input lines. These two lines are general purpose and can be used for any user-defined function.

Interface control is effected through the R5 OUT register. The bit pattern for this register is as follows:

Interface control (R5 OUT) register

7	6	5	4
INT	DMA	RESET	AHS

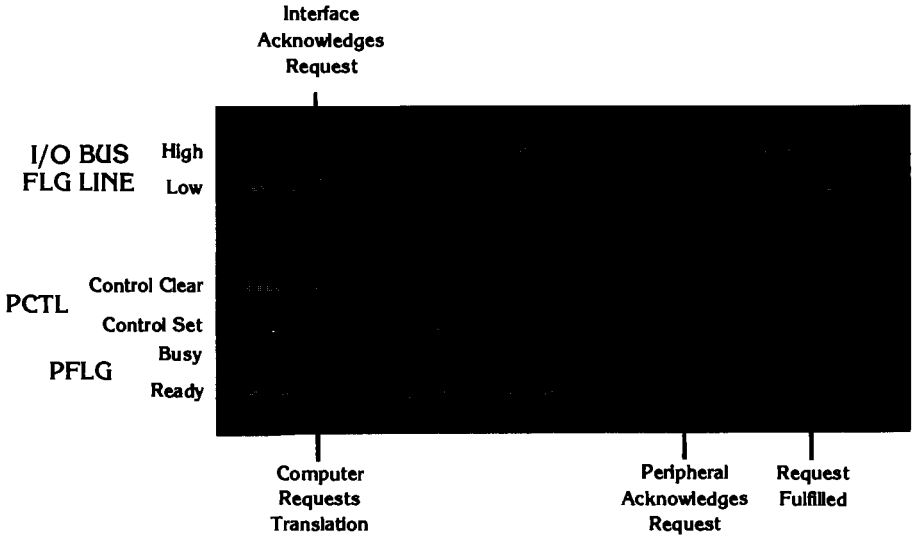
3	2	1	0
X	X	CTL1	CTL0

The INT and DMA bits are used in the interrupt and direct memory access modes mentioned earlier. The RESET bit is used to place the interface in the initial, power-on state. In addition, when the RESET bit is set, a reset signal is sent out on one of the 98032A peripheral lines.

The AHS bit is the auto handshake bit. When this bit is set, the R7 DATA TRANSFER TRIGGER is not needed. This mode is useful for higher speed operations and is usually used by the internal software only. Bits three and two are unused.

The CTL1 and CTL0 bits are directly connected to output lines. These lines are separate from the output data lines and may be used to control the peripheral device. Such an application might be to latch the door of a printer while it is printing.

The R6 registers are data registers similar to the R4 registers. When the 98032 is set to the "byte" mode, the upper eight of the 16 data lines, in both directions, are allocated to the R6 registers instead of the R4 registers. This splitting of the two sets of 16 data



Handshaking between the computer and the interface, and between the interface and the peripheral involves the same basic sequence of events. The diagram shows related changes on three key lines.

lines into four sets of eight data lines is useful for some peripheral devices with unusual protocols.

Peripheral handshaking

Placing data on the output lines or reading the levels of the input lines connecting the interface to the peripheral device is not sufficient for smooth data flow. A set of signals signifying "new data ready" and "ready for new data" is needed.

These two lines are called handshake lines and serve to synchronize the interface and the peripheral. Each controls one line, but the meaning of the line depends on the direction in which data is flowing. We will call the line controlled by the interface PCTL for peripheral control and the line controlled by the peripheral PFLG for peripheral flag. We now have enough connections between the interface and the peripheral to discuss handshaking.

Data output

Output is the simpler of the two data transactions. As mentioned before, the computer may place information in the R4 OUT register, setting the interface data output lines. It may then perform an R7 OUT operation, starting the handshake mechanism.

The interface recognizes the R7 OUT operation and causes the PCTL signal line to change from the clear state to the set state. The transition is a signal that "new data is ready" and that the peripheral should accept this new data.

The peripheral responds by changing the PFLG line from ready to busy, signifying that the data has been recognized and is being processed by the peripheral.

From the time that the computer performs the R7 OUT operation to the time that the peripheral returns to the ready state after processing the information, the interface is busy transferring the information placed in its R4 OUT register.

It is extremely important that the computer not access the R4 OUT register before the transaction has been completed. For this reason, the interface and the computer have a handshake mechanism also. While the interface is busy with a transaction, it will indicate this situation to the computer on the interface flag line.

