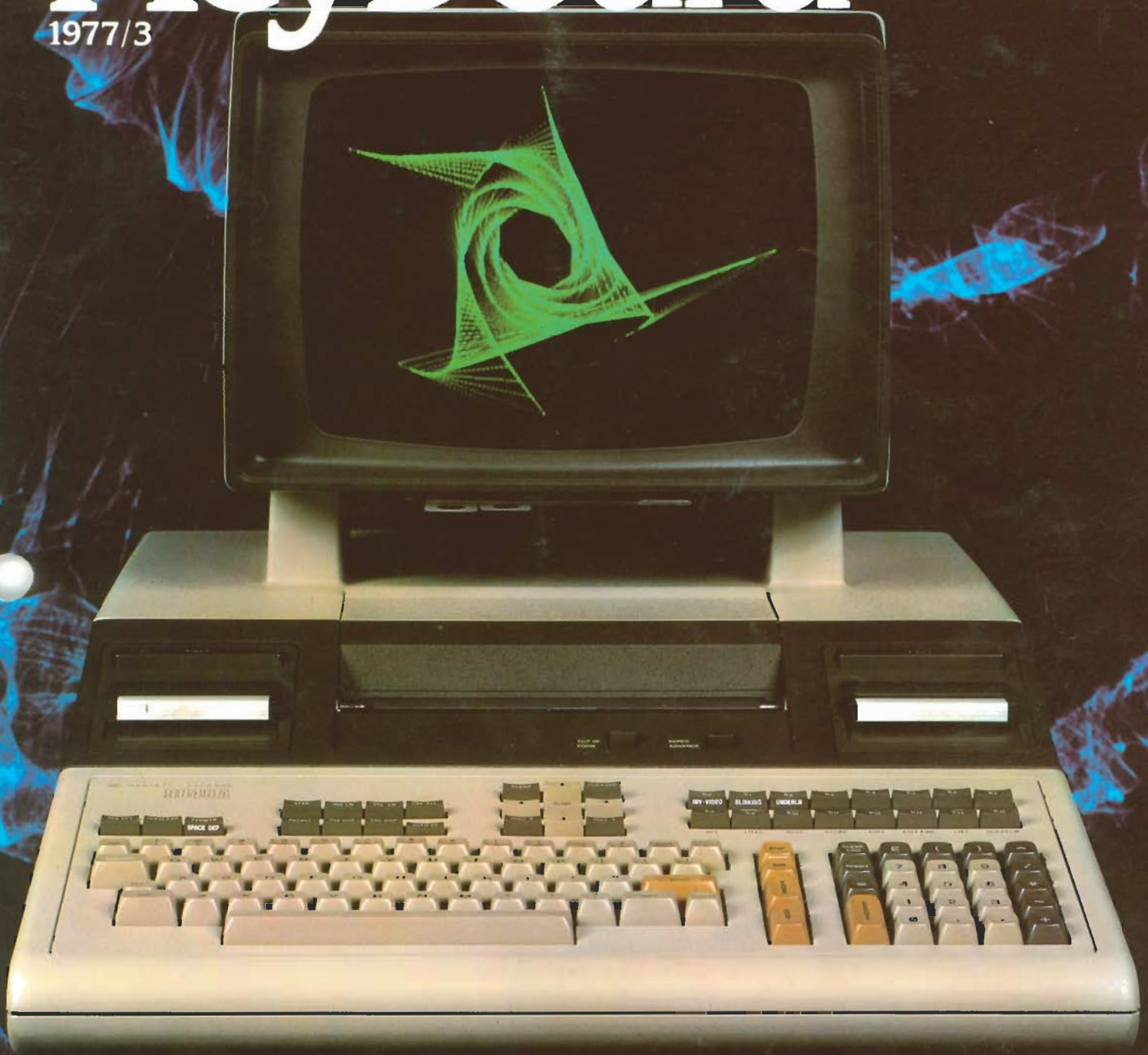
HEWLETT-PACKARD

Keyboard

1977/3



HEWLETT-PACKARD
Keyboard
1977/3

Features

Departments

HP Computer Museum
www.hpmuseum.net

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System 45

A New Breed of Friendly Computers Challenges the Speed, Power, and Memory of Minis.

System 45 is the first of a new type of computing system. Challenging the speed, power, and memory of a minicomputer, yet retaining the convenience and interactiveness of a programmable desktop calculator, it combines capabilities of both to meet the increasing demand for a system that is sophisticated and powerful but still easy to use and readily accessible.

Packaged into a compact, self-contained unit are dual processors, a 12 in. (305 mm) CRT display, thermal line printer, keyboard, four input/output (I/O) ports, special function ROMs, up to 64k bytes of user memory, enhanced BASIC language, and the largest mass memory storage system available in a desktop computer system.

The scientist, engineer, designer, or manager can use System 45 as a problem solver, design tool, management aid, or computing controller in an instrument system. System 45 is especially well suited for those situations where upgrading from a desktop calculator is being considered, or where there is a need to supplement, or even replace, an older, large computer.

The "friendliness" of HP desktop calculators and desktop computers is retained, in both keyboard design and language, with added improvements. For instance, the keystroke on System 45 is the same as on the 9810A, 9820A/21A, and the 9830A/B — very much like a typewriter's. The keyboard and thermal line printer can be ordered in German, Spanish, or French.

System 45 uses conversational BASIC language conforming to the proposed American National Standards Institute (ANSI) standard for minimal BASIC and has been enhanced with many additional programming features. Any program conforming to the ANSI standard can be run on System 45, and the additional features offer further help in structuring programs and data for the operator's — not the machine's — convenience.

Integrated System Architecture

System 45 is an integrated computing system. Its components join into one compact chassis the computing tools required for the job at hand: built-in CRT, optional thermal line printer and tape cartridges(s) with drivers and 98k byte operating system in ROM, up to 64k bytes of user Read/Write memory. Computer-sized problems are solved on site where the problem exists.

Overlapped Processing

There are two processors in System 45 to increase throughput. One is for formatting data and controlling I/O and one is for program execution. This allows program execution and multiple I/O operations to occur concurrently. Depending on the number of peripherals and the program structure, throughput can be significantly increased — doubled, tripled, even more.

Keyboard

The keyboard contains the full 128-character ASCII set and has the feel and configuration of an electric typewriter. Optional character sets in German, Spanish, and French are available. In Space Dependent mode, BASIC keywords and multi-character variables are automatically changed to their proper upper/lower case format, no matter how they are typed in.

There are 16 special function keys (32 shifted) for use as typing and editing aids and immediate execute, continue or store commands. All of the special function keys may be redefined to user requirements. Also, any special function key can be defined to perform interrupt operations — a subroutine may be serviced like a peripheral.

The keyboard also contains keys for CRT editing, program control and editing, and the numeric pad. The Recall and "Autost "keys are especially significant. The Recall key buffer holds 344 bytes of prior entries, which, on the average, is 10 lines. "Autost" is the System 45 auto-start key. When latched down at power on, it automatically loads a previously defined program file and protects against loss of program data due to power outages.

CRT Display

This is a 12 in. (305 mm) diagonal, dual, raster-scan, P31 green phosphor CRT with adjustable brightness. The color, contrast, size, and brillance were chosen for maximum ease of viewing. Brightness can be adjusted for varying environments, from brightly lighted areas to dark ones. Inverse video, blinking, and underlining, which can be used in any combination, highlight selected areas on the screen.

The CRT operates in two modes, alpha-numeric and graphic. Executing a single statement produces a hard copy of the graphics display on the thermal line printer. The CRT also operates independently of user Read/Write memory. There is no perceptible flicker. In the alpha-numeric mode, the CRT displays 24 lines 80 characters wide. The bottom four lines are for input and system messages, and the upper 20 are used for program listings and data.

Thermal Line Printer

The thermal line printer provides 80-character-wide hard copies quickly and quietly. It has twice the speed of previous HP thermal printers (up to 450 lpm) and can underline, print characters 150% of normal height, and generate special or unique symbols, characters, and logos.

