Keyboard

1978/4 A Publication of Hewlett-Packard Desktop Computer Division

Keyboard

Overview

Since the first issue of Keyboard in spring, 1969, Hewlett-Packard's desktop computing devices have evolved from calculators into computers having broad control and interfacing capability, with a panoply of peripherals such as x-y plotters, digitizers, paper tape punches and readers. Another step in desktop computer technology is evidenced by the new System 35 described in this issue. Using HP's now standard enhanced BASIC as a primary language, the System 35 also offers assembly language programming capability, along with significantly increased speed, for some operations.

Steve Leibson, of our development laboratory, has offered to do a series of articles on interfacing that will appear in consecutive Keyboard issues. As an introduction, this Keyboard includes an I/O glossary that you may want to include in a permanent reference file. We hope the ensuing series will assist readers needing to expand their computation systems by interfacing with peripherals or by using their desktop computers as instrumentation controllers.

Future Keyboards will benefit from the skills of our new editor, Bill Sharp. Bill comes to us after gaining several years of experience editing for a technical journal. He will welcome any articles and programming tips you feel would benefit other readers, and will consider any suggestions you may have that would make Keyboard more interesting and relevant to your needs.

Features

Departments

HP 9815A In Quality Control

by George P. Thomas & Samuel C. Mock, Ford Motor Company

We in the Ford Motor Company at Indianapolis have made creative use of the Hewlett Packard 9815A desktop computer. The capabilities of the 9815 have been effectively used in our Quality Control Department in process control gaging, machine adjustment determinations for set-up operators, and lot sampling. One of our 9815s currently is being used for a floor back-up and has been coupled with an x-y plotter to generate reports. However, we have not limited ourselves to just these capabilities of the 9815. We have also utilized the 9815 functions and made it the controller for a Universal Multiple Dimensional Inspection and Analytical Device (UMDIAD) system.

The first usage of a Hewlett-Packard computer in our plant was to provide more expeditious gaging of our rotary valve input shaft. The input shaft for the rotary valve power steering gear produced at the Indianapolis plant has a unique configuration on its outside diameter. The configuration forms four hydraulic metering valves, all working in parallel with each other. The hydraulic characteristics are quite critical in relationship to the radial positioning of the 16 edges of the eight grooves, as well as the comparative locations of the four individual valve shapes. The actual diameter of the part at the time the slots are machined is approximately eight thousandths of an inch larger than the finished part. The diameter variation has a direct relationship to the valve function, and as a result, the radial location parameters vary as the diameter varies (see Figure 1).

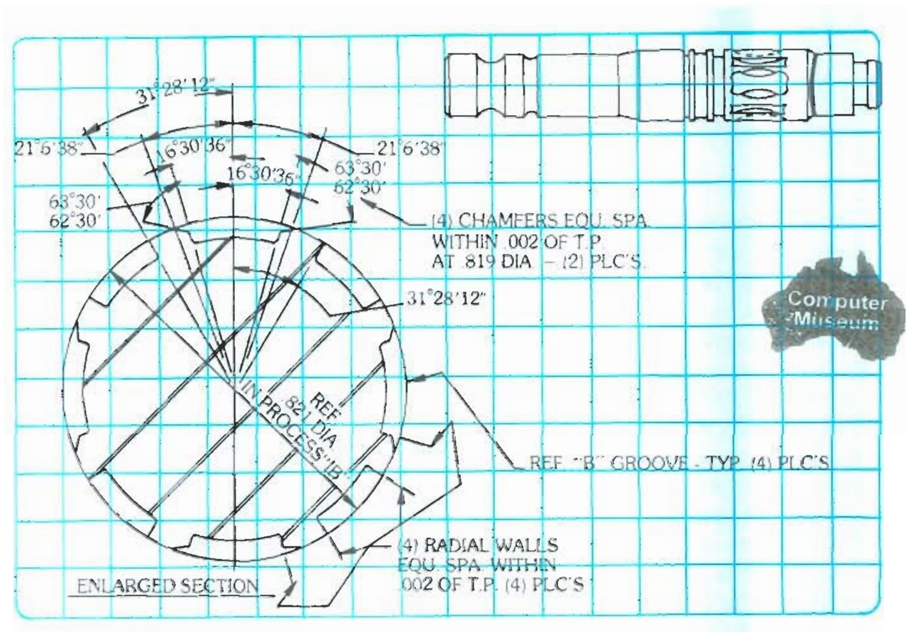


Figure 1. Cross-section of rotary valve input shaft for power steering gear.

When the first manufactured parts had to be checked, only conventional layout means were available. Conventional means for checking the part, an extremely slow, time-consuming process, would permit many hundreds of parts to be machined while results of checking one piece were being compiled. As a result, we were faced with the problem of providing a design for a gage that would give us fast answers about the initial part run quality while allowing the machine to sit idle until the quality was verified.

Initially, a simple index plate was provided that gripped the part in a collet while the break-out locations were checked optically and the deviations from nominal were recorded. These 16 figures were then processed through a programmable calculator to determine part acceptability. The process provided a significant improvement in inspection time as we went from approximately four hours per part for a layout check to five minutes per part by use of the index plate and calculator. However, with the advantage of speed came several disadvantages. The first disadvantage with the new method was that the process was accurate to only five ten-thousandths of an inch because of optics limitations. Another problem we had was that the first generation programmable calculator was so slow the operator could overrun the unit with his manual input data. Eventually, due to the age of the calculator, a service problem developed and a better gaging system had to be considered.

During the time we were having service problems, the new rack and pinion power steering gear came into existence. The rack and pinion program brought about a radical increase in production with a new part that had the same radial configuration but different length. Therefore, we had four new machines to audit and service, which provided the impetus needed to enter into new design considerations for a gaging method.

The new design resulted in the chucking portion of the gage being made to closer tolerances, positioning the shaft horizontally instead of vertically and using a rotary encoder instead of the index plate. In addition, the diameter check was added to the gage with readings being taken automatically along with each of the 16 radial readings from the encoder. The encoder and diameter readings are automatically input to a Hewlett-Packard 9815 computer via a single key stroke.

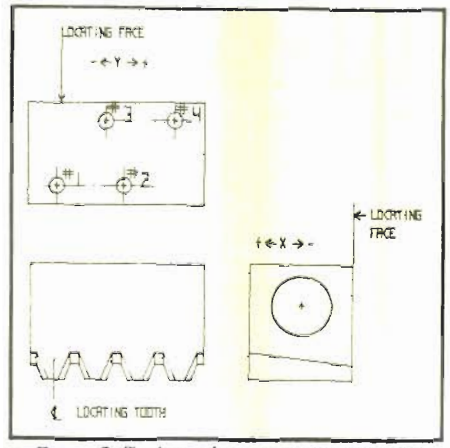


Figure 2. Rack nut for power steering gear showing relative hole location.

The use of improved optics for positioning and the automatic input of all data resulted in reduced operator error. The automatic data entry also reduced the gaging cycle time for checking a part from five minutes to one and a half minutes. Without using the 9815 and its input/output capabilities, it would have been difficult to reduce the time required to check a single part.

Because the capabilities of the first 9815 enabled us to gage the rack and pinion input shaft more rapidly, we requested more 9815s to replace the old calculators that were causing service problems. When two additional 9815 computers came in we replaced the old calculator that was in use with the index plate gage on the floor. One 9815 was left for back-up and office use. The back-up was used to develop other software and for experimentation with the 9815's potential. By using the computer's input/output capability linked with a plotter, an idea was reborn and amplified. The idea was given the acronym UMDIAD.

The UMDIAD system consists of a group of standard electronic gaging units connected to existing floor gages, and makes use of a 9815 through a special interface. The standard gage units used are amplifiers, memory units, pneumatic to electronic transducers and an analog-to-digital converter. The UMDIAD system has the capacity for a maximum of 16 separate and independent inputs at a rate of about six per second. Because accumulated data is stored on magnetic tape, virtually unlimited storage space is available. Presently, the UMDIAD utilizes "Federal Products Corporation" shelf item electronic gaging units. However, any make of electronic gage units can be used as long as they provide a linear analog signal output.

The UMDIAD can use existing floor gages with indicators, pneumatic displays or electronic displays that provide great flexibility at low cost. With pneumatic and electronic gages, it is a simple matter of disconnecting the gage unit from the amplifier and display, then connecting it to the proper UMDIAD input. For gages that presently use dial indicators, we replace the indicators with an LVDT (Linear Variable Differential Transducer) and use the UMDIAD's gage units. We are presently designing an attachment to connect the LVDT directly to the existing indicator to simplify the gage connections.

In addition to multidimensional fixture gages, UMDIAD can use such gages as small-bore air plugs (both single and multi diameter), air and indicator snap gages and dial bore gages. The practicality of special studies is increased by using the gages and fixtures that are in daily production on the floor. The diversity UMDIAD creates by using existing gages provides the ability to measure dimensions such as lengths, diameters (inside, outside, maximum, and minimum), concentricities, squareness and parallelism.