Data input

Data input from a peripheral is a slightly more complex operation because it is a three-step transaction. The computer first performs an R4 IN operation, reading the interface's R4 IN register. This operation is a dummy, and the information obtained is discarded because the interface did not have time to request a piece of information from the peripheral. The initial R4 IN serves to place the interface into the input mode and to set the peripheral I/O line to input.

The computer then performs an R7 OUT operation. As in the data output transaction, this causes the interface to set the PCTL line, signifying to the peripheral device that a piece of data has been requested.

The peripheral signals that it is busy and performs whatever operations are necessary to obtain the requested data. It then places the information on the data input lines and sets the PFLG line to ready.

When the peripheral returns to the ready state, the transition on the PFLG line holds, or "latches" the states of the data input lines into the R4 IN register and causes the interface to signal ready on the flag line. The computer, which has been waiting for the interface to signal ready, now performs a second R4 IN operation. The transaction is complete.

"Latched" lines

There may be times when peripherals are so simple that they are incapable of performing the two-wire handshake. In these instances the PFLG and PCTL lines may be tied together so that the interface handshakes with itself. This results in 16 "latched" output lines and 16 input lines which may be read on demand.

Most peripherals using the parallel interface use only eight bits. This allows two raised to the eighth power or 256 combinations. If these combinations are treated as character codes, then numerals, upper and lower case letters, punctuation marks and other characters can be represented.

There are notable exceptions however. The 9885 Flexible Disc Drive uses the full 16 bits because Hewlett-Packard desktop computers are organized as 16-bit machines. The 9862A Plotter uses 12-bit instructions. Many analog-to-digital converters come in 10-, 12- or 16-bit sizes. All of these applications are served by the single 98032 16-bit Interface.

The System 45B . . .

. . . 449K bytes of user memory . . .

by Doug Newlin, Hewlett-Packard Company, Desktop Computer Division

The new System 45B Desktop Computer represents the most advanced class of compact, interactive and powerful computing devices available today. Its unique, integrated system architecture combines all the necessary ingredients of computing power and versatility in one neat package:

- An efficient operating system,
- A graphics display device (CRT),
- An input device (keyboard),
- A large user memory (up to 449K bytes),
- Complete I/O capability and
- Mass storage capability (tape cartridge drives)

System 45B is an individual computer work station that is ready to start solving problems as soon as you turn it on. With it you can develop a solution, check the result, perform side computations, re-iterate the problem until you get the best result and then print-out a hard copy of your work.

The HP-enhanced BASIC language provides a conversational style for problem-solving. Easy-to-learn, literal commands and syntax coupled with familiar algebraic operators and expressions make HP-enhanced BASIC a breeze for programmers, experienced and novice alike.

With it, the scientist or engineer can envoke many of the powerful features found in other languages such as FORTRAN and APL to streamline high-order math calculations and other complex data manipulations.

The System 45B's memory is an expandable problem solver:

Operating System — 120K bytes built in

User Read/Write Memory — 56K bytes built in, expandable to 449K bytes

Optional Read Only Memory — up to 720K bytes

Since the operating system resides in its own ROM, the entire user memory (56K to 449K bytes) is available for programs and data.

Two upgrade kits, allowing any configuration of the HP System 45A to be converted to an equivalent System 45B configuration, are also available.

Integration: combining computing power and peripherals.

The strength of the new computer lies in its integration of a powerful computing device with the required peripherals into a single, manageable unit. The 12-inch (310-mm) CRT shows data listings, program segments or graphics images.

The keyboard of the System 45B features the full 128-character ASCII set, color-coded and configured like a standard office typewriter. In fact, the keys are staircased like an electric typewriter and require the same keystroke and movement. Alternate character sets are available for German, Spanish, French, Japanese and Swedish/Finnish.