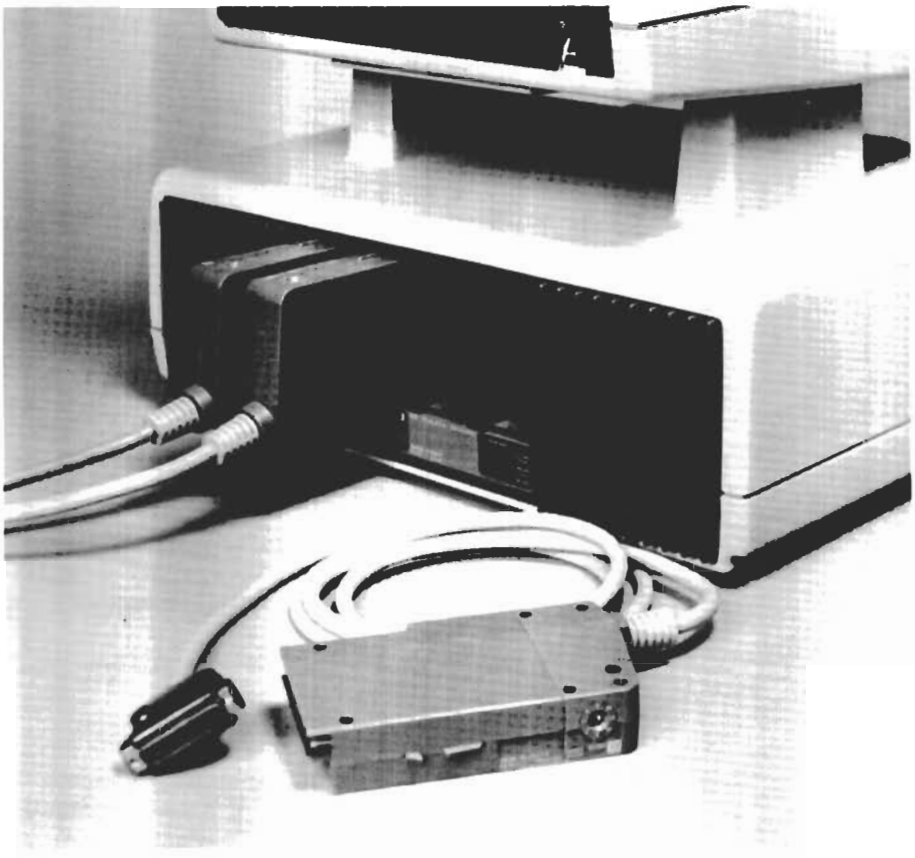
Unified Graphics

Graphics programs can be output to the CRT screen, the 9872A Plotter, or incremental plotters. Graphics displayed on the CRT screen can be transferred to the 9872A with a single BASIC program statement. Vector plotting speed on the CRT is 80 in/s for quickly visible plotted data.
Portions of the image can be changed or removed without erasing the entire display. This allows the user to work with a continual display until it is correct and then transfer the image to the thermal line printer dot for dot. By changing one program statement and rerunning the program, the image can be plotted on the 9872A Plotter.

Data from the CRT can be digitized and the cursor X-Y coordinates returned to the program. This interactive technique is very convenient for design and image analysis. Used with hard or floppy discs, graphics can be transferred to the storage device easily and quickly.

Unified Mass Storage

Data and programs can be stored three types of media; the 217k byte tape transport(s), 500k byte floppies, and the 15M to 50M byte fixed/removable discs. As with Unified



Graphics, changing one BASIC statement in the program will access a different storage device, a particularly useful feature when upgrading to a larger or faster device.

As many as 10 mass storage buffers can be defined to considerably improve throughput during sorts, data base searches, and other file manipulations. Serial and random file organization gives the operator the choice between data compaction and fast file access, depending on the requirements of the application. For verification and data/program integrity, System 45 does three separate read-after-writes if a bit error occurs and maintains a backup file directory automatically for each storage device.

Peripherals

For system expansion and versatility a variety of peripherals for System 45 is offered. Besides the internal thermal line printer, the 9866B Thermal Line Printer, 9871A Serial Impact Printer, and 9881A Line Printer are available for selection of hard copy output suitable to the application.

The 9872A Plotter with four-color capability, 9878A I/O Expander, 9884A Tape Punch, and 9885 M/S Flexible Disk Drive with 500k bytes per disk are also available.

Four Input/Output Ports

System 45 accommodates bit-serial, bit-parallel, BCD, or HP-IB (conforms to IEEE Standard 488-1975) interfaces and is equipped with four I/O ports. It can control or gather data from instruments; 500k byte floppy disks or 15M to 50M byte fixed/removable disc systems can be added. System 45 has 15 levels of programmable priority interrupts.

A real-time clock interface is also available.

Enhanced BASIC Language

System 45's language conforms to the proposed ANSI standard for minimal BASIC and has additional features providing more powerful programming tools and faster execution. Strings can be as long as 32k bytes, and six dimensional numeric or string arrays can be specified, each dimension with its own upper and lower subscript bounds. Element-by-element multiply and divide, row and column summation, and a function of each element in a numeric array or the sum of the entire array are done in one statement. To speed the process of looking for a programming bug, System 45 selectively traces logic and data flow, which can also be recorded on the printer for later analysis.

FORTRAN-like subprograms have Dynamic Memory Allocation. Memory is allocated when the subprogram is entered and restored to the system when it is exited. Since a subprogram resides in a separate environment, the variables used will not conflict with those in the main program. Programming projects may be broken into modules and assigned to several programmers, each using his or her own variable designations, and the modules combined into a complete package without complications.

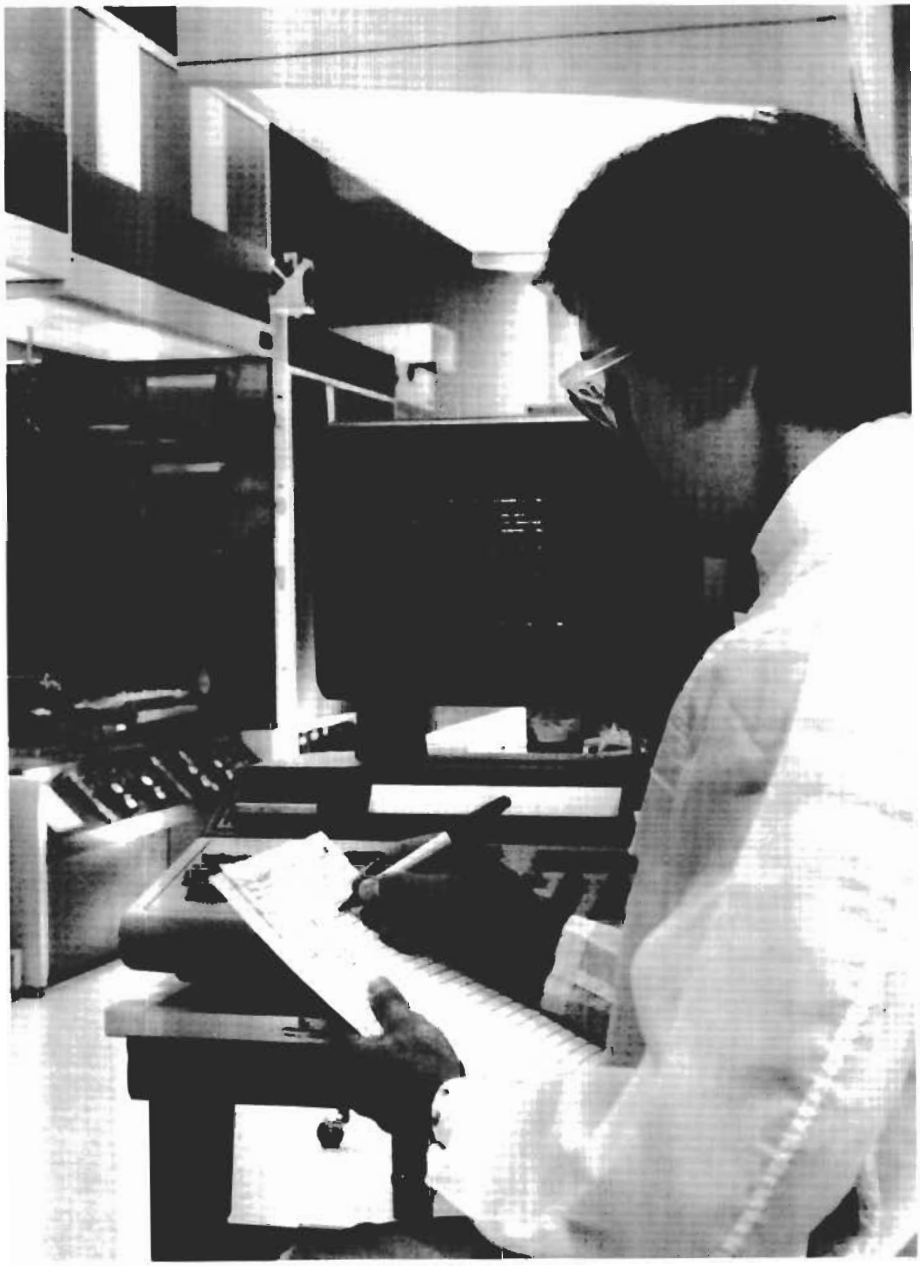
For clarity of program listings, names using as many as 15 characters can be ascribed to line labels, variables, and subprograms. Lines can be indented, and remarks can be made on the same line as program statements.

Software

- Utility Library
- Numerical Analysis Library
- Basic Statistics & Data Manipulation
- Regression Analysis
- Waveform Analysis
- Text Processing
- Forecasting & Graphics
- Linear Programming
- Inventory
- Payroll

The Utility Library package is included at no charge with each System 45. It contains commonly used computer routines for user convenience and quick start-up. Some of the programs included are routines for numerical integration, sorts, graphs and charts, and regressions.

All Hewlett-Packard software packages are designed to give the user standard routines common to the application for smooth transition to System 45.

