

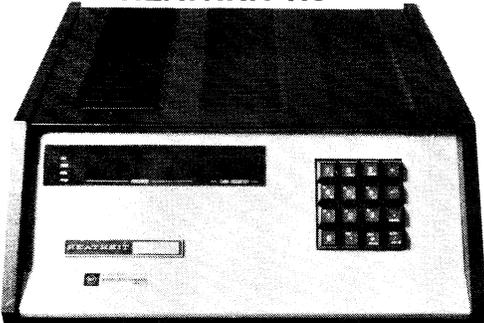
Introducing the Exciting New Computer Kits

FROM



A new value standard in personal computing systems featuring two powerful computers with better software, full documentation and service support from WARBURTON FRANKI. Now available throughout Australia.

HEATHKIT H8



HEATHKIT H8-Bit Digital Computer

The low-cost digital computer that's easy to build and to use! Features an intelligent front panel with keyboard entry and 9-digit display, a heavy-duty power supply with enough extra capacity for memory and I/O expansion and a 50-line fully buffered bus capable of addressing 65K bytes and a mother board with positions for up to 10 plug-in circuit boards. Includes BASIC, assembler, editor and debug software at no extra cost!

SUGGESTED APPLICATIONS: As a trainer—learn microprocessor operation, interfacing and programming. The powerful front panel lets you get at and use all parts of the unit. As an entertainment centre—use game and other applications programmes for entertainment the whole family can enjoy. As a hobby computer—the H8 can be used to process any information you programme into it—it's perfect for hobby experimentation and design. A variety of peripherals and

interfaces let you use it with other equipment—run your ham radio station, control your model railroad system, etc. As an educational system—the H8 is ideal for schools, community colleges, libraries, etc. Full H8 software permits teaching BASIC plus machine and assembly language programming. As a home management centre—use the H8 to keep telephone numbers, monitor your budget, keep your cheque book balanced, do your income taxes, inventory your personal belongings. There are hundreds of ways the H8 can make your life more convenient.



HEATHKIT H9 Video Terminal

The H9 Video Terminal features a bright 12" CRT display with twelve 80-character lines, 67-key keyboard, all standard serial interfaces, plus a fully wired and tested control board and a wiring harness for simplified assembly. The H9 Video Terminal is a general-purpose computer peripheral designed for use with the Heathkit H8 or H11 computers. It provides keyboard input and a CRT for the convenient entry and display of computer programmes and data. The H9 can be used with any digital computer in dedicated stand-alone applications or in time-sharing systems.

Also available the H10 Paper Tape Reader/Punch

A general-purpose mass storage peripheral designed for use with the H8 and H11 computers plus any other computer. Features a heavy-duty built-in power supply, totally independent punch and reader and a copy mode for fast, easy tape duplication.

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WF 529/77

Available in kit form, we review the . . .

Heath H8 home computer system

The Heath H8 Digital computer system has now been released in Australia. Based on the 8080A CPU central processing unit, it has provision for 64k of memory. A companion video terminal is also available, along with an audio cassette recorder, the complete system forming a self-contained home computer station.

by **DAVID EDWARDS**

Comprehensive software routines are available for the H8 system, including a BASIC interpreter, a console debugger (BUG-8), a text editor (TED-8), and an assembly language (HASL-8). We will leave the discussion of these till later in the article, and concentrate first on the system hardware.

The H8 computer unit measures 406 x 445 x 165mm, and weighs 9.5kg. As will be apparent from the photographs, it has a sloping front and is fitted with an eight digit LED display and a 16-key keyboard. Four status LEDs are included on the left-hand side of the display. The power switch is fitted to the rear panel, however, and is rather inconvenient to operate as a result.

Internally, there is a mother board, a front panel board, and provision for seven memory or I/O boards, plus one bus expansion board. The unit supplied for review was fitted with three 8k RAM boards and one serial I/O board, as well as the CPU and PAM-8 monitor board.