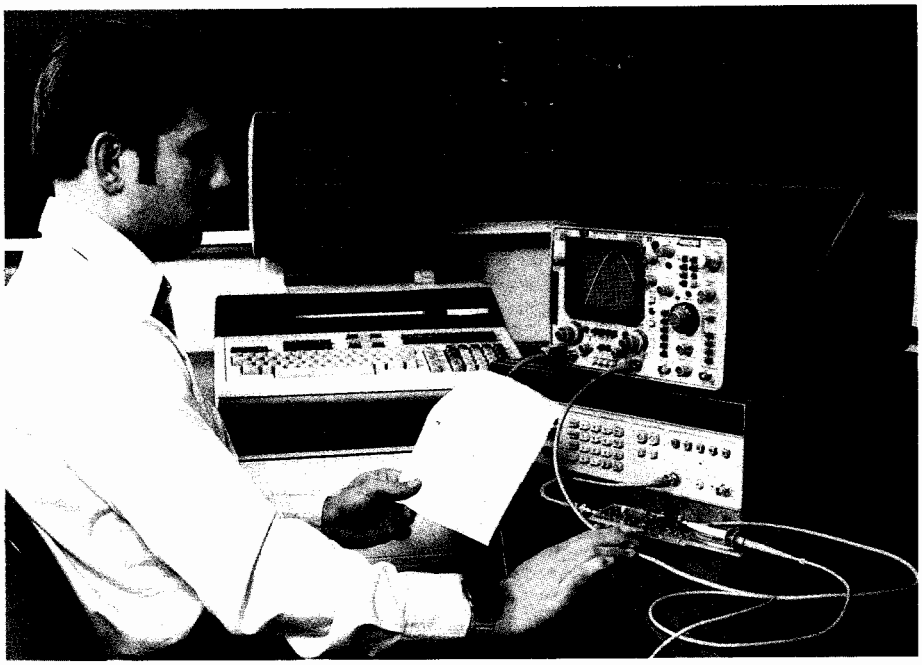
An optional built-in thermal line printer can output plots or data listings on command. The printer, a product of HP's advanced thin-film technology, is quiet, prints up to 480 lines per minute and can generate customized symbols or logos.

Two tape cartridge drives can be built into the computer (one is standard, the second optional). They provide an easy-to-use storage capability of 217K bytes (about 847 physical records) per tape cartridge.

Enhancements over System 45A/S

The System 45B has several features not available on the System 45A, including multi-terminal capability, advanced programming ROM, selective re-write on CRT, interaction with CRT in GRAPHICS mode, and five nationalized keyboards.

Significant enhancements over System 45A include a capacity of 16 additional ROMs rather than 8; increased line number capability to 32,769 from 9,999; tape cartridge directory in memory rather than on tape; read/write memory increased to a range of 56K to 449K bytes (from a range of 13.5K to 62K bytes); CRT buffer capacity increased to 3,584 words from 1,800 words; recall buffer capacity increased to 650 words from 172; and available software packs increased to 45 from 21.



. . . with heavy software backing

Owners of the new System 45B will have a large selection of software from which to choose. Hewlett-Packard has introduced 45 software packs which operate on the new desktop computer. Of the 45 packs, 17 are adaptations of previous packs, and 28 are entirely new.

These packs are designed to take advantage of the System 45B's features by utilizing the larger read/write memory options and addressable cursor. The following briefly describes the new packs available in each category.

Electrical engineering

AC Circuit Analysis software allows you to model your circuit and examine its performance quickly, easily, and accurately. By simulating designs, you can recognize design problems early in the development process, before large investments have been made.

Digital Simulation software greatly reduces the time-consuming and tedious handwork of verifying logic behavior and improving the accuracy of complex circuit designs. The pack provides a comprehensive library of logic elements for use in constructing your circuit.

In addition, the pack offers an assortment of macro devices. These devices represent often-used circuit components and they allow you to treat complex functions such as counters and decoders as elementary building blocks. The pack further provides, through a special MACRO CREATION function, the capability of constructing your own macro or MSI device and then storing it for future use.

The *Waveform Analysis* software consists of the following routines:

Single data input
Double data input
Fourier series coefficients for equally-spaced data
Fourier coefficients for unequally-spaced data

With these four routines, you can process digital-signal data to achieve such results as frequency domain and time domain measurements.

Structural engineering

Computerized Structural Design, Inc., Milwaukee, WI, and Hewlett-Packard have developed a series of 16 application programs for both analysis and design of commercial, institutional and industrial buildings and structures.

The structural analysis program series covers simple beam spans through planar frames of any configuration.

The design program series covers both steel and concrete members according to the latest AISC and ACI design codes.

To incorporate the concept of interactive design, data files from selected analysis programs can be accessed directly by certain design programs, thus saving time and avoiding data handling errors.

The expressed need for cost accounting has not been overlooked. The *Job Cost Accounting* program provides both periodic and summary reports on cost and status information for on-going design projects.

Statistics

As an extension of existing statistical analysis packages, an *Analysis of Variance Library* has been added. Using the same data structure as the other statistical analysis programs, this package contains routines for the analysis of data from statistically-planned experiments.

The pack will handle a number of designs including factorial, nested, split plot, one-way, two-way unbalanced, and one-way with covariate. In operation, the program will print the ANOV table, and produce the Literaction Plot and the Multiple Comparison Plot on the graphics CRT.