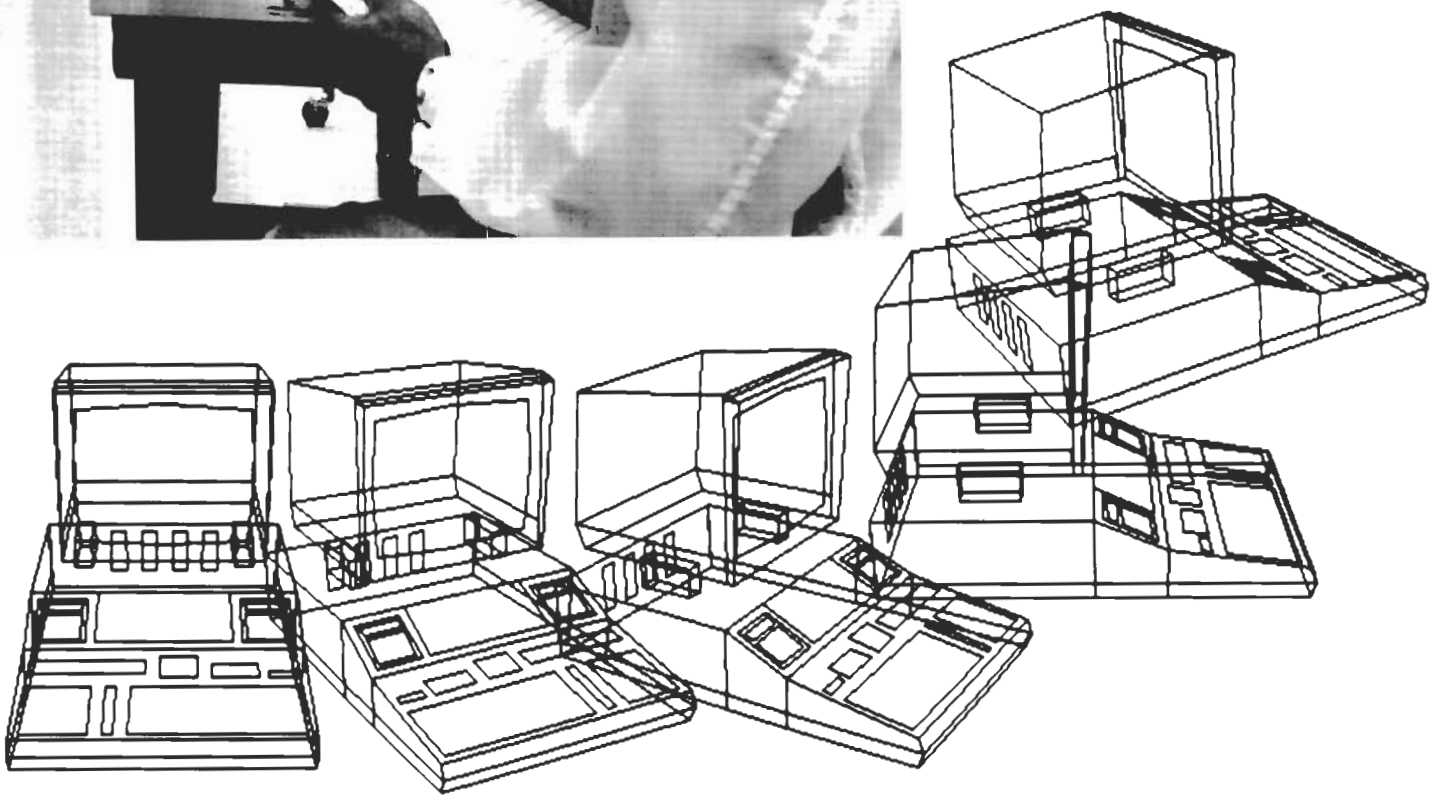


Applications

System 45 is designed for the user whose work requires on-site, no-delay access to a computing system and involves the following:

- Scientific computation and data analysis
- Engineering design
- Data acquisition and control

Scientific computation and data analysis. System 45's speed, memory, and graphics are important to these applications, as are many of the software packages available. Routine, repetitive tasks are performed quickly and simply. Investigation of alternatives is also simplified using the CRT in graphics mode for visual checks, corrections, and confirmation. Unwanted data or lines can be erased and the finalized version dumped to the thermal line printer for a dot-for-dot



hard copy record. Complex routines are easily handled by System 45 with its large internal memory and enhanced BASIC language.

Engineering design. System 45 is accessible when and where it is needed —on the engineer's desk or in the engineering group — a complete design system. The graphics feature is especially useful in design formulation/analysis and in simulation. System 45's enhanced BASIC is powerful, yet surprisingly simple. Customized software is developed in a straightforward, easily understood manner.

Data acquisition andcontrol. Five interfaces and four I/O ports offer versatility and easy system expansion and/or change. System 45 has 15 levels of programmable priority interrupt for controlling the most complex instrument systems.

Other applications. Management science and business administration are often of concern to the scientific/engineering user too. Budget control, forecasting, and job scheduling are a few examples. System 45 and either user-developed or HP-supplied software easily handles such jobs. The Forecasting & Graphics and Text Processing software packages are particularly useful for originating reproducible management reports complete with plots and charts.

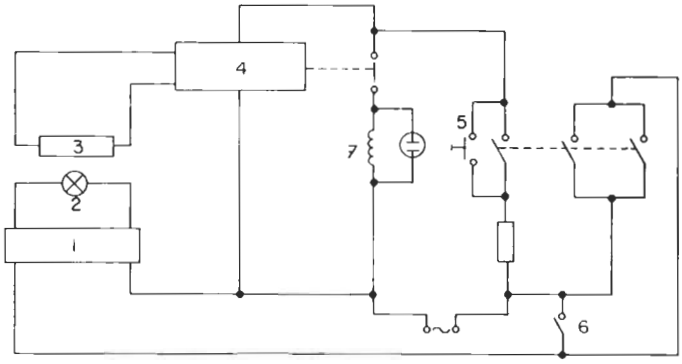
To learn more about this new type of computing system — interactive and accessible, yet with more power, speed and memory than any other desktop computing system — please contact your nearest Hewlett-Packard sales office or write to KEYBOARD, P.O. Box 301, Loveland, Colorado 80537, U.S.A.

END

Automatic Switch-off for the HP 9810A

by Karel Prochaska and Pavel Capek

Figure 1.



1 - Calculator HP
2 - Status
3 - Photoresistance
4 - Amplifier
5 - Start
6 - Manual Switch
7 - Relay

Figure 2.

The members of our industrial engineering department use the HP 9810A to solve numerous problems in research, chemical and system engineering, economy, etc. Many technical and match problems require the use of various iterative or even stochastic methods (including simulation) that often are time consuming. This limits our ability to take full advantage of the calculator for immediate and direct problem solving by the greatest possible number of users.

To meet the situation, we shifted the time-consuming calculations into the evening hours. They now are started near the end of the work day and the calculation process takes place after working hours in the absence of an operator.

The technical solution is based on the fact that the STATUS light is activated if an inadmissible step occurs. This signal is transmitted by a photo resistance probe (Figure 1) to a switch-off relay (Figure 3). Figure 2 shows the wiring scheme.

After the program is started, the photo resistance probe (removable) is placed over the STATUS indicator light. The terminating program steps take, for example, the following form:

..... CLR 20
..... DIV 35

thus stopping the calculation and activating the STATUS light. The circuitry then disconnects the calculator.

Another combination of program instructions can be applied, of course, for obtaining the same results.

About the Authors

Both authors are employees of Severoceske chemicke zavody (North Bohemian Chemical Works), Lovlsice, Czechoslovakia.

Karel Prochazka has completed his studies for Technical High School and works in the field of value analysis. His hobbies are radio engineering and motoring.

Pavel Capek acquired the same high school education and is engaged in labor organization, especially in specific organizational methods (MTM, etc.). His hobbies are motoring and aquatics.

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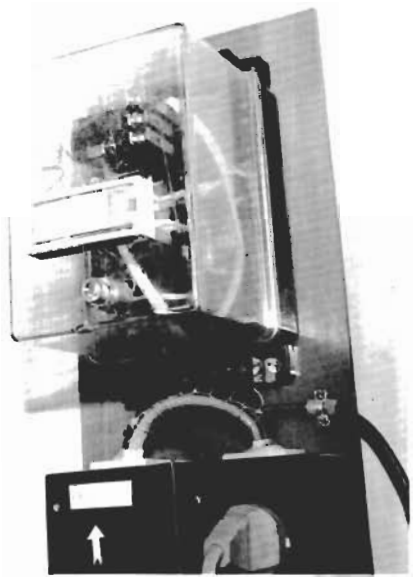


Figure 3.

Pavel Capek

Karel Prochaska

The MED Project

(Minimum Energy Dwelling)

Researching ways to reduce energy use in the home

Southern California Gas Company

Twenty percent of the energy consumed in the U.S. is used in the home — half of it for heating and cooling the interior, about 15% for water heating, and the rest for appliances and lighting. If home energy consumption could be reduced by 50%, 300,000 barrels of oil a day could be saved by 1985.