The unit is normally supplied with only 4k of RAM, and without the serial I/O board. Normally, it comes in full kit form, and is assembled by the user.

The panel monitor, PAM-8, resides in a 1k ROM, and has the following features:

- Memory contents display and alteration;
- Register contents display and alteration;

tion;

- Program execution control (both breakpoint and single instruction operation);

- Self-contained bootstraps for program loading and dumping;

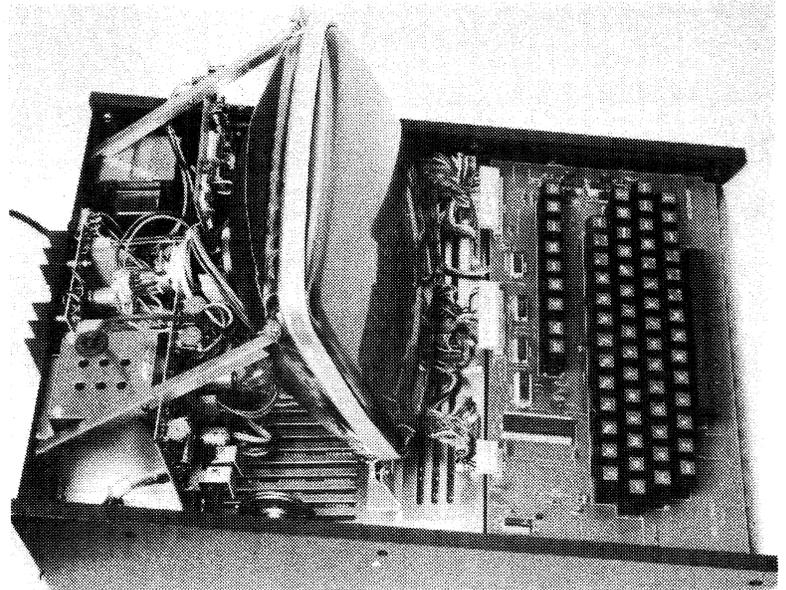
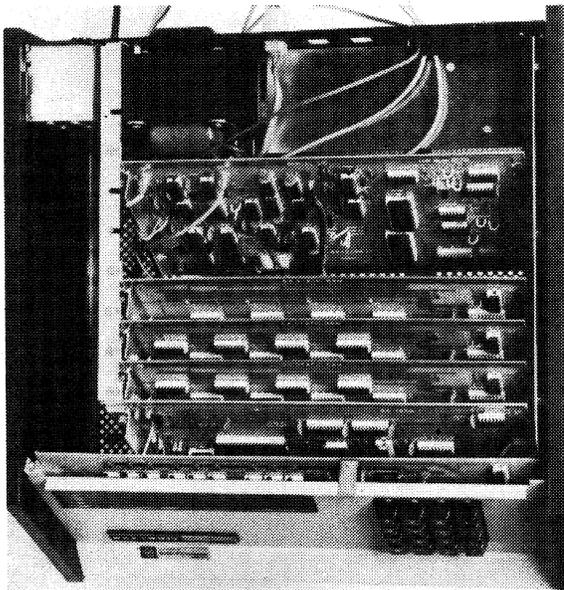
- Port input and output routines.