Monte Carlo Simulation Utilities software is intended for people performing complex statistical simulations. This pack contains a random number generator which will produce 10^{12} pseudo-random numbers before repeating. This uniform random number generator is a binary program to improve speed and periodicity. Random deviates are generated for a large variety of statistical distributions.

In addition to the simulation utilities, two elementary sampling utilities are included. The first of these

System 45B software packs

Electrical engineering

AC Circuit Analysis	(part number 09845-12620)
Digital Simulation	(part number 09845-12610)
Waveform Analysis	(part number 09845-12600)

Structural engineering-analysis

Beam Span Analysis	(part number 09845-12760)
Continuous Frame Analysis	(part number 09845-12750)
Multi-Story Frame Analysis	(part number 09845-12770)
General Frame Analysis	(part number 09845-12780)
Truss Analysis	(part number 09845-12790)
Dynamic Load Analysis	(part number 09845-12880)
Section Properties	(part number 09845-12900)

Structural engineering-design

Steel Beam Design	(part number 09845-12840)
Steel Column Design	(part number 09845-12850)
Composite Steel Beam Design	(part number 09845-12860)
Reinforced Concrete Beam Design	(part number 09845-12810)
Reinforced Concrete Column Design	(part number 09845-12820)
Flat Slab Analysis and Design	(part number 09845-12830)
Pre-Stressed Concrete Beam Analysis and Design	(part number 09845-12870)
Footing Design	(part number 09845-12890)
Job Cost Accounting	(part number 09845-12910)

Medical

Clinical Laboratory Library	(part number 09845-14350)

Statistics

Basic Statistics and Data Manipulation	(part number 09845-15100)
Regression Analysis Methods	(part number 09845-15110)
Statistical Graphics	(part number 09845-15120)
General Statistics	(part number 09845-15130)
Non-Linear Regression	(part number 09845-15140)
Monte Carlo Simulations Utilities	(part number 09845-15160)
Analysis of Variance Library	(part number 09845-15170)
Numerical Analysis Library	(part number 09845-10350)

Business management

Graphic Presentations	(part number 09845-10540)
Linear Programming	(part number 09845-10600)
Forecasting	(part number 09845-10610)
Text Management	(part number 09845-10620)
List Management	(part number 09845-10630)
Payroll	(part number 09845-10850)
Inventory	(part number 09845-10860)
Project Management	(part number 09845-11100)

General software

Graphics Utilities (2D)	(part number 09845-10050)
Computer Games Library	(part number 09845-10110)
HPL to System 45B BASIC Translator	(part number 09845-10130
Asynchronous Terminal Emulator	(part number 09845-10140)
Utilities II Library	(part number 09845-10150)
Terminal Manager	(part number 09845-10160)
Forms Utility	(part number 09845-10170)
Utility Library	(part number 09845-10200)
9830/31 to System 45B Translator	(part number 11141-10190)

routines allows election of a simple random sample without replacement. A second routine allows an array of numbers to be arranged in a random order.

Business management

Two new packs and one very recent pack comprise the added software available in the business management area.

The *Graphic Presentations* pack is designed to create, in an interactive graphics mode, overhead slides for management presentations. The pack features the capability to create text in four different styles in up to nine different text sizes. In addition to text, a variety of bar, pie and line charts can be created. Once slides have been created and stored, they can easily be recalled, scaled down, and combined to create a document consisting of text and charts (see article on page 12 for details).

The *Text Management* pack provides the capability to enter and edit text in an interactive mode. Many new features have been added to this pack, which replaces the System 45A *Text Processing* pack. Some of these new features include proportional spacing for right-hand justification, enhanced SEARCH/REPLACE to allow automatic or manual replacement of a given word string and word wrap-around to automatically pull a word to the next line if a margin is exceeded.

Another relative newcomer to the business management category of software is *List Management.* It is designed to solve two common business problems; creating mailing labels for customer and other mailing lists, and handling small data management needs. The pack allows the user to set up a small data list, specifying as many fields for each record as the user finds necessary, with user-defined field lengths.

General software

The *Forms Utility* pack can be tied to a user-specified program to enhance data input. The pack consists of three modules; BUILDFORM, USEFORM and FILLFORM. It can create a screen image utilizing the line drawing set. Once the image is created and stored, it may be accessed through the subprogram USEFORM, which is incorporated in the users program, or it may be stored as a string by utilizing the FILLFORM module.