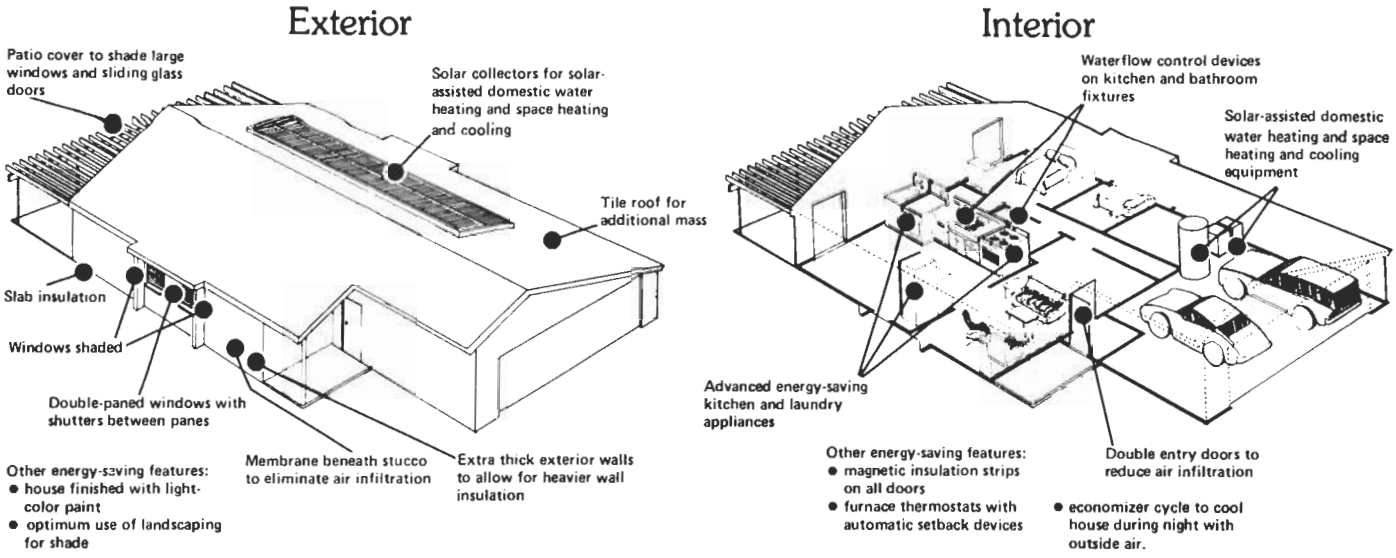
Two experimental homes in Southern California have been built to demonstrate that homes using at least 50% less energy can maintain the living standards and comfort enjoyed by the typical U.S. family in a conventional home. The project is called MED (Minimum Energy Dwelling) and is being conducted by the Southern California Gas Company, a utility company; Mission Viejo Company, a residential construction company; and the U.S. Department of Energy. A secondary goal is to encourage the construction industry to adopt some or all of the energy-saving features used in the building of the MED homes. The 9825A is used to gather, reduce and report test data from sensors installed inside and outside the MED homes.

The two homes built for the MED project are identical. One of the 1150 sq. ft. (106,8 m²), three bedroom, Spanish contemporary style homes is occupied by a "typical" U.S. family of father, mother and child and the other is open for tours for the building industry and the general public.

Energy usage of both MED houses is measured and compared with the energy usage from a sample of similar homes not equipped with the MED energy-saving features. Most of the equipment and materials used are currently available and are either cost competitive or have homeowner benefits that outweigh the additional cost. The only exception is the experimental solar-gas energy system, which is more expensive than conventional equipment at this time.

Some of these features are:

- Insulation of the concrete slab on which the house is built to block heat loss to the outdoors and underlying earth.
- Use of mastic, a putty-like sealer, between the concrete slab and the house to prevent air seepage into the house.
- Exterior walls built of 2 × 6 inch studs spaced 24 inches apart instead of the normal (in the U.S.) 2 × 4 inch studs spaced 16 inches apart. The volume of wood used is the same, but the 2 × 6 inch studs allow more insulation to be used. The roof raftering is 2 × 10 inches spaced 24 inches apart instead of 2 × 8 inches spaced 16 inches apart for the same reason. The greater depth of insulation provides almost twice the protection in the walls and about 35% more protection in the roof.
- 8 mil plastic, instead of standard tar paper, used for moisture penetration prevention. The plastic is also being tested to determine if it provides a better barrier against outside air filtration.
- Vertical wings on each side of the windows to reduce the amount of sunlight hitting the panes and a 3 ft. (1 m) roof overhang to further reduce the amount of sunlight on the windows and sides of the house. In Southern California, more energy is used cooling inside air than heating it.
- Other shading or reflecting techniques. The patios are roofed to help shade the house and the yard is landscaped to take advantage of shade thrown by trees, bushes and other plants. The house is painted a light color to reflect sunlight.
- A vestibule with an inner and outer door, something like an airlock, to minimize exchange of inside, treated air and outside air.
- A hollow steel entry door with a plastic foam insulated core. The door is fitted with a magnetic rubber gasket doorstop like those used on refrigerator doors to keep conditioned air from escaping.
- Wood-framed windows with removable double glass inserts. Small adjustable louvers, looking much like Venetian blinds, fit between the panes so that sunlight can be blocked out.
- A red tile roof, which was chosen because it heats up slowly. During the day, the roof remains relatively cool and thus does not contribute to the need for cooling the inside



Workmen are blowing the first coat of stucco on one of the specially built MED homes. Beneath the stucco is 8 mil plastic wrap — rather than standard tar paper — to help seal the homes from outside air. Vertical shading wings reduce the amount of sunlight striking the double-pane windows.

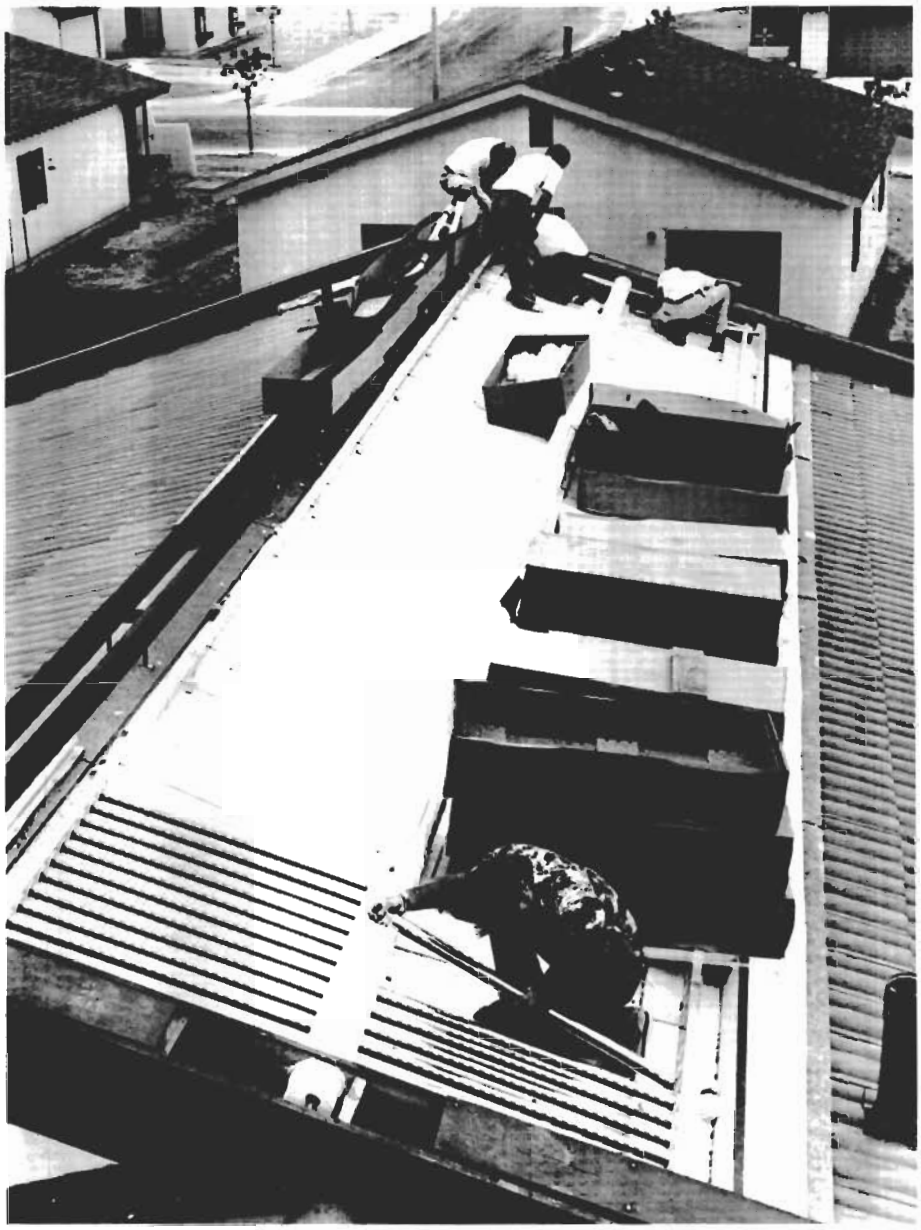
temperature. During the night, when heat may be needed, the roof will help maintain the inside temperature.