The capabilities and flexibilities of the UMDIAD allow it to be used in any number of problem areas for quality assurance and quality control. Automatic data gathering not only reduces the inspection time required per part, but on-spot analysis of the data reduces the time required per machine capability study. Time savings produced can be used to relieve the pressure that exists due to manpower shortages of layout inspectors and analysts. UMDIAD, through software and the x-y plotter, can perform a complete statistical analysis of accumulated data when desired. In addition to machine studies, UMDIAD also can be used for in-process gaging, receiving inspection and final inspection. Being transportable (cabinetized and on wheels), the UMDIAD also may be used for on-site vendor and subcontractor evaluations.

Much of the flexibility the UMDIAD system provides is achieved through the software programs created for its use. General programs to check independent dimensions exist, although special combined dimensions or inspection sequences require special programs. To a great extent, UMDIAD is limited by the program availability or the programmer's skills. However, programming the 9815 is not difficult to learn and does not require any previous training or ability.

Once the desired program exists and the gage is available, the normal procedure will be to place a part in the gage, actuate the 9815 and remove the part from the gage. Then the gaging process is repeated until all parts are gaged. Upon completion of the last part, data will have been stored on magnetic tape for analysis at that time, or when desired.

The first special analysis completed using the UMDIAD was a challenge, but it provided a greater cost benefit than anticipated. The assignment was to determine what, if any, movement took place as a result of heat treat stress in the four ball guide holes of the steering gear rack nut (Figure 2). One lot of 74 parts (one complete machine cycle) was gaged. The x and y coordinate values were taken for all four holes. The rack nuts were then processed through heat treat and the coordinate values again taken for all the parts.

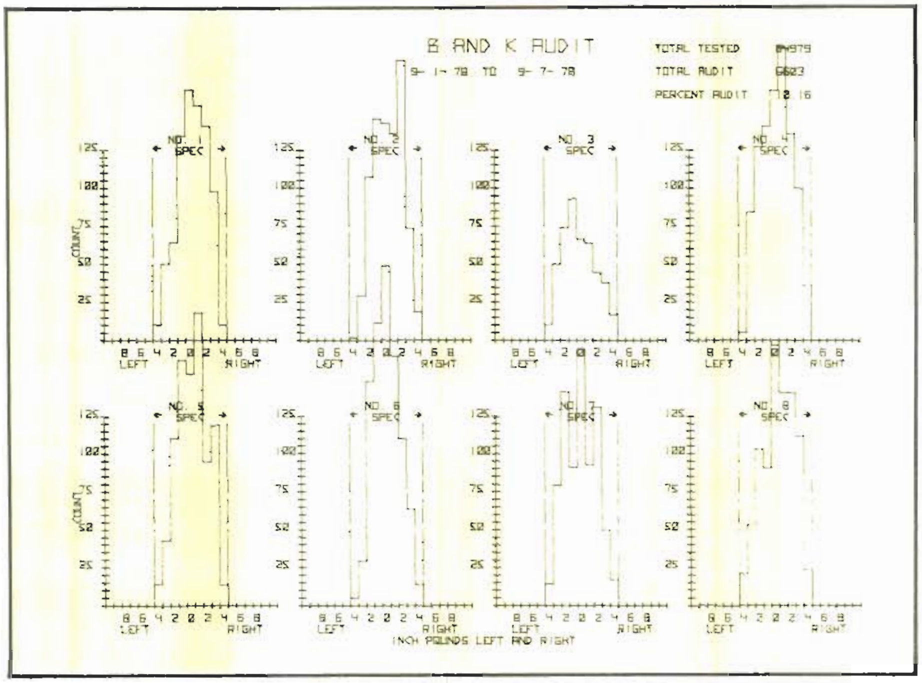


Figure 3. Weekly quality assurance audit report.

We then analyzed the data for the mean values of all four holes before and after heat treat. The mean values were plotted, and the hole movement due to heat treat stress was determined.

Later, data for a second lot of 148 rack nuts was gathered prior to heat treat. To date the rack nut study has involved the gaging and data gathering of 2,368 coordinate values.

Prior to UMDIAD's availability, the only means of gathering the data would have been via layout lab check. The layout method requires one labor hour of inspection time for every eight coordinate values. Estimated labor hours for layout inspection would have resulted in a cost factor of 888 hours. However, with the use of the UMDIAD the labor hour factor was only six hours, producing a significant savings for Ford. Using the x-y plotter to generate all graphs for the data resulted in a further labor savings of eight hours. The cost saving factor produced in just one study resulted in a 53 percent payback for the initial cost of the UMDIAD.

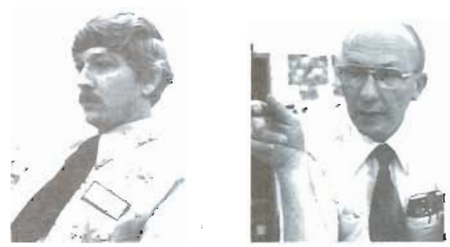
Another use of the 9815 in conjunction with the x-y plotter is preparation of quality assurance reports. The report can be prepared daily, or the data accumulated on the cassette tape and summarized weekly, monthly or as required. Daily reports are prepared early in the morning using the preceding day's test results. The time required to prepare the report has been reduced by half. The use of the 9815 provides greater assurance that the report deadlines will be met for the management meetings. Because all calculations are automatic, with the input data double checked, confidence in the report itself is increased.

For the periodic report, we now input data daily and store the information on the cassette tape. With the end of the report period, the last day's data is input and the processing program is initiated. The processing program requests the inclusive dates for the report period and the production total. The period's test results are retrieved from the tape automatically, the data is processed and the form is filled out. Once again reporting accuracy has been reinforced, because all input data is double checked and all calculations are automatic and without human error. The time required to accumulate the weekly data has not been significantly reduced. However, the time required to prepare the actual report has been drastically decreased from about two hours per period to approximately ten minutes per period (Figure 3).

Presently, we have two general purpose inspection programs, and six data output or analysis programs. In addition, there are programs that describe the UMDIAD system capabilities, zero a gage, initialize information and establish new blank data tapes.

Any type of report can have any desired format and is limited only by the software programs used to process the data. Currently, we have a general statistical routine that assimilates input data, checks for needed corrections and then outputs maximum and minimum data values, ranges, means, standard deviations, skewness, kurtosis, and sample size on the computer's paper tape printout. Another program provides the same capability with the addition of outputting on the x-y plotter, with both histogram and smooth curve presented along with all identifying information. This program was generated primarily for machine capability studies where the plotted output could be utilized in a formal report, with descriptive statistics.

The software generated by the creative use of the 9815 is a powerful tool. Quality Control has had a problem of acquiring and evaluating reliable data quickly. Industry long has needed a speedy but precise instrument for decision making, and now a tool is here. At Indianapolis, we use the 9815 to achieve the necessary fast, reliable answers for process control, machine setup, lot sampling, special studies, machine capability studies, and reports.



George P. Thomas (left) is an inspection gage and equipment coordinator.

Samuel C. Mock is responsible for developing new gaging techniques and their applications. Both are with the Ford Transmission and Chassis Division in Indianapolis.

New Products

System 35

by Brenda Hume, Hewlett-Packard Company, Desktop Computer Division

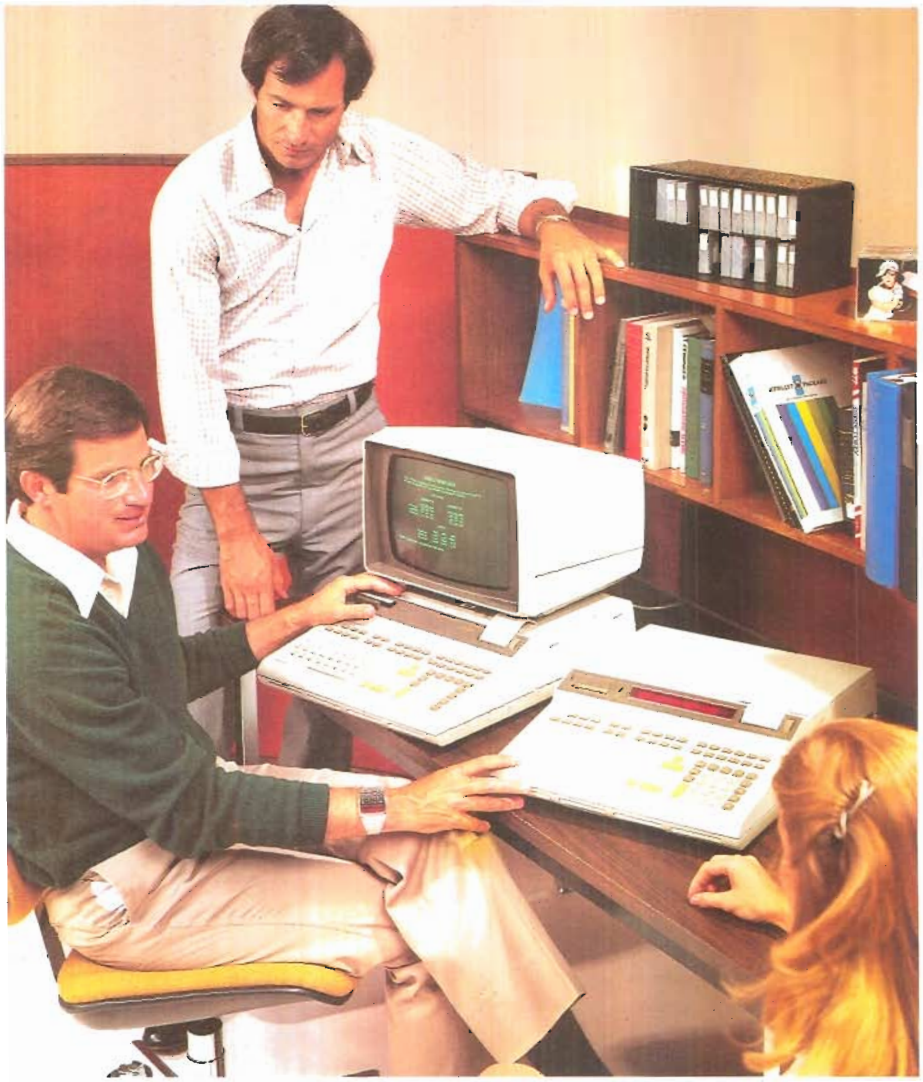
System 35 is the latest addition to HP's powerful line of Desktop Computers. Patterned after its predecessors, the System 35 combines the I/O performance of the 9825 with the enhanced BASIC language and CRT of the System 45. New features incorporated into the System 35 include read/write memory capacity of up to 256K bytes and the ability to program in assembly language. These features, along with unified plotting and mass storage, will help to extend the applications of System 35 into areas previously dominated solely by minicomputers.