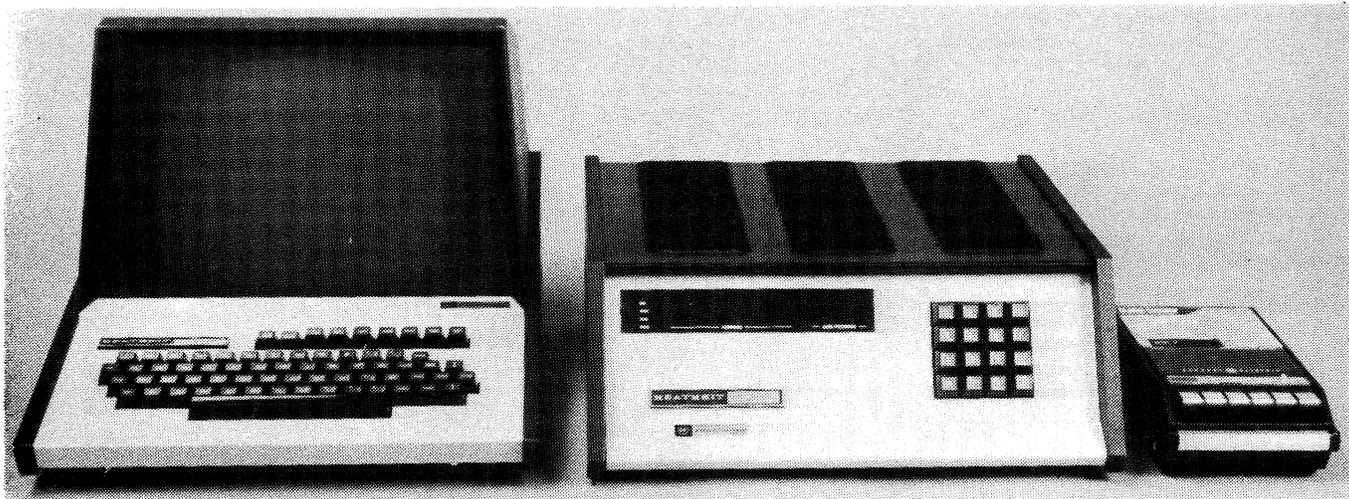
Instruction codes are entered via the keyboard and displayed via the displays in octal notation, with 16 bit numbers being treated in offset octal notation (i.e. 11111111 11111111 is coded as 377 377 and not 177777). Codes are entered as three consecutive octal digits, without the use of any terminating key.

As a result, all leading zeros must be entered. A cancel key is provided to enable erroneous keystrokes to be re-

The mother board is at the bottom of the case, and is fitted with PCB sockets.

Internally, the VDU is dominated by the cathode ray tube and the keyboard assembly.





entered, an audible indication being provided for each keystroke. The decimal points of the displays are used to indicate the display mode (memory address, memory alter, register display and alter).

The load and dump routines are intended for use with an audio cassette recorder, or with a paper tape punch and reader. Programs can be loaded and dumped with a single keystroke. A tape transport control facility is provided, along with error checking routines.

The cassette recorder provided is a self-contained 110V unit, which is powered from a convenience socket on the rear of the computer chassis. Three cables are provided to interconnect it with the H8 unit.

The H8 can be used as a stand-alone computer, with data and programs entered via the keyboard, and results and outputs displayed on the LED displays. It uses the 8080A CPU chip, and can therefore be used with a large range of 8080 compatible software. The reference manual supplied with the system includes a listing of the instruction set, as well as a section on basic computer fundamentals.

The companion H9 Video Terminal has 305mm (dia.) cathode-ray tube, a 67 key ASCII keyboard, and can communicate through a standard 20mA, EIA or TTL serial interface, or through a parallel I/O interface. Overall dimensions are 397 x 527 x 318mm, and the weight is 14.5kg.

The baud rate is user selectable to one of the following values: 110, 300, 600, 1200, 2400, 4800 or 9600. Characters are displayed using a 5 x 7 dot matrix, allowable characters being upper case alphabetic, numerals and punctuation.

A total of 960 characters can be displayed, the normal mode being 12 lines of 80 characters. A plot mode is also available, which has 48 lines of 20 characters. Other features include automatic scrolling, cursor controls, erase to end of page, short form (four 12 line columns of 20 characters), automatic line carry-over, built in audible bell, transmit page.

The operation manual supplied with

the unit contains full details of the various options and controls, including detailed instructions for any alterations that may be required.

Four software routines are supplied with the H8 system. The first of these is the BUG-8 Console Debugger, which is designed to allow machine language programs to be entered and debugged from the video terminal unit.