The *Asynchronous Terminal Emulator* provides asynchronous terminal capability for the desktop computer, allowing it to go on-line to most large computers that support an asynchronous ASCII terminal. The pack also provides the ability to send data from a file on the mass storage device to the host computer and to record data sent from the host. In addition, a graphics compatibility feature permits the desktop computer to emulate certain graphics terminals.

The *Terminal Manager* provides a framework for writing applications software for a system including up to seven asynchronous, ASCII terminals. Two utilities are included: one tailored for a terminal operating in character mode and one tailored specifically for HP terminals operating in block mode.

Utilities II is a collection of routines with a wide range of applications. The documentation utilities include a cross-reference program, a list formatter and a routine that searches for up to 20 strings in a program file.

The thermal printer enhancements portion of the Utilities II pack includes an interactive program to define your own characters, a program that prints headers in large block letters and a program that prints banners in characters that are the full width of the printer. Base conversion routines include decimal to binary, decimal to octal and a general routine for converting from one number base to another. ◼

Programming Tips

Instant success using System 45A/B graphics

By Donna Kimble, System 45 Instructor, Hewlett-Packard Company, Desktop Computer Division

Any manager, engineer or secretary can create graphic outputs on the System 45 CRT and get printed copy from the internal printer. All you need is the Graphics Option and the Printer Option.

1. Type PLOTTER IS "GRAPHICS"
   Press EXECUTE
2. Type LETTER
   Press EXECUTE
   Type your message, using the display control arrows ↑ ← → ↓ to move the cursor to any part of the screen. To gain finer control over the cursor, press the SHIFT key and the display control arrows at the same time: this will cause the cursor to move 1/10th of a character space at a time.
   When finished typing your message,
   Press STOP
3. Type DUMPGRAPHICS
   Press EXECUTE
4. If you want another copy, repeat Step 3.
5. If you want to add more to your graphics, repeat Steps 2 and 3.
6. To draw a box around the graphics output in the CRT, add following Step 1:
   Type FRAME
   Press EXECUTE
7. If you want to create larger letters, insert before Step 3:
   Type CSIZE 6
   Press EXECUTE
   Go to Step 2.
8. If you want to letter vertically, at a 90 degree angle, insert before Step 3:
   Type DEG
   Press EXECUTE
   Type LDIR 90
   Press EXECUTE
   Go to Step 2.

You can also use this capability to add your own text to any completed plot when the output remains in the CRT. Simply begin at Step 2, *not* Step 1. Step 1 erases the previously-stored graphics output.

The CSIZE statement specifies character size as a percentage of the height of the CRT. The standard is CSIZE 3.3; with CSIZE 10 the characters are 10 percent of the CRT height.

The LDIR statement specifies rotation of the lettering as a counterclockwise angle from the horizontal. The standard is LDIR 0; with LDIR 180 the lettering would be upside down if the DEG (degrees) statement has been executed. K

A fix for backup copy command (9825A)

Submitted by Alberto Rodriquez, Caribe 60, Apt. 4A, Condado Santurce, Puerto Rico 00907

If 9825 users have ever tried to do a backup using the copy 0$, D, S, N$, D, S format of the copy command, they may have realized that although the new file is created, the file, in effect, contains unreadable data. One could easily miss this until there is a need of using the backup file. Only the format using string (or substring) variables as file names has this problem, so a ready subterfuge is available:

```
drive0;renm0$, "FILE1"
copy "FILE1", D, S,
   "FILE2", D, S
drive1;renm "FILE2", N$
drive0;renm "FILE1",0$
```

Although cumbersome, this is the only way to do this backup if the string variable name must be used. K

9862 BASIC language drivers

by Dave Page, Hewlett-Packard Company, Desktop Computer Division

In answer to a number of requests, a set of BASIC language drivers has been written by Pierre Daubine of HP to allow using the 9862A with a System 45 or 35.

The drivers are simply a set of BASIC subprograms that can be appended to your main program and used with CALL statements. The only big drawback is that they don't label.

Here are the available subprograms:

CALL Scale (Xmin, Xmax, Ymin, Ymax)
CALL Penup
CALL Plot (X, Y, P) (P has the same meaning as in the System 45 graphics ROM)
CALL Move (X, Y)
CALL Draw (X, Y)
CALL Xax (Yvalue, Xticspacing, Xstart, Xend)
CALL Yax (Xvalue, Yticspacing, Ystart, Yend)

To use these subprograms, you must reverse the first six numbers in COMMON for use by the subprograms:

COM (Xmin, Xmax, Ymin, Ymax, Scalex, Scaley)

It is not necessary to set these numbers in the main program; the Scale subprogram handles that. It is necessary to declare the COMMON area in the main program, and furthermore, if there are other things in COMMON, these six must be the first ones.