System 35 has the power you normally expect in a mini, but it retains the friendliness of an HP desktop computer in both design and language. There is no complicated start-up procedure to follow, no operating system to load, no compiling to do. Slightly larger than an electric office typewriter, System 35 can be moved to where the work is. Its language is HP's enhanced BASIC, which is easy to learn and use.

Engineers, scientists, mathematicians and statisticians, technicians and manufacturers can use the System 35 for varied tasks such as data acquisition, instrument control, production and process control, engineering design, regression analysis, mathematical modeling, or mechanical environmental testing. Technological advances enable the System 35 to handle tasks previously too complex for computers in its price range.

System Integration

Many peripherals have been integrated into the System 35, including an interactive keyboard, an alphanumeric display (a 24-line CRT for Model A, a 32 character single-line display for Model B) and an internal tape cartridge drive with a capacity of 217K bytes per tape. An optional 16-character thermal strip printer is available for users who require low-cost permanent copy for such applications as data logging or program debugging.



Keyboard

The computer keyboard includes a block of keys with standard typewriter layout, a block for program control and editing, a block for CRT editing and control, a block of user definable keys, a system command block and a numeric computation block. A typewriter mode allows the computer to be used in conjunction with an output device in the way a typewriter is used. A live keyboard feature allows changing variables or program statements while the program is running, or to list the program while it is running. Optional character sets include German, French, Spanish and Katakana.

CRT Display

The CRT supplied with the System 35A is a 12 in. (305 mm) diagonal, dual raster-scan, P31 green phosphor screen with adjustable brightness. The color, contrast, size and brilliance were chosen for maximum ease of viewing. Screen brightness can be adjusted for best viewing in work areas from brightly lighted to dark. Inverse video, blinking and underlining can be used in any combination to highlight selected areas on the screen. Cursor control is identical to that of the HP 2645 or 2648 terminal.

Peripherals

A variety of peripherals is offered for versatility for System 35. In addition to the internal thermal line printer, the 9866B Thermal Line Printer, 9871A Serial Impact Printer, 9881A Line Printer and 2631A Matrix Impact Printer are available for selection of hard copy output.

The 9872A Plotter, 9874A Digitizer, 9878A I/O Expander, 9884A Tape Punch, 7245A Thermal Printer Plotter, 7225A Graphics Plotter and 9885M/S Flexible Disk Drive are also available.

Integrated Printer

An integrated thermal line printer provides 16-character-wide hard copies quickly and quietly. It prints 190 lines per minute using the standard 128-character ASCII set.

Memory

Standard memory for the System 35 is 64K bytes of read/write and 112K bytes of read/only memory. The user (read/write) memory is expandable in increments of 64K to the full 256K bytes. At this maximum configuration, a System 35 can manage a 30,000-element array of 12-digit floating-point numbers.

With the new smaller HP ROM configuration, read-only memory can be expanded by 128K bytes. ROMs include input/output, compatible with the System 45, a plotter ROM and a mass memory ROM. The last enables the HP System 35 to communicate with flexible disc memory.

Software

System 35 software packages are available for sorting, numerical analysis, information management, financial and statistical applications.

The use of HP enhanced BASIC on both the HP System 35 and 45 greatly simplifies the exchange of data and programs between the two machines. Because of their common language, System 35 and 45 share an extensive library. Some programs available for the System 35 include basic statistics and data manipulation, regression analysis, numerical analysis, nonlinear regression and information management.

All Hewlett-Packard software packages are designed to give the user standard routines common to the application for smooth transition to System 35.

Assembly Language

The Assembly language programming option provides improvements up to 100 times in speed over traditional desktop computer languages, depending on the application. This capability is of particular interest to experienced programmers. Both computation and I/O can be accelerated because Assembly language allows the programmer to converse directly with the computer's CPU in its own internal language. The HP System 35 models are the first desktop computers to offer this capability.

Enhanced BASIC Language

The standard language for both models is HP enhanced BASIC. In addition to handling programs written in ANSI BASIC, HP enhanced BASIC makes available to users such FORTRAN-like capabilities as subprograms, multicharacter identifiers, large-scale array operations, line labels and flexible output formatting.

System 35 is designed for the scientist or engineer who wants an integrated computer with minicomputer capability or is involved in research and needs desktop computer flexibility combined with true minicomputer power. Providing more internal storage allows for manipulation of large arrays and for programs to format output and to solve complex mathematical problems. Throughput improves because less time is required for overlays of large programs.

The 9835A allows for editing multiple program lines since many program lines can be viewed at once and the user can examine data to make changes *before* the data is output or manipulated. System 35B provides the same computer power as the 35A without the added expense and volume of the CRT display. A 32-character LED display provides user interaction while keeping size to a minimum for applications where mechanical ruggedness or space constraints are essential.

System 35 joins HP's powerful line of desktop computers that are characterized by more power, speed, and memory than any other desktop computing system. If you would like to learn how System 35 can be of help to you please contact your nearest Hewlett-Packard sales office or write to KEYBOARD, 3404 East Harmony Road, Fort Collins, Colorado 80525, U.S.A.

9825S

by Evan James, Hewlett-Packard Company, Desktop Computer Division

In response to customer requests, Hewlett-Packard has repackaged the popular 9825A Desktop Computer into a more powerful system that is significantly less expensive than an equally-equipped 9825A. The 9825S features 24K bytes of memory, three times the standard memory of the 9825A, along with enhanced I/O capability in the form of included Strings/Advanced Programming and 9872A Plotter/General/Extended I/O ROMs that were previously optional. This system meets the most commonly expressed needs of our 9825A customers.

The 24K bytes of memory provide the increased read/write space frequently needed to process large programs or arrays of data. In addition, the included Strings/Advanced Programming ROM, 98210A, allows the 9825S to accept and manipulate alphabetic information. All the relational operations permitted in numerical comparisons apply to string computations in the 9825S. The advanced programming capabilities include parameter-passing functions, subroutines with local variables, FOR...NEXT statements and a cross-reference operator. These prove particularly useful when using the 9825S for program development.

The included 9872A Plotter/General/Extended I/O ROM, 98216A, not only provides the statements to drive the HP 9872A Plotter, but it also incorporates extensive read/write, HP-IB bit manipulation, interrupt and other I/O capabilities. A 98214A ROM providing the same powerful capabilities, but substituting the 9862A Plotter statements for the 9872A statements, is available in place of the 98216A ROM.

We have also reduced the prices of factory- and field-installed additional memory for the 9825A Desktop Computer by 50%. ROM prices are reduced as well, particularly the Strings and Advanced Programming ROMs. Full price lists are available from the nearest HP sales office.

These packaging and pricing moves reemphasize Hewlett-Packard's support of the 9825A. Its friendliness, speed and powerful I/O capabilities have made it appealing to a wide range of customers in instrument control, engineering, mathematics and statistics.

New peripherals have been introduced recently to meet needs expressed by our customers. The 7225A Graphics Plotter offers powerful and flexible graphics at a moderate price. The graphics offerings are rounded out with the 7245A Plotter/Printer. It uses thermal print technology to accomplish professional-looking finished documentation and long-axis plotting, and includes unattended graphics and printing capabilities.

If you would like more information, please contact your nearest Hewlett-Packard sales and service office or write to *Keyboard*, 3404 East Harmony Road, Fort Collins, Colorado 80525, U.S.A.

An I/O Glossary For Hewlett-Packard Desktop Computer Users

by Steve Leibson, Hewlett-Packard, Desktop Computer Division

One of the most difficult problems encountered when entering a new technical field is that of jargon. Every discipline seems to have developed its own unique vocabulary, and the world of computer I/O (input/output) is no exception. To aid the computer user inexperienced in such matters, this I/O glossary is presented.