BUG-8 contains facilities to perform the following major functions:

- Display and alter the contents of a selected memory location;
- Display and alter the contents of any 8080 register;
- Insert and execute breakpoints;
- Execute programs;
- Execute programs one step at a time;
- Load and dump programs to and from tape storage.

Memory locations and memory and register contents can be displayed as either bytes or words, and in octal, decimal or ASCII format. No provision is made for hexadecimal format.

A text editing program called TED-8 is provided, and is intended mainly for producing a source code for processing by the assembler program. However, it can also be used to produce error-free text, such as would be required for reports, letters and manuscripts.

The next software package provided is the Heath Assembly Language, HASL-8. This program assembles a source program composed, using the companion editor program, into a binary program (the object code) for use by the CPU and a symbolic listing for use by the programmer.

Two passes are required through the assembler, the symbolic listing being produced on the second pass, along with a list of any errors present. As well as recognising the standard 8080 opcodes, the assembler also recognises a number of pseudo opcodes, which are used to direct the operation of the assembler and to generate constants in the object code.

The final software package, and perhaps the most interesting, is the conversational programming language,

The complete home computer station is shown above, including the data storage system (the cassette recorder).

BASIC. Two versions of this are available, Benton Harbour BASIC and Extended Benton Harbour BASIC.

Extended BASIC provides for string manipulation, as well as more advanced functions, but is otherwise similar to the unextended BASIC. Standard commands provided include CLEAR, FOR and NEXT, GOSUB and RETURN, IF THEN, IF GOTO, GOTO, LET, LIST, ON GOSUB, ON GOTO, PRINT, READ, DATA, REM, STEP, INPUT and STOP.

A process called command completion is used with these commands. Once sufficient letters of a command have been typed so that the command is defined uniquely, the program takes over and fills in the remaining letters. This saves the programmer time, but does not save program storage space.

The more normal system is to just to allow commands to be abbreviated, thus reducing program length. Integer and floating point numbers can be handled, with a range from 10^{38} to 10^{37} . The resolution is 6.9 digits.

Variables are named by a single letter, or a single letter followed by a single number. Subscripted variables are allowed, as well as string variables.

Two commands, LOAD and DUMP, are provided for loading and dumping programs via cassettes or paper tapes. Programs can be given names, and the load routine will test each program on the tape till a match with the specified name is found, and then automatically load it. A VERIFY command is also provided, to enable tapes to be checked.

The documentation supplied with the units is quite comprehensive, but presumes a deal of knowledge on the part of the user. A newcomer would find it quite difficult to know just what the various software programs are used for, and would probably also have difficulty in actually using some of it.

Further details regarding price and availability are available from the Warburton Franki agent in your capital city.

Two of the finest names in modern electronics, Heath and Digital Equipment Corporation (DEC) combine to bring you the world's first 16-bit computer priced within reach of the general public!

THE HEATHKIT

H11

DIGITAL

COMPUTER



HEATH
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Heath and DEC join forces to bring you mini-computer performance at a microcomputer price! The H11 features a fully wired and tested DEC KD11F board that contains the 16-bit LSI-11 CPU, 4096 x 16 read/write MOS semi-conductor memory, DMA operation; and includes the powerful PDP-11/40 instruction set, PLUS Heath/DEC PDP-11 software. Equivalent commercial versions of the H11 would cost \$1,000's of dollars more!

The New Heath/DEC H11 personal computer is one of the most powerful and sophisticated units available today! It combines the advanced, performance-proven hardware and software of the LSI-11 with Heath's expertise in kit design and documentation to bring you a personal computer of almost incredible power and flexibility. Equivalent commercial versions of the H11 would cost over twice as much, and you still wouldn't get the superior documentation and support of the H11!

POWERFUL HEATH/DEC PDP-11 SOFTWARE AT NO EXTRA COST!

The H11 includes a sophisticated software system that lets you get your computer up and running with practical programming capabilities. This paper tape based software would cost over \$1200 if purchased separately. A minimum of 8K memory is required to run the software. The programs include:

ED-11. Assists you in the creation and modification of ASCII source tapes, also used to write assembly language programs and for general text editing or word processing functions.