•An economizer system, which senses the inside and outside air temperature and humidity. When the outside temperature reaches a predetermined level, the air conditioner is turned off, a fan draws in outside air, and a relief damper is opened to flush the hot air from inside the house. When the outside temperature is not at a comfortable level, the economizer system causes the air conditioner or furnace to operate and maintain a comfortable temperature in the house.

•Home appliances selected for their energy-saving features. The gas kitchen range and clothes dryer have no pilot lights. Self-energizing starters light the range burners. The range also has a fan-driven convection oven that bakes and roasts in half the usual time. The refrigerator is modified so that heat from the compressor and condensor is channeled outside during the summer and into the house in winter. The clothes washer and dryer are located behind weather stripped doors to isolate the heat generated when in use.

•Pre-blended water of a specified temperature chosen by pushbuttons. Instead of hot and cold water faucet handles, there is a panel of buttons from which to choose the water temperature needed. The water is mixed at the water heater and is fed through a single insulated pipe.

•Each water outlet in the house is fitted with a water-saving device.



An array of solar collectors is mounted on the roof of each MED home. The collectors capture the sun's energy to provide heating, cooling and domestic hot water for the house.

Day and night thermostats and a clock are used to control the demand for heating and cooling.

The Mission Viejo Company estimates that the added features, not including the solar system, increase the cost of a home by about 10%.

•Natural gas-assisted solar energy system. The homes are heated and cooled and the domestic water supply is heated by solar energy. The heat storage medium is water. On clear, sunny days the solar system provides all the energy needed. Natural gas is used only when solar energy is insufficient. Heating and cooling are accomplished by a single-coil air handler, which has either chilled or heated water running through it. The hot water is supplied directly from the solar system's 500-gallon water tank, and the chilled water comes from a hot water-fired absorption chiller. The domestic hot water, after being pre-heated by solar energy, is delivered to an experimental heat pipe water heater, which will heat the water to the required temperature if it is not already hot enough.

Many of the highly accurate sensors were built in during construction of the homes. More than 100 readings of temperature, flow, wind, humidity, and electrical usage are read into the 9825A every 30 minutes.

The 9825A's Role

Southern California Gas Company is responsible for data gathering and analysis. The results will be shared with other gas utility companies, construction companies, and the public in general.

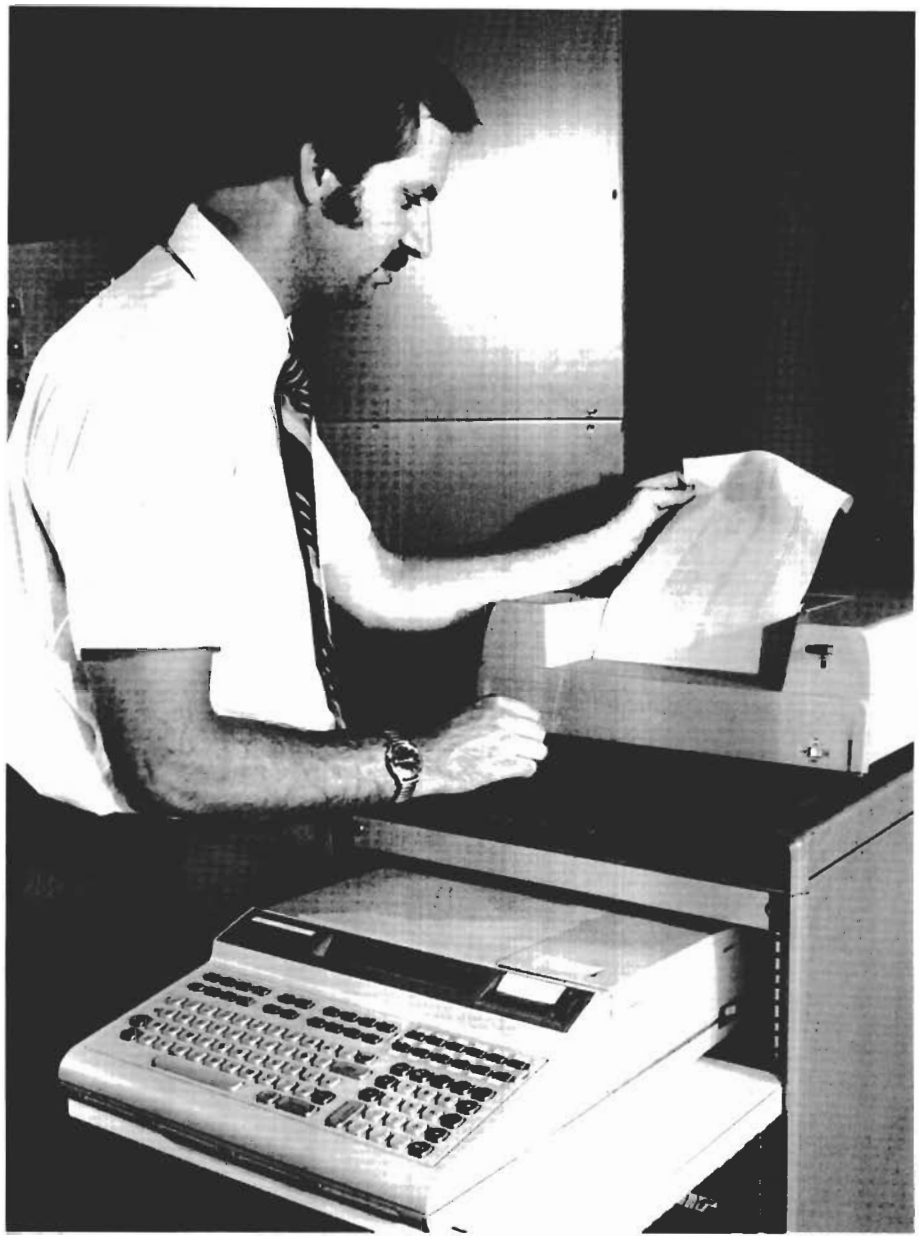
The project's purpose is to monitor total energy usage at the two MED homes and to compare that data with data gathered from the sampling of conventional homes. 97 data points are monitored — 51 temperatures; 24 water, air, and gas flows; 16 electrical consumption; and 6 meteorological.

The data acquisition system includes a Neff 620 Multiplexer, an HP 98032A for interface to the 9825A, a 9866B Printer, an HP 59308A Timer and 59309A Clock, and 9825A Desktop Computer with 24k bytes and General I/O, Extended I/O, Strings, Advance Programming, and Matrix ROMs.

Other systems were considered but the combination of Hewlett-Packard and Neff appeared to be the most suitable for this project. The Neff Multiplexer is compatible with the 9825A and requires only a few simple commands to operate.

The 9825A can store the calibration curves for all sensors so calculations can be made at the site. Data is stored permanently on the magnetic tape cassettes, and the 9866B is used for continuous data output. The real-time Clock and Timer are used to control the 9825A and Multiplexer for proper sequencing of data collection.

The data acquisition procedure is initiated by an interrupt command from the Timer. During the next second more than 100 channels of temperature, flow, wind, humidity, and electrical usage data are read into the 9825A. After conversion to engineering units, the data is accumulated in the 9825A and another interrupt occurs. Every 30 minutes the data is integrated and stored on magnetic tape.



Ever 30 minutes the 9825A gathers over 100 readings of temperature, flow, wind, humidity and electrical usage.

Besides performing data acquisition, the 9825A uses subroutines to ensure that the system is maintaining the required 5% cumulative accuracy on data measurements. Using the 9825A to check accuracy has significantly reduced the cost of obtaining the 5% accuracy.

Data can also be printed out on-site without disrupting the data gathering procedure, and servicemen, using the display, can verify proper operation of the mechanical plant of the homes.

Since the data acquisition system is on-site, portability and ease of installation are primary advantages appreciated in the 9825A.

Project Results

Because the 1976/1977 winter was so mild in this part of the United States, Southern California Gas does not feel firm data has yet been obtained on year-round energy efficiency of the two MED homes. However, their preliminary findings show that, due to better construction and the energy-saving features of the homes, a savings of better than 50% is being achieved. The project will continue through at least this winter to verify these findings.

Southern California Gas Company, 720 West Eighth Los Angeles, California 90017, U.S.A.

END

Record Keeping on the 9830A

by Bryon L. Karren,
The British Columbia
Sugar Refining Co., Ltd.

On-site record keeping on the 9830A system has two advantages. The responsibility for records remains within the department responsible for the work, and quick turnaround is gained by not "fighting" the more traditional jobs of the central data processing department such as payroll.

The British Columbia Sugar Refining Company purchased an HP 9830A in 1975 to establish an automatic system for maintaining processing and operating records. This system consists of interactive data input through the 9830A keyboard using the display as a prompting device, data storage on the 9865A External Tape Cassette, and report generation on the 9861A Typewriter and 9862A Plotter.