A

accumulator a register inside the computer processor used to store operands to be operated upon and to receive the results of such operations. A computer may have several accumulators.

alphanumeric pertaining to a device, system, character set, etc. that is capable of representing letters and numbers.

ASCII (American Standard Code for Information Interchange) a seven bit code capable of representing letters, numbers, punctuation marks and control codes in a form acceptable to machines.

analog a characteristic that is continuous in form as opposed to digital, which is characterized by discrete levels.

analog-to-digital (A to D) conversion a process which quantitates an analog quantity and produces a digital representation of this quantity.

APL a high level computer language which is strongest in the procedural/algorithmic area. Specially developed mathematical operators are used.

assembler language a low level computer language used for implementing higher level functions. One assembler statement produces one machine instruction.

asynchronous device a unit which operates at a speed not associated with any particular portion of the system to which it is connected and is therefore not a time-critical component.

asynchronous data communications a serial I/O protocol in which each byte transmitted is self-sufficient and bears no exact time relationship to preceding or succeeding bytes.

B

background program that portion of the resident computer program which is run when no immediately pressing needs exist in the system.

base the radix or number of characters in a particular number system. The decimal system is base 10.

BASIC language (Beginners All-purpose Instruction Code) a high level language which is particularly easy to learn. The American National Standards Institute (ANSI) has standardized a minimal set of BASIC. Hewlett-Packard has a set of BASIC statements that is compatible across a wide range of machines.

baud rate (bit rate) the rate in bits per second at which information is transmitted over a serial data link.

BCD (binary coded decimal) a four-bit system of coding the numerals 0 through 9, leaving the six most significant codes unused.

benchmark a test program used to compare the relative speeds of two or more systems.

bidirectional lines links between devices in a system that may carry information in either direction, but not both simultaneously.

binary a number system of radix 2, using the numerals 0 and 1.

bit (binary digit) a single digit of a binary number.

binary synchronous (BISYNC) a synchronous data communications protocol that is byte oriented.

bipolar an integrated circuit technology characterized by high speed, medium power and wide availability.

bit rate see baud rate.

BPS (bits per second) see baud rate.

buffer, hardware a register or set of registers used to temporarily store information, usually to act as a transition medium between a fast and a slow device.

buffer, software a location or set of locations in memory given a name by the resident program and used to hold information until it can be utilized.

bus (buss) a set of hardware lines that may be used to connect several devices together for communications purposes.

byte a group of eight bits.

C

card, interface a device that converts a computer I/O bus into some standard I/O configuration (eight or sixteen bit parallel, BCD, RS-232, IEEE-488, etc.).

character one of a set of elements in a set used together with other elements in the set to express information.

character set a group of elements, which taken as a whole can express all of the information desired in a particular system.

checksum a quantity, usually following a string of characters, used in several error-checking algorithms.

chip, integrated circuit an electronic component comprised of a large number of basic devices all combined on a single silicon chip.

CMOS (Complementary symmetry metal-oxide semiconductor) a logic family of integrated circuits characterized by extremely low power, medium speed, wide availability and static discharge susceptibility.

clock a periodic signal used throughout a system for timing and synchronization.

code, machine the basic instructions of a computer processor.

compiler a program having a high level language program as its input and machine code as its output.

complement, ones the inversion of every bit of a binary number, i.e. all ones are changed to zeros and all zeros to ones.

complement, twos a ones complement plus one.

compute bound a program which is speed-limited by the computations being performed.

control character an element of a character set which may produce some action in a device other than a printed or displayed character. A character may become a control character in some systems by a special preceding character or set of characters.

controller the device in a system that dictates the occurrence of events in that system.

control line a line in a data link which causes information to be transferred.

CRT (Cathode Ray Tube) a popular display device used in computer systems to display multiple lines of text or graphics.

D

data bus a set of lines for carrying data or characters between devices.
data communications generally taken to mean serial data I/O but may include any I/O between digital devices.
data set a device used to encode digital data onto voice phone lines. Also called a modem.
data terminal a class of devices characterized by keyboards and CRT displays.
decimal pertaining to the number system with ten numerals.
digital a quantized method of representing a quantity or information.
digital-to-analog (D to A) conversion a technique for converting a quantized representation of a quantity into a continuous signal.
DMA (Direct Memory Access) an I/O technique for transferring data between a device and memory without the aid of the computer processor. Special hardware is required to operate the memory independently.
driver, hardware a circuit used for impressing a signal on a conductor.
driver, software a program that is used to transmit information to a device using a device-dependent protocol.
DTL (Diode Transistor Logic) a logic family, compatible with TTL, now extinct.

E

EBCDIC (Extended Binary Coded Decimal Interchange Code) a special IBM character set.
emulator a circuit or program that imitates another circuit or program in real time.
erasable programmable ROM (EPROM) an integrated circuit used to store programs or data which may be erased. Usually used in development work.
exponent the power of ten used in scientific notation.

F

fan in the load a logic circuit input places on a signal line.
fan out a measure of the drive capability of a logic circuit output.
firmware a program placed into ROM. Hewlett-Packard places the operating systems of desktop computers in firmware.
flag line a line in a data link used to signal the status of a device.
foreground job a portion of a program that has highest priority and runs whenever possible.
full duplex a characteristic of serial I/O where data may flow between two devices in both directions simultaneously.

G

gate the minimal logic element.
GIGO (Garbage In Garbage Out) the usual explanation for "Why doesn't my program work?"
ground, earth or safety a wire that is at earth potential, or at least is supposed to be.
ground, logic a level that is used as a reference for digital signals in a system. Not necessarily at the same potential as earth or safety ground.

H

half duplex a characteristic of serial I/O where data may flow between devices in only one direction at a time.
handshake may be either hardware or software and characterizes a protocol for transferring information between devices.
hardware the circuitry in a system.
hardware interrupt a mechanism by which the computer processor may be interrupted from what it is doing to perform a more urgent task.
Hewlett-Packard Interface Bus the Hewlett-Packard implementation of the IEEE 488-1975 Instrumentation Bus used to interface multiple devices together with a well-defined hardware protocol.
high-level language a computer language characterized by powerful statements and highest ease of programming.
HPL (High Performance Language) a high level computer language implemented in the 9820, 9821 and 9825 Hewlett-Packard desktop computers. Characterized by extensive I/O capabilities.

I

IEEE (Institute of Electrical and Electronic Engineers) a professional organization that has produced several I/O standards.
initialization a process which takes place whenever the state of a device or program must be known at startup.
input a process of transferring information into a computer.
input/output (I/O) a set of processes for information transfer.
interface the boundary between two devices or programs.
interpreter a program which executes a high-level language directly.
interrupt a disruption in the normal flow of a process.
inverter a logic element that outputs a one for a zero input and outputs a zero for a one input.
I/O bound a program that is speed-limited by the information interchange taking place between devices in a system.

K

k 1024 used in specifying memory size.
K - 1000 used in specifying resistance and dollars.
kluge a concoction of hardware and software which is neither pretty nor producible.

L

latch a logic device which is used for memory.
LCD (liquid crystal display) a display device characterized by extremely high visibility in high light levels and no visibility in darkness.
LED (Light Emitting Diode) a display device characterized by high visibility in darkness and less visibility in high light levels.
logic a group of circuits that perform Boolean arithmetic and memory functions.
LSI (Large Scale Integration) highly dense logic circuits on single chips.

M

machine code the instructions executed by the computer processor.
mainframe the physical computer without devices attached by external cabling.
mantissa the significant digits of a number in scientific notation.
mass memory a device for semi-permanently storing data and programs in a readily retrievable form.
MOS (Metal-oxide Semiconductor) an integrated circuit process characterized by high density, medium speed and medium power.
modem *see data set*

N

negative-true logic a logic system in which the voltage representing a logical 1 has a lower or more negative value than that representing a logical 0. Most parallel I/O buses use negative-true logic due to the nature of commonly available logic circuits.
network a term used in data communications to describe a group of devices with varying degrees of intelligence that are interconnected to form a large system.
non-volatile memory a memory within a device that will retain information even when the device is switched off. Implementation is usually with ROM, PROM, EPROM, or RAM with battery backup.
nybble half a byte (four bits). BCD data is packed into nybbles.

O

object code a program in machine code, the ultimate form that any program must be reduced to before it can run on a processor.
octal a base-eight number-representation system using numerals 0 through 7. Used in the creation of machine code programs and useful in visualizing bit patterns.
ones complement arithmetic a binary arithmetic system in which negative numbers are created by inverting individual bits in the binary representation of the positive number.
open collector a type of output structure found in certain bipolar logic families. The output is characterized by an active transistor pulldown for taking the output to a low voltage level, and no pullup device. Resistive pullups are generally added to provide the high level output voltage. Open collector devices are useful when several devices are to be bused together on one I/O bus such as IEEE-488-1975 (HP-IB).
operating system a systems program that provides the programmer with utilities including I/O routines, peripheral handling routines, and high-level languages.
output the act of providing information from a device to the outside world. Generally accompanied by a device that inputs the information being output by the first device.
overlap a mode of computer operation in which several processes take place seemingly simultaneously. In a multiprocessor system, simultaneous operation is truly possible. In a single processor system, processes timeshare the processor and appear to happen simultaneously while actually occurring in a time-sequential mode. In either case, real time savings can be realized, especially when extensive I/O to many devices of differing speeds is taking place.