PAL-11S. Relocatable assembler converts ASCII source tapes into relocatable binary modules. This lets you create programs in small, modular segments for easier coding and debugging. These binary modules serve as inputs to LINK-11S

NOTE: H11 owners are eligible for membership in the Digital Equipment Computer User's Society (DECUS). This organization provides useful sym-

LINK-11S. Link editor which links the modules created by the PAL-11S into a load module ready for execution on the H-11. The module is loaded into the H-11 via the Absolute Loader.

Absolute Loader. Loads absolute binary tapes into the H11 memory for execution.

ODT-11X. Lets you debug the programs which you have created. Permits modifying and controlling program execution "on the fly" for quick, efficient debugging.

IOX. Executive program permits I/O programming without developing device-driving programs. Links to your programs using the LINK-11S. For use with high speed paper tape reader/punch and line printer.

DUMP-AB AND DUMP-R. Lets you dump absolute binary contents of memory into the paper tape punch.

BASIC. DEC's powerful version of standard Dartmouth BASIC interpreter uses english-type statements and mathematical symbols to perform operations. Immediately translates, stores and executes the program. Includes string capability.

FOCAL™. DEC's own interpretive computer language which combines simplicity with computing power. Ideal for most scientific, engineering and math applications. FOCAL™ programs can be written and executed easily. Both 4K and 8K versions are included.

posia, newsletters, program library and other useful information to help you get the most from your LSI-11 computer.



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THE HEATHKIT H11 DIGITAL COMPUTER



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WF 560/77

Heath's H-11 16-bit minicomputer kit

The recently-released Heathkit H-11 is the first fully professional 16-bit minicomputer system to be made available as a kit. Based on the Digital Equipment LSI-11, it is able to make use of the vast amount of software available for the well-known PDP-11 series of computers. This review of the Heathkit H-11 has been written by an experienced user.

by **D. W. RICKARD**

Computer Centre, Australian Institute of Marine Science
P.M.B. No. 3, MSO Townsville, 4810

The Heathkit H-11 digital computer system is now available in Australia. Based as it is on the Digital Equipment Corporation (DEC) LSI-11 16-bit computer, this is the first fully professional mini-computer to be made available as a kit.

Actually, to call the H-11 a kit is a bit of a misnomer. The LSI-11 central processor board comes completely assembled and tested by DEC, and includes an onboard 4K by 16-bit memory. The constructor only has to assemble the heavy duty switching mode power supply, the back plane and sockets, and the case. Total time to get a system operational is usually under 30 hours.

It is well to note that the H-11 does not include any form of terminal, either VDU or hard copy, nor does it include interfaces for these devices. Like all PDP-11 systems, the H-11 has available for connection to it a range of interfaces and I/O devices which must be ordered separately. For example, the H-9 Heathkit VDU and the Heath H-36 hard copy terminal (actually a DEC LA-

36 DECwriter II) are available and the H-11-5 serial interface to connect them to the LSI-11 bus. Similarly, the Heathkit H-10 paper tape reader/punch combination is available with the H-11-2 parallel interface module to connect to the LSI-11 bus. A 4K by 16-bit memory module, the H-11-1 is also available.

A word of warning should be given about these boards. Due to the close spacing of boards on the back plane, the height of components must be kept to a minimum. However the 820pF capacitors supplied for +5V bypass exceed this height and foul the adjacent board. It is quite possible for the tops to be scraped off the capacitors and for the exposed metalisation to short out against the next board. If this happens to be the LSI-11 CPU board the results could be disastrous. It has been found that miniature .001 uF capacitors are an effective substitute.