Because of space considerations, we cannot print the entire listing here. If you would like a copy of the listing, please write to Keyboard at the address listed on the back page. We will be happy to send it to you. K

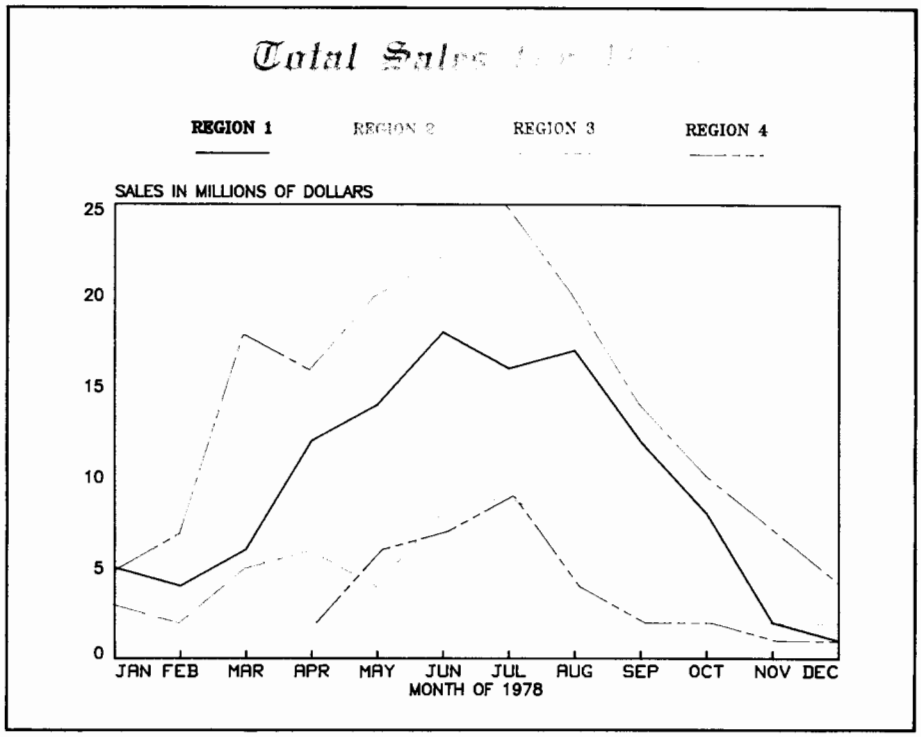
Desktop computers solve problems "graphically"

by Dave Conner, Ron Tolley and Jan Kok, Hewlett-Packard Company, Desktop Computer Division

Presentation graphics is that set of graphic materials which includes transparencies for overhead projection and viewing, as well as material rendered on paper for formal use.

During the past several months, two simultaneous and independent efforts have been underway, both intended to bring better quality presentation graphics to users of HP desktop computers.

One effort, in the laboratories at HP's Desktop Computer Division, Fort Collins, Colorado, produced a comprehensive software pack for the new System 45B. The other effort, by a research scientist at Lawrence Livermore Laboratory, Livermore, California, resulted in a powerful program for producing overhead transparencies using the 9825 Desktop Computer and a 9872A four-color plotter. The following article details the capabilities of the System 45B Graphic Presentations pack. An article on the overhead transparency program for the 9825 will appear in the Jul-Aug issue.



Line charts such as this one can be generated either by drawing with the cursor, or by entering a table of values into the desktop computer, and allowing the software to do the work.

The Hewlett-Packard Graphic Presentations software pack for the System 45B is designed to make it easy for non-technical users to create quality charts and overhead slides. The program is divided into five major areas. These areas are:

1. File management for storing and recalling charts and slides.
2. Chart creation for generating pie charts, bar charts and line charts.
3. Text generation for creating text overhead slides or annotations to graphs.
4. Line drawing for constructing simple figures or tables using arcs and lines.
5. Combining a chart with text for annotations or comparisons.

The entire program is designed around the concept of relabeling special function keys. The special function keys are relabeled on the CRT as new functions are requested. For example, if the LINE DRAWING key is pressed, the special function keys are redefined to allow line drawing functions and new labels are displayed on the CRT to indicate these new functions.