P

packed data information which has been compressed to make optimal use of memory. Four BCD digits can be packed in a 16-bit memory location.
paper tape one of the oldest, slowest and cheapest methods of storing archival information in a computer system. Data is stored in punched-hole sequences on a strip of tape.
parallel I/O the fastest, simplest method of interconnecting two devices using a minimum of circuitry. Data is transferred in a bit-parallel format, with the width of the interconnect bus generally equal to the computer memory width, in bits. Eight-bit buses are common, as they are ideal for character code transmission.
parity an error detection method used in I/O where noise is a possible problem. Parity is determined by counting the number of ones in the data word. Odd parity sets the parity bit so that the total number of ones sent is odd. Even parity sets the parity bit for an even number.
peripheral a device connected to the computer's processor and used to accept or provide information from/to the external environment.
peripheral processor a processor used to interface to external devices. Generally provided to increase program throughput by allowing simultaneous computation and I/O.
polling a technique used to discern which of several devices on an I/O connection requires service. In a simple form, the processor may periodically interrogate each peripheral device in order to determine the device's status.
priority interrupt an interrupt structure in which devices with higher priority may interrupt the servicing of devices with lower priority. In other systems, priority may only be used in the arbitration of simultaneous interrupts, disallowing interruption of an in-process interrupt service routine.
program a series of statements defining a process or procedure in some form that can be used by a computer.
programmable read only memory (PROM) a logic circuit which can be programmed once in a special PROM programmer and is used to store data and/or instructions that are invariant. Also comes in an erasable model called EPROM.
protocol a set of conventions for transference of information between devices. The simplest protocols define only the hardware configuration. More complex protocols define timings, data formats, error detection and correction techniques, and software structures. The most powerful protocols describe each level of the transfer process as a layer, separate from the rest, so that certain layers such as the interconnecting hardware can be changed without affecting the whole.

Q

queue a list of processes to be executed in sequential order, information blocks to be processed in sequential order, or a mixture of the two.

R

random access memory (RAM) a misnomer applied to read-write memory.
read only memory (ROM) a memory device in which the memory locations are set to fixed patterns when the device is manufactured. Used for invariant programs and data.
read-write memory memory that may be both stored into and read from by the attached processor. Used for storing variable programs and data.
real time operation of a system at a speed sufficient to perform the required tasks within the actual amount of time in which they must be performed.

real time clock a device which measures time at a rate consistent with the tasks being performed. Sometimes used for pacing the occurrence of events within a system.
register a device used for holding a piece of information to be processed or transferred.

S

schematic a drawing showing the interconnection of circuits to form a device. Generally needed when interfacing two devices that are not plug-to-plug compatible and sometimes for those that are.
SDLC (synchronous data link control) a protocol specifying a layered approach to serial data communications.
serial I/O a type of interconnection in which information is transferred one bit at a time. The most common serial I/O hardware schemes are RS-232 and current loop. Both of these are pseudo-standards in that most interfaces implementing these schemes work similarly but are not necessarily plug-to-plug compatible.
simplex a unidirectional implementation of an I/O protocol.
software interrupt the interruption of a user-level program in response to the acknowledgement of a hardware interrupt by the operating system. In high-level language programs, software interrupts can safely occur only at the end of a program line.
status information pertaining to the current state of a device.
status line a simple method of representing some state of a device in an interconnection scheme.
string a set of characters ordered in some manner.
strobe a control signal used to effect information transfers at the hardware level.
synchronous data communications a serial I/O hardware protocol in which transmitter and receiver are synchronized to a common clock signal.
synchronous device a device that transfers information at its own rate and not at the convenience of any interconnected device.
synchronous transfer an I/O transfer which takes place in a certain amount of time without regard to feedback from the receiving device.

T

threshold the signal level at which a change in logical state is encountered in a circuit, such as 1 to 0 or 0 to undefined transitions.
transceiver a circuit or device that is capable of both sending and receiving.
transistor-transistor logic (TTL) a logic family characterized by high speeds, medium power consumption and wide usage.
tristate an output configuration found in several logic families which is capable of assuming three output states: high, low, and high impedance. This feature is useful for interconnecting large numbers of devices on the same wires while allowing only one to control the levels of the lines at a given time.

U

universal asynchronous receiver/transmitter (UART) a logic circuit that converts parallel information to an asynchronous serial format, and serial information to a parallel format. Useful for connecting processors with parallel data buses to serial I/O lines.
universal synchronous/asynchronous receiver/transmitter (USART) a logic circuit that can interconnect a parallel I/O bus to either an asynchronous or a synchronous serial I/O line.

V

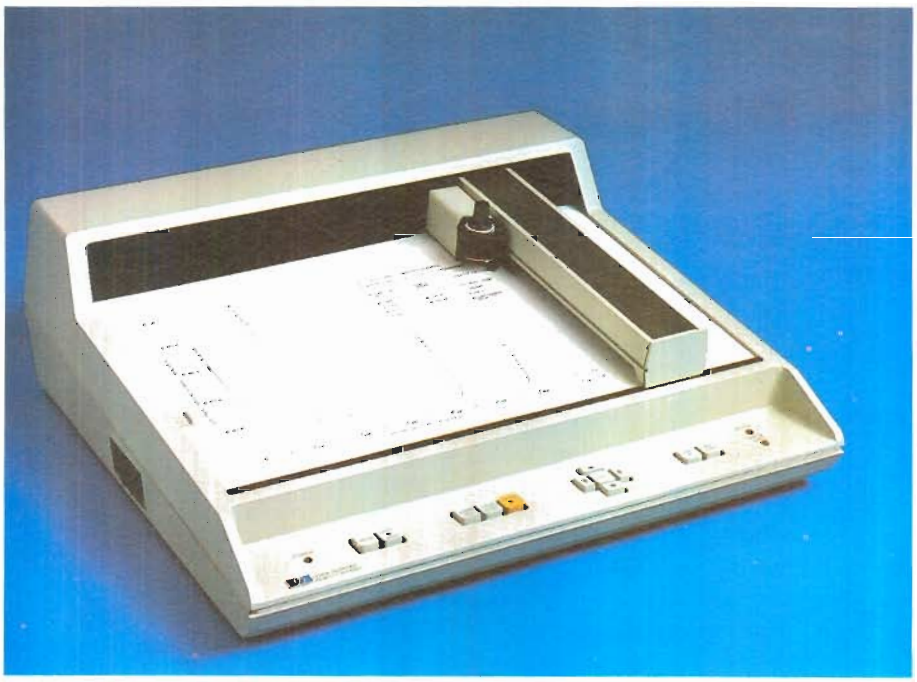
vectored interrupt an interrupt scheme where each interrupting device causes the operating system to branch to a different interrupt routine. This scheme is useful for very fast interrupt response.
voice channel a transmission medium originally designed for voice (i.e. a telephone line). Modems can be used to impress digitial information on these channels for long distance I/O.

W

word the basic size of a piece of information in a computer system. Most current microprocessors have a word size of eight bits or one byte. Newer processors and minicomputers may have word sizes of 16, 24 or 32 bits.

Conclusion

The terms given in this article do not form a definitive list of words used in the field of I/O. In addition, the definitions given are not necessarily universal. This glossary has been written only to acquaint the reader with the more commonly used terms encountered when trying to interface modern computer equipment. Whenever attempts are being made to get devices to communicate, it is always desirable to ensure that the human designers and users of these devices have communicated first.



7225A Plotter

by Bob Reade, Hewlett-Packard Company, San Diego Division.

If you want to add graphics capability to your desktop computer, cost should not deter you. The newest addition to Hewlett-Packard's growing line of plotters, the 7225A, was designed specifically to bring low-cost plotting capability to the full spectrum of HP desktop computers. It is priced between $2000 and $2600, depending upon your interface requirements.

The 7225A has a modular design. It is a rugged, high quality plotter that can be configured to operate with a wide range of desktop computers by means of personality modules that provide both interface and language.

The modules provide a range of capabilities from a minimal interface for pen-up, pen-down, and basic motor control functions, to a full HP-IB (IEEE-488) interface with Hewlett-Packard Graphics language (HPGL) capability.

There are two personality modules of importance to HP desktop computer owners. The 17601A makes the 7225A an HP-IB plotter for interfacing with the 9825A, 9835A, and the 9845A. It uses HPGL and offers 38 instructions for vector plotting, character set and line type selection, point digitizing, user unit scaling and labeling. The size, slant and direction of characters are programmable. Plotting commands are simple, two-letter mnemonics.

The 17600A personality module brings the GP-10 interface to the 7225A and makes it plug-to-plug compatible with the 9862A. The 7225A becomes a plotter for HP desktop computer models 9815A, 9820A, 9821A, 9825A, and the 9830A/B with the 17600A personality module.

Paper up to 8½ x 11 inches (ISO A4 size) or an equivalent 216 x 280 mm can be used on the plotter. Line quality is excellent. The 7225A plotter draws straight lines of any length and angle within the plotting area, given only the end-point coordinates. Plotting accuracy, including linearity and repeatability, is 0.4 mm (0.016 in.). Addressable microsteps of 0.032 mm (0.00125 in.) provide visually clean, continuous ink lines to produce publication-quality plots. Plotting speed between points is 250 mm/s on either axis, and text is drawn at 3 characters per second (2.5 mm high characters).