Initially, the system was put into service with 2k words of memory (3520 bytes Read/Write memory), a String Variables ROM, and a Plotter ROM. This system has now been upgraded with the addition of a further 2k words of memory and an advanced programming (API) ROM. In 1976, another complete system was put into a similar service in another division of the company located at Winnipeg, Manitoba. This new system employs an HP 9871A Printer instead of the 9861A Typewriter.

The major reasons for selecting the 9830A are:

- The initial cost vs. the final capability is very attractive.
- Operating and programming are easily carried out by the personnel who maintained the records in the manual system that has been replaced.
- The ability to produce graphical plots to present large amounts of data is considered to be extremely important.

The application described in this article is merely a subsection of the entire system. It serves as a good illustration of interactive data input, data storage, and data retrieval for report generation. A complete description of the entire system may be obtained from a paper presented at the 36th annual meeting of Sugar Industry Technologists held in San Francisco, California in May of 1977. The title of the paper is "A Computer Approach to Technical Records at the B.C. Sugar Refinery."

Packaging Department Record System

One of the major motivations contributing to the decision to automate the record keeping function at B. C. Sugar was the need to present data to management in a more meaningful manner. The packaging department records demonstrate this new capability very well.

The packaging department records consist of information on the performance of about 37 different styles or sizes of sugar packages produced by B. C. Sugar. The packaging lines operate on a two- or three-shift basis. Each operating day, management reviews the performance of each of these packaging lines in an effort to locate problem areas and maintain maximum efficiency. For the more active lines, major maintenance shutdowns must be scheduled in accordance with package inventory and shipping rates. Since orders are generally filled immediately from stock, inventory control is a major responsibility of the packaging department. They are often called on to make decisions regarding the scheduling of required maintenance or extra packaging activity for particular products. Therefore they appreciate up-to-date information on packaging line performance to make these decisions. As well, the packaging department utilizes a significant portion of the labor, and it is imperative that supervisors have information regarding the performance of each station.

A manual system had been in service for a number of years. The packaging performance was calculated for each shift that a particular product was packaged by expressing the output as a percent of the theoretically possible

DAILY PACKAGING PERFORMANCE REPORT

DATE: AUG 19,1977
FILE: 224

	DAY SHIFT			AFT. SHIFT			NIGHT SHIFT		
	PACK	HRS	%	PACK	HRS	%	PACK	HRS	%
MERRIFIELD-FINE 40KG	30	0.25	34						
MERRIFIELD-OTH. 40KG				710	2.75	74			
MERRIFIELD-SIG 40KG	587	2.00	84						
ST. REGIS 40KG	1290	2.00	92	327	1.00	47			
DELTA SEAL 10/2 KG				1236	5.00	96			
ICING 40 KG							150	5.00	88
ENVELOPES	450	7.50	83	332	5.50	84			
NORTH WRAPPERS	44	3.00	92						
CUBE TRAYS	2250	5.50	91	2175	5.00	97			
CUBE 30/454	381	7.50	85	397	7.00	95			
BROWN 20/1KG	580	7.50	82						
DEMERARA 20/1 KG	469	7.50	114						

	MAN HR	%	MAN HR	%	MAN HR	%
SHIFT EFFICIENCY	201	94	72	88	5	88
DAILY EFFICIENCY	278	92				

Figure 1. The underlined figures indicate packaging lines operating at less than 80% efficiency.

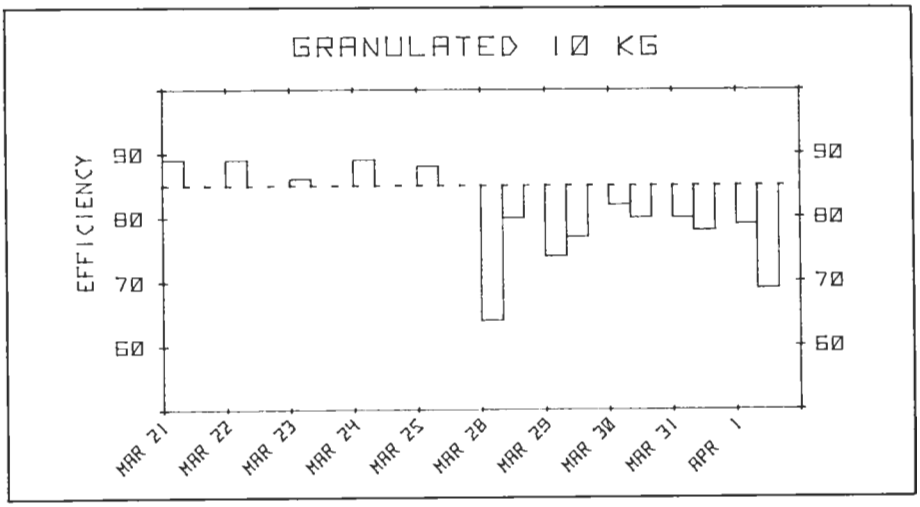


Figure 2. Bar graph of packaging performance.

"standard pack" for the same number of hours. These calculations were carried out daily, but no attempt was made to provide weekly summaries or historical information due to the extra work involved.

A new system utilizing the HP 9830A Calculator was developed to make use of the basic information in a much more efficient way. Each day the basic packaging information is entered for each operating packaging line — the number of hours worked and the number of packages produced. The data input is in an interactive mode using the LED display of the 9830A as a prompting device.

Data entry relies on the use of the Special Function keys and key overlays for efficient data entry. Rather than question the operation of all 37 packaging lines for all three shifts, the Special Function keys are used to select the operating lines in a random order. A small amount of program coding assigned to each specific key fills a number of variables and then accesses the main data request routine by use of an HP BASIC defined function. This avoids the unsatisfying task of a whole series of null entries for non-operating lines.

Simultaneously with data entry, a hard copy record is produced on the 9861A Typewriter. Various correction options are available during data entry, again through the Special Function keys. Once the data have been entered to the operator's satisfaction, they are okayed, which initiates the generation of the Daily Packaging Performance Report (Figure 1) and storage of the basic data. During the printing of this report, every packaging line operating below a set efficiency (80%) is highlighted by underlining for rapid recognition. A recent addition has been the printing of shift efficiencies and an overall daily efficiency calculated by a technique weighting each packaging line by the man hours used. This is an attempt to condense the information into a relatively few numbers for comparison purposes. The daily report is produced each morning from the past 24 hours packaging records and delivered to the Packaging Department. They review the report and may submit changes or corrections. If necessary, a new report is printed. The finished report is included on the agenda of a daily supervisory meeting at 10:00 a.m. This rather tight schedule requires that all steps progress smoothly without unnecessary delays.

The basic data are stored on an appropriate data tape in the 9865A cassette unit. Including the 9865A in the system leaves the internal cassette free for program linking and keeps programs and data on separate tapes. The ability to link sections of programs from the program tape allows us to use programs equivalent to many times the

actual memory size of the 9830A. Programs progress through the entire system without manual intervention, going from one program to another under control of the 9830A.

A single data tape is used to hold the data on a daily basis for one year. Now that the data are stored, they are available for the generation of many subsequent reports and data plots, which have become important tools in the management process. At the end of each week, a duplicate tape is updated for backup purposes.

At the end of every week a summary is produced from the basic stored information. The philosophy behind this report is that daily fluctuations may tend to mask the overall results at each station. The weekly report smoothes these fluctuations. This report includes cumulative year-to-date figures for comparison purposes and acts as a key to the general packaging activity on a cumulative basis. Again, this report uses the underlining technique to highlight efficiencies below 80%.

Two graphical reports are produced for the more active packaging lines to provide management a means of trend analysis and some historical background. The first is produced every two weeks in the form of a bar graph giving information on a shift basis (see Figure 2). The bar graph has a center line of 85% so that efficiencies exceeding this go up, and those below go down. This provides a rapid visual indication of the relative performance of each station.

Also, monthly graphs are produced showing efficiencies for the past year on a weekly basis. The year is divided into quarters and average efficiencies for each quarter are shown by means of a dotted line on the graph. Both graphs provide management with some historical depth for analysing the performance of the packaging equipment.

On a weekly basis a graphical plot is produced to illustrate the Packaging Department product distribution. This plot employs two pie charts, one showing distribution of packages according to the weights packaged, and the other according to the labor utilization. This graph illustrates the flexibility of the 9862A Plotter as well as being a good example of the extraction of new information from the basic data.

In order to schedule and record the completion of the various activities, a calendar plotting program is used. The calendar shows the five work days of the week. Regular repetitive jobs are printed on their respective days. Pertinent information, such as week numbers and month ends, are automatically added by the program. The plot is used by the statistician to schedule work to be completed and has proved particularly useful should the statistician be absent.