The program is contained on two tapes. Programs on one tape can load the programs from the other tape if needed. The programs are compatible for use with a mass storage device such as the 9885 Flexible Disc. The program is approximately 300K bytes of memory, not including slide data storage requirements.

File manager

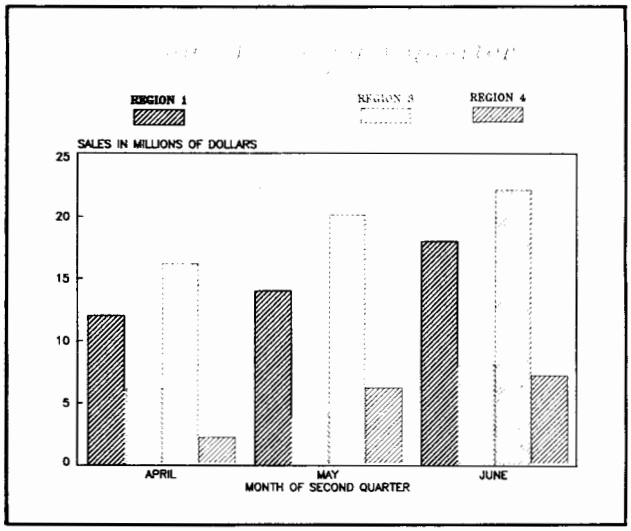
1. Store a new slide.
2. Recall a previously stored slide.
3. Restore a recalled slide that has been edited.
4. Make a copy of a previously stored slide.
5. Print a list of slides that are stored on the storage file.
6. Delete old slides from the storage file.

Line charts:

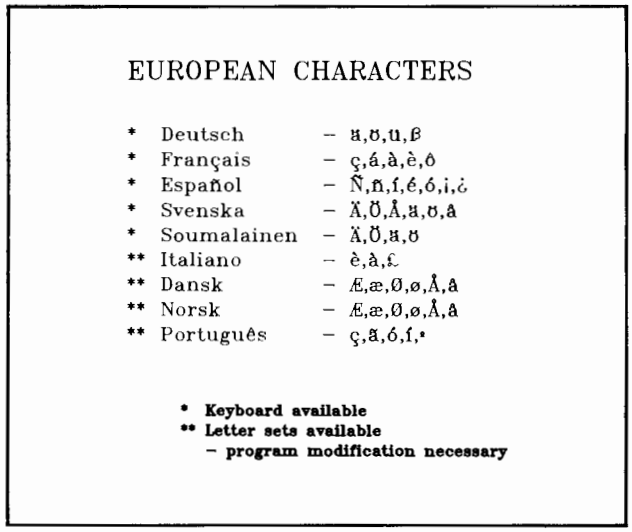
In preparing a line chart or line graph, there are typically two approaches taken. For those who have a chart visualized, it is best to sit down and draw it out. This approach is permitted using the GRAPHIC ENTRY mode. Points indicated on the screen using the graphics cursor are entered into the chart data base.

In contrast, there are those who wish to plot a table of numbers. For these, the TABULAR ENTRY mode allows data to be entered and edited as a table. The data is immediately plotted on the screen.

One of the major concerns of line chart presentation is proper scaling. When the minimum and maximum values are specified, this program selects the "nicest" scaling of the axis. "Nice" scales include numbers like 0, 10, and 500 instead of 37 and 98.6254. Of course, if the range of values changes, simply re-enter the minimum and maximum, and the chart may be replotted immediately.



Like line charts, bar charts can be drawn in GRAPHIC ENTRY mode, or plotted from TABULAR ENTRY. This chart was made with colors available with the Overhead Transparency Kit (see back page).



System 45B keyboards and/or letter sets are available in a number of European languages, making it possible to easily prepare overhead transparencies for non-English-speaking audiences.

Bar charts:

The approach to vertical bar chart preparation is similar to that of line charts. The GRAPHICS ENTRY mode is available for the user with a particular bar chart message in mind, and the TABULAR ENTRY mode is used for charting a set of data. As the user may wish to have stacked bars in addition to clustered bars, both chart types can be prepared.

Slide quality has been a key issue in the design of the software. The texturing of bars has been designed to give crisp, clean slides with no muddying of colors. The textures and colors available provide flexibility while preserving unity and clarity of presentation.

Line drawing:

Line drawing is intended for drawing simple figures and tables. It is not a drafting program, nor is it intended for drawing graphs. It does allow the user to draw straight lines, arcs and circles in any of the plotter pen colors.

Lines and circles may be moved, changed, or deleted using editing functions. For example, construction lines may be drawn for use in construction of a figure and then erased when no longer needed. Lines within an area may also be moved as a block.