If you would like more information on this latest addition to our x-y plotter line, please contact your nearest Hewlett-Packard sales office or write to Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94303, U.S.A.

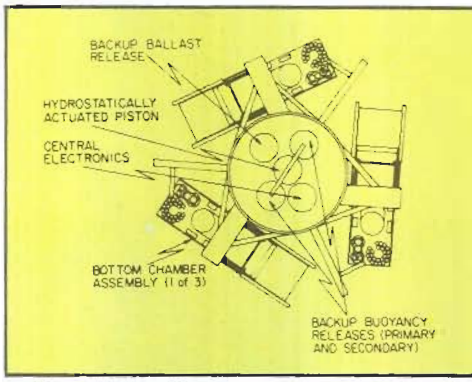
Manganese Nodule Research

by Albert B. Sperry, Hewlett-Packard Company, Desktop Computer Division

In recent years, oceanographic research has witnessed a number of research projects that are either unprecedented or are being undertaken in much greater detail than ever before. The Manganese Nodule Program (MANOP), sponsored by the U.S. National Science Foundation at several U.S. universities and oceanographic institutions, involves studying the chemical and biological environments that control the formation of deep-sea ferromanganese nodules found on the ocean bottom in water depths up to about 6 kilometers.

Although the presence of nodules in the deep sea has long been known and there is considerable literature on their descriptive, geochemical and petrological studies, the mechanisms responsible for their growth and the processes controlling their distribution and chemical composition remain largely undiscovered. MANOP has resolved to study these problems through a detailed chemical investigation of the seawater-sediment boundary in areas where the nodules are indigenous.

The seawater-sediment interface experiments are conducted by a microprocessor-controlled instrumented vehicle, the MANOP Bottom Lander, now being developed at the Scripps Institution of oceanography, University of California at San Diego. This vehicle can operate submerged for periods of up to one year, performing chemical flux experiments and storing the resulting data for recovery and processing after resurfacing. A desktop computer, an HP System 45, is being used to program the microprocessors, recover the lander's memory contents and analyze the data.



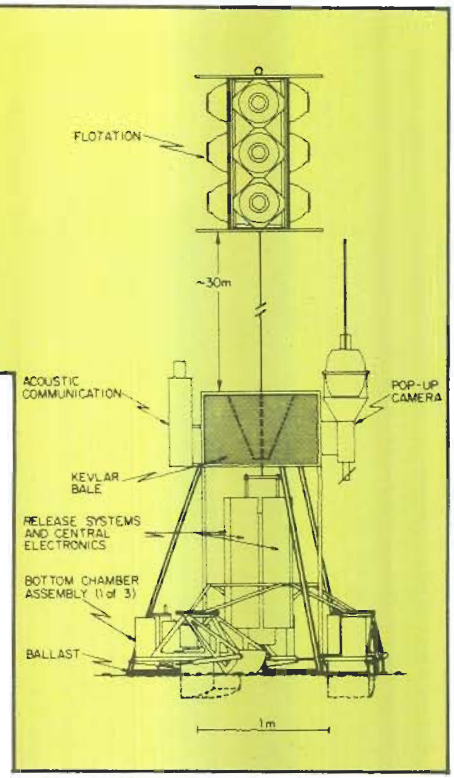


Figure 1. Simplified top and side views of MANOP Bottom Lander.

An acoustic link to the surface allows shipboard monitoring of the data collected by the lander to verify performance during the experiments. Capability is provided to modify the lander programs from shipboard if desired. The acoustic link also enables shipboard initiation of lander surfacing procedures, either when initial deployment is unsatisfactory or at the end of the scheduled immersion period.

Initial operational tests of a few days duration will take place in early 1979. Summer will see the lander deployed on its first data-gathering mission about 1200 nautical miles southeast of Hawaii..

Lander Operation

The MANOP Bottom Lander (Figure 1) is basically a tripod. It stands within an area about two meters in diameter, and is about 2.5 meters high, excluding a flotation array tethered 30 meters above the lander so as not to obscure acoustic communication. Three identical, microprocessor-controlled bottom chambers located on the tripod legs contain the equipment for the interface experiments.

The Scripps Institution of Oceanography is surveying five planned North Pacific deployment sites and will select exact placement within each site according to structural, sedimentary, topographic and nodule-coverage considerations. The lander will be lowered on a conducting cable until it is several meters above the chosen ocean-bottom site. After acoustic checkout of the systems, the lander will be released from the cable. The entire system including the flotation array will have sufficient weight to allow implanting the bottom chambers, the lids of which will be open, on impact. After waiting for any turbidity caused by implantation to settle or be swept away, the chamber lids are closed and the experiments begun. The chamber lid closing is monitored by a camera, which is floated to the surface for film processing and inspection to verify proper operation.

Bottom Chamber Experiments

Each bottom chamber is equipped with twenty-four 100-ml sampling volumes. One or more of the sampling volumes is filled with a radioisotopic or chemical spike intended for injection into the chamber during the experiment; the remaining sampling volumes are used solely for sample collection. One or more sampling volumes can be preloaded with a suitable chemical if it

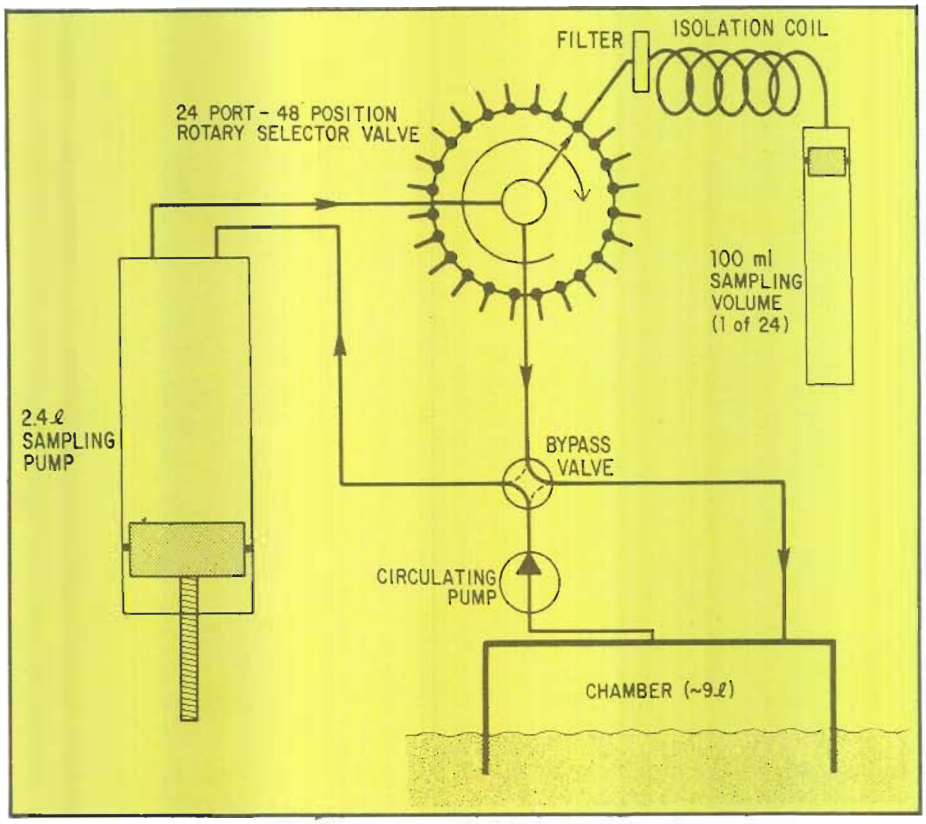


Figure 2. Water flow diagram for each of three bottom chamber experiments.

is desired to poison samples against biological degradation.

At each chamber (Figure 2), the experiments are controlled by a bidirectional sampling pump, a circulating pump, a 4-way bypass valve and a 24-port, 48-position rotary selector valve. With the 4-way bypass valve in its normal position, the circulating pump is used to flush the sampling pump and selector valve with the water in the bottom chamber. The return flow is used to stir the chamber contents.

When the lander is first deployed and the chamber lid is still open, the valves and sampling pump are purged with ambient bottom water by running the circulating pump. When the chamber lid is closed, the total volume of the system is fixed, and experiments are conducted with zero pressure gradient between the chamber and the surrounding seawater.

In order to inject a spike or take a sample, the bypass valve is turned to isolate the sampling system and allow the circulating pump to continue its stirring. The rotary valve is indexed from one of its intermediate off positions to the appropriate sampling volume, and the sampling pump piston is moved either in or out, depending on whether a sample is being taken or a spike is being injected. The rotary valve then indexes to one of its off positions and the bypass valve returns to its normal position so the circulating pump can continue to flush the sampling system. The change in the active circulating system volume due to sampling or injection is thus exactly compensated by the sampling pump piston, and there is no tendency for the chamber-sediment seal to leak during the sampling process.

All surfaces inside the chambers, pumps, tubing and sampling volumes are made of chemically-inert plastics, and seals exposed to the samples are made of silicone and pure butyl rubbers to minimize experiment contamination.