Conclusion

The HP 9830A has become an integral part of the management process at B. C. Sugar, with the Packaging Department's application being only a small part of the total involvement. Due to the ease of programming and simple nature of the equipment, it has been possible to leave these specialized data processing functions within the department that has been traditionally responsible for the manual system. This seems to work better than turning over the job to the central data processing department where this work would be dwarfed by the more traditional applications such as payroll.

END

About the Author

Bryon Karren received a BSc in Chemistry from the University of Alberta in 1967 and a MSc in Chemical Engineering from the same university in 1972. He is employed at the British Columbia Sugar Refining Co. Ltd. as a process engineer.

During graduate study he took several computer courses and learned to program in FORTRAN and APL. Computerized data acquisition and report generation was the subject of Mr. Karren's MSc thesis. He has had the opportunity at British Columbia Sugar to add experience to his knowledge, and since 1975 he has been responsible for the application of small computers within the Company's technical department.

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Crossroads

by John Nairn, PhD
Hewlett-Packard
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Here, at last, are the solutions to the brain teasers presented in the 1977/1 issue of KEYBOARD, along with my thanks to those fellow puzzle buffs mentioned below who sent in solutions to the various problems. I hope that by missing the Crossroads column in the last issue I did not tax your patience too heavily.

1. In the problem of finding the bag of counterfeit coins, the bogus bag can be determined in one weighing. This is done by labeling the bags with the numbers 1 through 10 and placing on the scale one coin from bag #1, two coins from bag #2, and so forth up to ten coins from bag #10, giving a total of 55 coins on the scale. If all of the coins weighed 16 grams each, then the 55 coins on the scale should weigh 880 grams. But since one of the bags contained 17-gram coins, the actual weight will be too heavy by one gram for each counterfeit coin on the scale. Thus, for example, if the scale reads 887 grams, I would know that there are seven counterfeit coins on the scale and that bag #7 contains the bad coins. Correct solutions to this problem were sent in by Gustavo Avitabile, Ed Jaramillo, Howard Mark, Ron Mifflin, Samuel C. Mock, and G.D. Wedlake.

Because I did not make it clear that the weighings were to be taken on a scale, some readers assumed that I intended the use of a two-arm balance. Earl F. Burkholder and C.S. Narayanan correctly deduced that three balancings would be required in this case to detect the bag of counterfeit coins.

2. I was somewhat surprised to find that no one submitted solutions to the two numeric sequences, from which I conclude that I either made them too difficult or that no one finds the problem of determining the next element in a sequence to be interesting. Howard Mark did mention that any infinite sequence of n + 1 values can be fitted by an n – th order polynomial and extrapolated to the next value, but this obviously wasn't the solution I had in mind.

In sequence A, the n^{th} term, t_n, is the number of distinct prime divisors of n. Thus the 30th and the next term in the sequence is 3, since 30 has three distinct prime divisors — 2, 3, and 5.

While sequence A is mathematical in nature, sequence B should be more readily apparent to computer programmers. It is the representation of the number 16 in all possible base systems that use the common digits as symbols. Thus 10 is 16 in base 16, 11 is 16 in base 15, and so on until 121 is 16 in base 3. The next (and last) term in the in the sequence would be 10 000, which is 16 in base 2.

Okay, puzzle fans, I can take a hint. No more sequences.

3. The geometric proof that all angles equal a right angle received the largest number of incorrect solutions, with almost every step of the process being selected by someone as being the candidate for the fallacy. As with most geometric fallacies, the problem arises from an incorrectly drawn figure. When drawn accurately, the intersection point, I, lies far below the original square and triangle EDI lies outside the square. The apparent fact that angle EDG is the difference of angles EDI and GDI is merely an illusion created by the incorrect figure, and step i is the one that cannot be justified. Thanks to Gustavo Avitabile, Earl F. Burkholder, Howard Mark, Samuel C. Mock, Clay K. Perkins, and G.D. Wedlake, Euclid is still resting in peace.

4. A little analysis shows that the monarch who tried to increase the ratio of women to men in his kingdom is in for a disappointment. According to his decree, since every family must stop having children when they have their first boy, there is exactly one boy per family. If we look at the number of girls in each family, one-half of the families have no girls, one-quarter have one girl, and so on. Thus the average number of girls per family is

$$G = \frac{1}{2}(0) + \frac{1}{4}(1) + \frac{1}{8}(2) + \frac{1}{16}(3) + \ldots + \frac{(N-1)}{2^n}$$

Summing this series either analytically or using a computer program, we find that G = 1, and so the decree did nothing to alter the ratio of girls to boys. Correct solutions were received from Gustavo Avitabile, Earl F. Burkholder, Ken Campbell, Howard Mark, and G.D. Wedlake.

5. If I come to the fork in the road and find only a truther and a liar, I can determine the correct road to take in only one question. I pick either of the two men and ask, "What would the other man say if I asked him which road to take?" Assume the right fork is the correct one. If I ask the question of the truther, he knows the liar would say to take the left fork and accurately reports this fact to me. If I put the question to the liar, he will lie and tell me the truther would say to take the left fork. No matter which one I ask, I will get the wrong answer and should take the opposite road. To put it in mathematical terms, by the wording of my question I have forced both men to operate on the answer with exactly one inversion occurring.

The solution becomes slightly more complex when the man who answers at random is added to the group. Notice that in the version with only the truther and the liar, we also could have asked either man the question, "If someone were to ask you which road to take, what would you tell him?" The truther would correctly say to take the right

fork. The liar would tell the inquirer to take the left fork. But since I asked him what he would tell someone who asked him the question, he also lies about what he would say (remember, he always lies!), and so, he tells me he would say the right fork. By posing the question this way, I can get either the truther or the liar to give me the correct information. Now that I am faced with three men, if I can determine that I am not talking to the random I can find the correct road in one more question. I begin by lining the men up and calling them A, B, and C. There are six possible orderings as shown by Figure 1.

	A	B	C	Q1
1.	T	L	R	N
2.	T	R	L	Y
3.	L	T	R	N
4.	L	R	T	Y
5.	R	T	L	Y/N
6.	R	L	T	Y/N

Figure 1.

I now ask A the question, "If someone were to ask you, 'Is B the random?', what would you tell him?" The last column in Figure 1 shows the answer I would get for each arrangement. Notice that if A is the random, I could get either a yes or a no to my first question. If the answer I get is yes, C cannot be the random. If the answer is no, B cannot be the random. Now that I have identified one man who is definitely not the random, a second question as given above will determine the correct road to take.

Many readers sent in solutions involving three questions, but no one succeeded in solving the problem in two.

6. The final problem was one in which apparently not enough information was given. Most readers who concluded this ignored one important piece of data; namely, I guaranteed that enough information was given. Since neither the radius of the sphere nor the radius of the hole was given, and yet I claimed there was sufficient information, the only conclusion to be drawn is the answer must be independent of these radii. Therefore, I am free to choose any radius I like for the hole. So I will pick the easiest one to work with and let the radius of the hole be zero. This fixes the radius of the sphere at one inch and leaves the volume of material remaining equal to the volume of a one-inch radius sphere, or $4\pi/3$ cubic inches.

If you are not convinced, you can solve analytically using the methods of either solid geometry or calculus, and you will find that all radii (both of the sphere and the hole) cancel completely out of the final expression. This problem was correctly solved by Gustavo Avitabile, Earl F. Burkholder, Ken Campbell, and Irwin Tessman.

Many thanks to those other readers who sent me some of their own favorite brain teasers. I am always looking for new and interesting problems. But enough of these diversions for now. Next issue I will get back to presenting topics from the crossroads of mathematics and computers.

END

Programming Tips

Obscure Uses of the RES Register (9830A)

Submitted by William Zehner,
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The thrifty 3-line program below causes the 9830A to display a running balance for use in balancing your checkbook, etc.

```
10  INPUT A
20  DISP A + RES;
30  GOTO 10
```

Its operation may not be obvious. The register called RES always contains the last number displayed or printed. Hence, line 20 is really equivalent to two operations that accomplish the running summation DISP A + RES; RES = (RES + A).

If you are short of variable names or memory, you can use the RES register for temporary storage. For example, to interchange the values of two variables without the use of a third temporary variable,

```
10  INPUT A, B
20  DISP A          (saves A in RES)
30  A = B
40  B = RES
50  GOTO 10
```

Another interesting use for the RES register is to pass a number from one program to another through a LOAD (file) operation. Unlike other variables, the value in RES is not altered by RUN, LOAD, INITIALIZE, SCRATCH, SCRATCHK, or SCRATCHV. It is only altered by SCRATCHA or by turning the machine off and on (both of which initialize RES to 0), or by any operation resulting in a number being displayed, printed, or sent to a peripheral device. Hence, to pass the value of a variable, say X, from program A to program B, the last lines executed in program A should be

```
990   DISP X    (saves X in RES)
1000  LOAD 22, 10
```

and the first line in program B should be

```
10  X = RES
          (replaces RES into X)
```

Incidentally, I wish to thank Mr. Rahmann for his ingenious KEYBOARD tip on obtaining non-keyboard characters. I found it very useful in writing ALGOL programs in TEXT mode, because of the frequent need for square brackets [] and the \, which is used for multiplication.