Text slides:

All text which is input, including titles and labels on charts, has three attributes associated with each text field. These attributes are:

1. Size, specified in millimeters from 1 to 9 mm.
2. Style, including four letter styles; computer stick, smooth stick, Roman and Old English Gothic. These styles may be specified as straight or slanted (12° italics).
3. Color, with four pens available for plotting on the 9872A plotter at one time, and as many as seven colors.

The text fields may be placed anywhere in the workspace on the graphics screen. The text may be edited, centered, moved, deleted, or a block of text may be moved.

Pie charts:

The pie chart section of the CHARTS program is divided into four main parts. The first, which is duplicated in the TEXT program, plots a chart. The second part creates a chart by asking the user for titles, sector sizes and other necessary information. Sector sizes may be entered either as percentages of the total pie area, or in the user's own units, such as dollars or tons.

The third part allows the user to select various parts of a completed chart and change them. In most cases, the CRT image is immediately updated with the corrected information. The one exception is sector sizes. Instead of replotting an entire pie after each sector size change, the program waits for the user to make all his sector size changes before replotting the pie.

The fourth part of the pie chart section is entered after clearing or editing is complete. It is simply a point from which the user can go back and

Combining charts:

In addition to text and line drawing, a composite slide may include previously-prepared charts. In laying out a composite slide, the rectangular area available for a given chart is delineated. The program then scales and centers the chart to best fit the given area. If this placement is not satisfactory, the chart may be moved and scaled to get a more pleasing result.

For further information on graphics presentation software for the System 45B, contact your local HP sales office, or Dave Taylor, Hewlett-Packard, 3404 East Harmony Road, Fort Collins, CO 80525 U.S.A.

Editor's note: See Update for information about a kit that helps make the most of presentation graphics.

Update

Off-line plotting and printing using 9875A

If you want to store plots that you have generated on a desktop computer, here is an easy way to reproduce copies.

After the plot is perfected in the desktop computer and you are ready to make a hard-copy on the plotter, a 9875A Cartridge Tape Unit can be connected to the HP-IB. Switch the 9875 to "listen-only" mode by setting the address switches to address 30. While the plot is being made on the plotter, the plot commands are also stored on the 9875. Both the plotter and the 9875 must be connected to the bus. The plot cannot be sent out to the 9875 without the plotter on the bus because the plotter needs to send some parameters back to the desktop computer while the plot is being constructed.

Once this plot is recorded, the 9875 can be used in "talk-only" mode (address 31) to drive a plotter that has a "listen-only" mode. Examples are the 7245A and 7225A. This enables the customer to make, without the help of a desktop computer, as many copies of the plot as he needs.

If you are printer-bound because of the speed of your printer, there is a solution to that problem. For example, if you are using a 9871A printer with a System 45, on-line printing speed is limited to 30 characters/second. You can solve this problem by replacing the 9871 on-line with a 9875 Cartridge Tape Unit. The 9875 is set to "Listen-Only" mode and connected to the System 45 with an HP-IB cable, and you run your program as if the 9871 were connected. Your data to be printed is then stored on the tape cartridge in the 9875. Later, you can connect the 9875 (in "Talk-Only" mode) to the 9871 (in "Listen-Only" mode) and print the desired output off-line. The System 45 will not be tied up while you are doing your printing.

Overhead transparency kit

Desktop computer users who have either a 7221A or 9872A plotter can obtain an Overhead Transparency Kit that provides orange, brown and violet, as well as the four usual colors (black, red, green and blue). The kit includes all seven colors in both 0.25 and 0.7 mm-tip pens, solvent to remove errors, and 100 sheets of transparency film.

9874A option 130

Recently Option 130 was added to a number of peripherals. This makes it less expensive for 9830 users to interface to HP-IB peripherals. Ordinarily when ordering the 59405 HP-IB interface, the Extended I/O ROM is included. Ordering the 9874 Opt. 130 provides the 59405 cable but deletes the ROM. This way, if you already have an Extended I/O ROM for your 9830, you need not purchase a second one.

Consumables brochure

The brochure provides a photograph and description of each consumable item for all 9800 desktop computers and peripherals. This includes plotter and printer supplies, optical cards, key overlays, program pads, storage media and digitizer supplies. Ordering information is included in the brochure. The consumables can be purchased through two distribution centers, one in the U.S.A., and the other in West Germany.

The brochure can be obtained through your local HP sales office. Ask for publication number 5953-1007.

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