Each chamber has a horizontal skirt to limit sediment penetration to about 20 cm, leaving about a 10-cm water depth inside the chamber. This water depth corresponds to about 9 liters per chamber; the water volume is calibrated precisely by measuring the dilution of a known isotopic or chemical spike.

At the end of the experiment, hydraulic cylinders force scoops under each chamber, thus closing the chamber to collect box-core sediment samples for further examination after the lander resurfaces. The sediment and nodule sample volume will be about 18 liters per chamber.

Oxygen and pH measurements are also made in each chamber periodically to add to the experiments' verification and chemical data.

Lander Recall

At the end of the chamber experiments, an acoustic command or an independent timed backup release will recall the lander to the surface. The recall command actuates a vertical, hydrostatically-operated piston, which first actuates the hydraulic scoops to close the chamber bottoms, collecting the core samples. Continuing piston travel then releases ballast weight from the bottom of the lander, pushing against the weights with up to several tons pressure to extract the lander and its chambers from the sediment.

The lander design includes considerable redundancy in the recovery operation. At any time during the operation, the lander can be made buoyant by releasing ballast through a redundant mechanism, and venting the bottom chambers to relieve suction. Further backup is provided by a 6,000-meter bale of 6-mm Kevlar aramid fiber cable fitted to the top of the lander tripod. Using an acoustic release with a timed

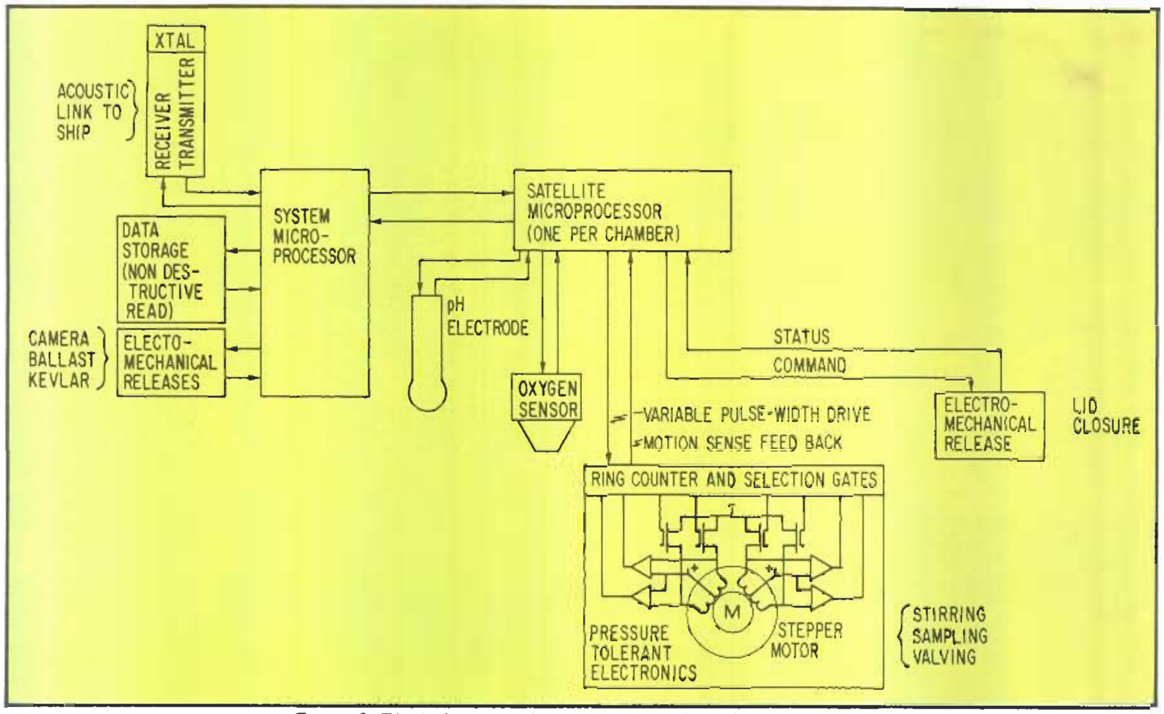


Figure 3. Block diagram of microprocessor-based control system.

backup, the entire flotation array can be released to the surface, pulling the Kevlar line, which can then be used to winch the lander to the surface. If all else fails, the lander's transponder can be used to guide a grappling operation.

Control System

A simplified block diagram of the MANOP Bottom Lander's microprocessor-based control system is shown in Figure 3. Where there are several nearly identical control circuits, only one example is shown. The system uses four RCA CDP 1802 CMOS microprocessors: one for the central system, and one satellite microprocessor for each of the three bottom chamber experiments.

One principal advantage of this approach is its inherent flexibility. Sampling, spike addition, and oxygen and pH measurement sequences can all be controlled by software, including the capability to adjust these sequences in the case of unexpected results or equipment failure. By monitoring the system through the acoustic data link, it is possible to instruct the lander to follow an alternate plan of operations based on shipboard analysis of the data.

The microprocessor system is also assigned the critical task of minimizing power consumption. Because the microprocessors use CMOS circuitry, their own power consumption is negligible compared to that of the motors required to operate valves and the stirring and sampling pumps. Stepper motors without magnetic detents are used for this purpose, with the satellite microprocessors sensing their motion and optimizing their power consumption. The satellite microprocessors will also control the duty cycle of the oxygen and pH probes by sensing their approach to equilibrium readings. Finally, the microprocessors will monitor the various battery systems and will be able to adjust or transfer power usage in the case of premature failure.

Desktop Computer Roles

The System 45 desktop computer plays several important roles in the MANOP research. It is used in the engineering design; it interacts with the microprocessor system; it acts as a communication link in the acoustic communication system; it recovers and stores data from the experiment and interprets the data.

Designing a submersible vehicle such as the MANOP Bottom Lander is much like designing a space vehicle, except that the inside-to-outside pressure gradient is reversed and is much greater for a vehicle that operates at up to 6,000 meters below the ocean surface, where pressure can be as high as 600 atmospheres. Weight becomes an important consideration, both because of the cost of flotation and because a large flotation array is difficult to handle during launching and recovery.

Among various System 45 programs written at Scripps, one optimizes pressure container design, outputting the resulting wall thickness and other dimensions, the total weight, and the buoyancy.

The MANOP engineers have written an assembler that allows the System 45 to program the microprocessors in hexadecimal code using keyboard-selected mnemonics. The computer handles the addressing and jumps. This approach saves a significant amount of time over manual coding. It also saves the expense of buying a separate development system for microprocessor coding, and the computer is available for other use in design, control, communication, and data recovery and analysis.

The acoustic communication system exercises a wide range of control in lander operations. The System 45 aboard a monitoring ship generates binary code to select one of two acoustic frequencies used by the system. During the experiment, changes can be made in operation sequence or an entirely different procedure can be initiated by an acoustic message, based on analysis of data retrieved from the lander.

On signal from the System 45, the acoustic communication system can recall the lander to the surface, either when a deployment site proves unsatisfactory or at the completion of the experiment.

After the lander is recalled to the surface at the end of the experiment, the desktop computer retrieves the data from the lander's memory, stores it on flexible discs with tape cassette backup, and interprets it.

Conclusion

At the end of the MANOP Bottom Lander experiments, along with supplemental coring, sediment trap deployments and mineral exposure experiments, the MANOP scientists hope to gain considerable knowledge about the processes controlling the formation and growth of the ferromanganese nodules, as well as their distribution and chemical composition. Knowledge gained from these experiments may help to determine how to optimize the use of this mineral resource which may soon be the subject of extensive commercial mining operations.

Reference

FREE VEHICLE INSTRUMENTATION FOR THE *IN SITU* MEASUREMENT OF PROCESSES CONTROLLING THE FORMATION OF DEEP-SEA FERROMANGANESE NODULES by R. F. Weiss, O. H. Kirsten and R. Ackermann. In *Oceans '77 Conference Record*, paper 44D, Marine Technical Society and Institute of Electrical and Electronics Engineers (1977).

Programming Tips

WRITE and FORMAT Incorporating Variable Length Strings (9830A/B)

By means of Keyboard 1978/2 we discovered that a sure way to receive world-wide comments from our customers is to publish a programming tip using one of several possible techniques to accomplish a particular purpose. In response to the programming tip by G. Fletcher, we received letters from ten readers from Australia, South Africa, Italy, the Netherlands, Spain, the United Kingdom and the U.S.A., suggesting alternate means to improve the method of maintaining string length and tabulation of output columns. We appreciate these letters, and have determined that the following coding will accomplish the task effectively. This was suggested by W. Guttormsen, McWilliam & Partners Pty. Ltd., Brisbane, Australia, and Josep M. Masso, La Vanguardia, Barcelona, Spain.

The coding in line 20 is changed as follows, and lines 30, 40 and 50 can be eliminated.

```
20 READ A$[1,32], A,B,C
```

Character Slant in a 9845/9872 System

by Rita Wigglesworth, Hewlett-Packard Company, Desktop Computer Division.