Synchronization Between Timeshare and the 9830A

Submitted by Finn Hendil,
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Copenhagen S, Denmark

When the 9830A is used as a terminal for a remote timesharing system having more than one fixed transmission speed, the speed is sometimes indicated from the 9830A by transmission of one specific character repeated several times.

In the TERM mode of the 9830A, the TRANSMIT function is terminated with a Carriage Return, which disturbs the proper synchronization to the time-sharing system, and as there should be a time interval between the transmitted characters, we have found that this little programme on one of the unused Special Function Keys gives a perfect synchronization each time:

```
10  FOR N = 1 TO 8
20  WRITE (4, •) "H";
30  WAIT 400
40  NEXT N
50  END
```

After the 9830A is in the TERM mode, the procedure is to press the key when the characters are to be transmitted and proceed in the usual way.

Refill of Word-Oriented Buffers (9825A)

Submitted by Sue Kolb
Hewlett-Packard
Calculator Products Division

If you want to calculate a complex series of words to be sent repetitively to a black box and perform other calculations at the same time, you can avoid recalculating the series each time it must be sent.

Let's say that "FOON" is as follows:

"FOON" = B$ = | X | Y | Z | P | Q | R | | |

Contents | Pointers

Code to create buffer:

```
dim B$(6 + 16)
buf "FOON", B$, 2
wtb "FOON", 88•2 ↑ 8 + 89,
90•2 ↑ 8 + 80, 81•2 ↑ 8 + 82
```

Since "FOON" is a word-oriented buffer, we can think of its contents as pairs of characters:

X	Y	word 1
Z	P	word 2
Q	R	word 3

B$ references the same information as single characters:

X	char. 1
Y	char. 2
Z	char. 3
P	char. 4
Q	char. 5
R	char. 6

The wtb command tried to write characters into a word-oriented buffer, so it had to pad the rest of each word with blanks:

ß	X
ß	Y
ß	Z

Notice that now only half of the old contents will fit; the buffer overflows.

The solution to the problem is as follows:

"FOON" = [XYZPQR]

T$ = [XYZPQR]

Retain two copies of the contents. When the transfer is complete and the buffer is empty, fill the buffer with blanks to reset the pointers and then copy T$ into the buffer content area. The buffer is thus refilled with the old contents and can be again transferred. The code to perform this operation, in general, follows:

```
0:  dimB$[2N + 16], T$[2N]
    where N = number of words in
    buffer.
1:  buf "FOON", B$, 2; oni 2, "reset"
    set up buffer; when device is through
    with transfer, branch to service
    routine "reset".
2:  0 → Q
    Q is a flag indicating end-of-transfer
    and time to start again.
3:  . . . . . .fill FOON. . . . . .
4:  . . . . . .using wtb. . . . . .
5:  B$[1, 2N] → T$; buf "FOON"
    set up T$; wipe out old FOON as
    though transfer completed.
6:  "clean FOON": fmt Nx, z; wrt
      "FOON"
    fill FOON with blanks (sets pointers
    to full).
7:  "reload FOON": T$ → B$
    replace blanks with old contents.
8:  tfr "FOON", 2
    transfer FOON out to device 2.
9:  if Q = 0; jmp 0
    wait loop (could be other parts of
    the main program calculations).
10: 0 → Q; gto "clean FOON"
    when interrupt has been acknow-
    ledged, reload FOON and start
    process again.
11: "reset": 10 → Q; iret
    set Q flag to signal interrupt.
```

Note: you must substitute a number for N everywhere in the above program.

In summary, you can refill byte-oriented buffers using:

wtb "Buffer name", string variable associated with buffer, but word-oriented buffers require lines 5, 6 and 7 above.

Increasing Storage Capacity (9830A)

Submitted by Philippe Kent,
6 Chemin de Beau-Rivage,
CH 1006 Lausanne, Switzerland

A substantial amount of memory may be wasted when storing large numbers of experimental results in full precision arrays. The values are often of (rather low) constant relative precision and/or of small dynamic range. The use of split precision arrays will double the storage capacity, but use of the following procedure will double that capacity again. The gain in access time, if the values are stored on the tape cassette, is also considerable.

The trick is to use a signed, biased logarithm of suitable base. The base and bias are chosen such that the log of the maximum absolute value encountered is 32767 and the log of the minimum absolute value is 1:

$\log_a(\max|V|) + b = 32767,$

$\log_a(\min|V|) + b = 1,$ or

$a = (\max|V|/\min|V|)^{1/32766},$

$b = 1 - \log_a(\min|V|)$ with

$\log_a x = 1/\log_e a) \bullet \log_e x.$

The absolute experimental value is then converted into its biased log, signed as the original value and stored in an integer precision array.

Encoding is accomplished by:

```
10  DEF FNC (X)
20  N = 0
30  IF X = 0 THEN 50
40  N = b + c•LOG(ABSX)
50  N = SGNX•INT
      (N•(N > 0) + 0.5)
60  RETURN N
70  END
```

where b is the bias as above and c is $1/\log_e a$.

Decoding is accomplished by:

```
80  DEF FND(N)
90  X = SGNN•EXP
      (d•(ABSN – b))
100 RETURN X
110 END
```

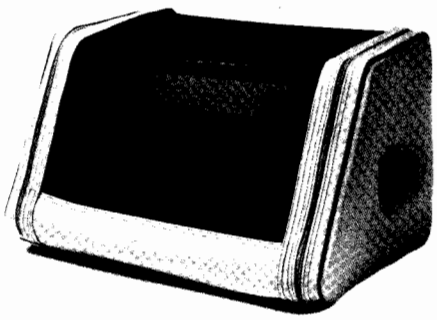
where d is $\log_e a$.

For b = 16000, c = 2000 and d = 5E – 4, for example, numbers between ± 0.0003357 and ± 4374 as well as ± 0 can be represented, with an accuracy greater than 3 parts in 10,000, by an integer. The smaller the dynamic range, the greater the accuracy.

Properties of the coded value are such that zero will always convert to zero, an underflow results in zero, an overflow in recoverable Error 105 on attribution to the integer variable, and the relational expressions (< , = , >) remain valid between variables coded with the same base and bias. The relational expressions always remain valid when one side is zero. Direct multiplication and division may also be performed after separation of the sign, but checks on sign, overflow and underflow will nullify the gain in execution time compared to decoding-multiplication/division-encoding.

END

Update



98020A Soft Sound Enclosure

The 9802A Soft Sound Enclosure is an inexpensive, compact accessory that allows the HP 9871A Printer to be used in a quiet office environment. Installation of the soft sound enclosure takes only a few minutes and requires no special tools. Since the 98020A is designed to work best with printers having the 98021A Formfeed Mechanism, it is recommended that the 98021A be installed on your printer.

9831A Analysis of Variance Package, 09831-15030

Contains programs for 2-, 3-, and 4-way analysis of variance, split plot, repeated measures with replicates, contrasts, and orthogonal polynomials. Requires a 9831A with Opt. 001, 9866B or 9871A Printer, and 98223A or 98223B version of Matrix-Plotter ROM. The 9869A Card Reader is optional.

9831A General Statistics Package, 09831-15000

Contains one-sample analysis, paired-sample analysis, test statistics, distributions, and multiple linear regression. Requires a standard 9831A and 9866B or 9871A Printer. The 9862A or 9872A Plotter is optional.

9831A Stepwise Regression Package, 09831-15020

Contains programs for stepwise, forward, backward, and manual regression analysis, with transformations and plotting features. Requires a 9831A with Opt. 001 and 9866B or 9871A Printer. The 9862A or 9872A Plotter and 9869A Card Reader are optional.

9825A 6800 Microprocessor Assembler Package, 09825-13750

Provides means for developing 6800 Microprocessor assembly language programs. The pack includes Editor, Assembler, and routines for transferring source program and object code. Requires a 9825A with Opt. 001, String-Advanced Programming ROM, General I/O-Extended I/O ROM, 9866B or 9871A Printer, 9883A Tape Reader Subsystem. The 9884A Tape Punch is optional.

9825A Documentation Package, 09825-10020

This pack contains programs for annotating listings, complete cross referencing, program comparison, and calculating check sums without listing. Requires a standard 9825A, General I/O-Extended I/O ROM, String-Advanced Programming ROM, and 9866B or 9871A Printer.

9815A Surveying Package Vol. 4, 09815-13530

Contains programs for triangle and curve solutions, line and curve layout, field reductions, earth work and map check. Requires a 9815A with Opt. 001 and Opt. 002 and a 9871A Printer.

9815A Blood Gas Analysis Package, 09815-14260

Complete analysis and interpretation of laboratory blood gas (pH, PCO_2, PO_2) measurement for arterial and mixed venous blood for both infants and adults. Requires a 9815A with Opt. 001 and Opt. 002. The 9871A Printer is optional.

9815A Industrial Statistics Package, 09815-15040

Contains three control chart programs, basic statistics, and a histogram program. Requires a 9815A with Opt. 001 and Opt. 002 and the 9862A Plotter.

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1977/3

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