Characters drawn via the LABEL, LABEL USING or LETTER statements are defined within the Graphics ROM and cannot be slanted. To slant characters, use the 9872A as a printer and send HPGL slant and label instructions. An example is shown below. Use FIXED 4 format to send the tangent of the slant angle. If the tangent is so large as to require scientific notation, the plotter will generate an error when it encounters the "E". For reasonable slant angles, this problem should not occur.

```
10 DEG
20 FIXED 4
30 PRINTER IS 7,5
40 FOR Angle=−70 to
70 STEP 10
50 PRINT "SL";TAN(Angle)
60 PRINT "LBH^E_x "
70 NEXT Angle
80 END
```

HHHHHHHHHHHHHHHH

9815A Data Entry

by Chris Jennings, Research Officer, Graylingwell Hospital, Chichester, Sussex, United Kingdom.

Entering and storing strings of single digit numbers on the 9815A can be a tedious process because of the need to press Run/stop after each digit. The routine below enables the user to key in up to 10 digits at a time, pressing Run/stop once only at the end of the string, thus saving time. The program splits the 10 digit number into 10 single digit numbers and stores each one in a separate register.

```
0000 0
0001 #REGS
0002 1
0003 1
0004 #REGS
0005 CLRA→J
0006 1
0007 STO      E
0008 1
0009 STO      I
0010 1
0011 0
0012 STO      B
0013 STOP
0014 STO      D
0015 RCL      B
0016 RCL      I
0017 -
0018 STO      J
0019 0
0020 STO      H
0021 1
0022 STO      A
0023 RCL      B
0024 RCL      I
0025 ÷
0026 STO      F
0027 FOR      A→F
0028 RCL      D
0029 1
0030 0
0031 RCL      J
0032 Y↑X
0033 ÷
0034 INT
0035 STO      C
0036 RCL      H
0037 1
0038 0
0039 RCL      I
0040 Y↑X
0041 *
0042 -
0043 STO I    E
0045 PRINT
0046 RCL      C
0047 STO      H
0048 RCL      I
0049 STO-     J
0050 1
0051 STO+     E
0052 NEXT     A
0053 END
```

The number of digits entered together can be set to any number from 2 to 10 by changing the value of B. The value of E indicates the register into which the single digit number will be placed. The program can also be used to store multi-digit numbers. By changing the value of I, a string of digits can be split, instead, into 2-, 3-, 4- or 5-digit numbers.

This routine can be incorporated into larger programs and by use of a further loop, longer strings of digits can be entered in groups of up to 10 (e.g. 50 digits in 5 groups of 10).

9815A/S Tape Duplication

This is an expanded and corrected version of F. William Schueler's programming tip for duplicating tapes with the 9815A that was published in Keyboard 1978/2. The listing below allows handling cassettes with empty files, a condition that was not covered in the original program. This tip works equally well with either the 9815A or the new 9815S.

Operating instructions remain the same as for the original listing. Additionally, if a different 'cushion' is desired between the program length and the file length, merely change the constant in lines 122-124 and, if the change is an order of magnitude, adjust the constant in line 126 accordingly; i.e., if lines 122-124 were changed to 10, then line 126 would be changed to 1. If no 'cushion' is desired, delete lines 122 through 127.

Since the original programming tip was published, we have introduced the new 98137A Tape Duplication Interface (Keyboard 1978/3). This offers a considerably simplified means of tape duplication when used with two 9815As with the optional two I/O channels and identical memory size, or with two 9815Ss. You may want to consider this alternative if you have a continuing need for copying tapes.

```
0000 2
0001 EEX
0002 3
0003 STO      J
0004 1
0005 9
0006 2
0007 STO      I
0008 PRNTα
0010 M
0011 I
0012 N
0013
0014 F
0015 I
0016 L
0017 E
0018
0019 #
0020 ENDα
0021 STOP
0022 PRINT
0023 STO      B
0024 IF -
0025 SFG      1
0026 PRNTα
0028 M
0029 A
0030 X
0031
0032 F
0033 I
0034 L
0035 E
0036
0037 #
0038 ENDα
0039 STOP
0040 PRINT
0041 STO      C
0042 IF -
0043 SFG      2
0044 IF CFG 1
0045 GOTO     0162
0047 0
0048 IF SFG 2
0049 RCL      C
0050 +⇌-
0051 STO      A
0052 RCL      B
0053 +⇌-
0054 STO      F
0055 FOR      A→F
0056 0
0057 #REGS
0058 PRNTα
0060 1
0061 S
0062 T
0063
0064 I
0065 N
0066 ENDα
0067 STOP
0068 GOSUB    0187
0070 IDENT
0071 ROLL↓
0072 STO      D
0073 ROLL↓
0074 STO      E
0075 1
0076 8
0077 1
0078 6
0079 IF X<Y
0080 SFG      3
0081 ROLL↓
0082 ROLL↓
0083 2
0084 IF X=Y
0085 SFG      4
0086 CLX
0087 5
0088 IF X=Y
0089 SFG      5
0090 IF CFG 4
0091 GOTO     0098
0093 RCL      E
0094 8
0095 ÷
0096 #REGS
0097 STO      G
0098 RCL      I
0099 IF SFG 4
0100 0
0101 GOSUB    0187
0103 IF SFG 5
0104 GOTO     0108
0106 IF CFG 3
0107 LOAD
0108 PRNTα
0110 2
0111 N
0112 D
0113
0114 I
0115 N
0116 ENDα
0117 STOP
0118 IF SFG 5
0119 GOTO     0130
0121 RCL      E
0122 2
0123 0
0124 0
0125 +
0126 2
0127 ROUND
0128 IF SFG 3
0129 RCL      J
0130 IF SFG 5
0131 RCL      D
0132 1
0133 GOSUB    0187
0135 MARK
0136 IF SFG 3
0137 SFG      5
0138 IF SFG 5
0139 GOTO     0171
0141 RCL      G
0142 IF SFG 4
0143 0
0144 IF CFG 4
0145 RCL      I
0146 GOSUB    0187
0148 IF SFG 4
0149 RCDATA
0150 IF CFG 4
0151 RCPRGM
0152 CFG      3
0153 CFG      4
0154 CFG      5
0155 NEXT     A
0156 IF SFG 2
0157 GOTO     0191
0159 IF CFG 1
0160 GOTO     0191
0162 RCL      B
0163 IF SFG 1
0164 0
0165 STO      A
0166 RCL      C
0167 STO      F
0168 CFG      1
0169 GOTO     0055
0171 GOSUB    0187
0173 PRNTα
0175 #
0176
0177 PRINT
0178
0179 E
0180 M
0181 P
0182 T
0183 Y
0184 ENDα
0185 GOTO     0152
0187 RCL      A
0188 IF SFG 1
0189 +⇌-
0190 RETURN
0191 END
```

Update

9830A/B and 9831A Support

The 9830 and 9831 Desktop Computers have been two of our most popular and versatile products, opening the door to the world of small desktop computing systems. However, with the introduction of more cost-effective BASIC language systems (the System 45, System 35 and HP 250), sales are diminishing on both older machines. It is becoming impractical to keep production lines devoted to these machines; therefore, we plan to discontinue their production in a few months.

We will continue supporting the 9830 and 9831 through the availability of ROMs, interface cables and field installation kits for one year after the mainframe goes out of production. Technical support and consumables will be available for 10 years after mainframe discontinuance. Full service will be available on site for five years after mainframe discontinuance, and at an HP service facility for five additional years. After that, service will be provided on a "best effort" basis — the standard HP policy for obsolete products.

The 9830A was discontinued November 1, 1978; the 9831A will be discontinued February 1, 1979, and the 9830B May 1, 1979.

Most peripherals that are compatible with both the 9830A/B and other mainframes have been replaced by newer, more powerful products with similar multiple-system capability. One example of this is the new HP 9874A Digitizer, described in the last issue of Keyboard, which offers significantly increased resolution and accuracy over the preceding 9864A, as well as rear projection capability and other improvements in versatility. A few peripherals, including the 9865A Tape Cassette, 9868A I/O Expander, 9870A Card Reader and 9880B Mass Memory Subsystem, which are compatible with just the 9830A/B, will continue to be avilable for 9830 owners wishing to expand their systems, until November 1, 1979.

With the above dates in mind, you may want to advise your local HP sales office or field engineer of your foreseeable needs for these mainframes, supporting parts and software in the near future.

9845 Asynchronous Terminal Emulator, 09845-10040

This software provides asynchronous terminal capability for the 9845. There are two operating modes: LINE sends the entire line to the computer; CHARACTER sends characters as they are typed. The package includes utility programs useful for writing custom emulators, and allows access to mass storage devices via escape code sequences.

9845 List Management, 09845-10530

This software pack allows the user to build, maintain and restructure lists for mailing, library cataloging, personnel files and others. Mailing labels can be generated using an optional HP 9871A or 2631A Impact Printer. The entire list, or parts of it, can be sorted according to name, zip code, occupation, catalog number or any other specified variable.

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For further information on HP products or applications, please contact your local Hewlett-Packard Sales and Service Office or write to Keyboard

CHANGE OF ADDRESS: To change your address or delete your name from our mailing list please send us your old address. Send changes to Hewlett-Packard Keyboard, 3404 E. Harmony Road, Fort Collins, Colorado 80525, U.S.A.

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