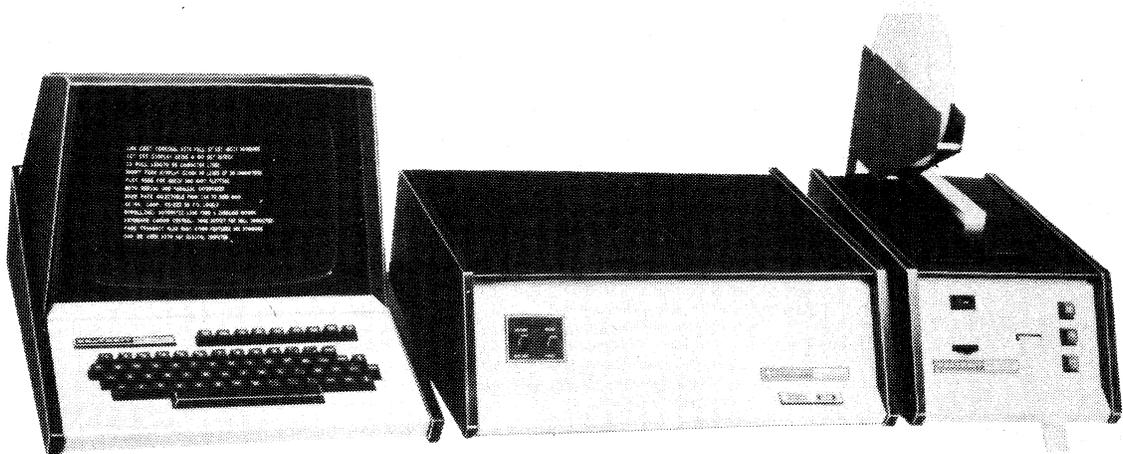
The construction documentation is up to the usual high standard of Heath. However, during construction of the power supply a couple of anomalies in component numbering will become

apparent. These can be resolved with reference to the parts list.

The software supplied with the H-11 is in fact the standard DEC PTS (Paper Tape Software) system. It comprises ED-11 (a source editing program), PAL-11S (an assembler producing relocatable object modules), LINK-11S (which links together different object modules to produce an absolute binary load module), IOX (an input/output executive to be incorporated into user written programs), ODT (an octal debugging system), BASIC and FOCAL.

Because of the use of the LSI-11, the H-11 is software compatible with the great range of PDP-11 computers, and much of this software can be run on the H-11. Note, however, that the PTS software requires as a minimum an ASR-33 teletype with paper tape reader and punch. This is only suitable for small program development, and any reasonable size programs really necessitate an LA-36 hard copy terminal and a separate high speed paper tape reader/punch.

Most of the software will run in 4K x 16-bit words but this sometimes leaves very little user space. BASIC is the worst offender, and should only be attempted in systems with 8K x 16-bit words or greater. FOCAL is an interpretative language somewhat like BASIC but can be extremely recursive, and because all commands can be cut to the first letter only, user storage requirements can be minimised. Because of its inbuilt scheduling facilities and powerful I/O facilities, FOCAL can be used for implementing quite high level



The Heath H-11 is shown here in the centre, with the matching H-9 VDU to the left and the H-10 paper tape reader/punch to the right. A hard copy terminal (H-36) is also available.



Here the Heath H-11 is shown with an SMS dual floppy disc unit and a Micro-Tec model 70 video terminal. The H-11 runs a great deal of the software written for Digital Equipment PDP-11 computers.

data acquisition or industrial control systems.

One program which is not included in the Heath supplied set but can be obtained from DECUS, the DEC Users Society, is called PALEDIT. This is a combined editor-assembler which requires 8K x 16-words in which to run. It allows both the editor, the assembler, and the user's source code to all be in memory at the same time. The editor is used to create assembler source code stored in memory. Then the user jumps to the assembler and assembles the source code also in memory. If any errors are found, you jump back to the editor, make the necessary corrections, back to the assembler, etc, until such time as an error free assembly is achieved. Due to the fact that the program only has to be loaded once, and that the assembler is getting its input from high-speed memory and not a paper tape reader, this is a tremendously fast system and worth some effort in obtaining the program.

On the whole, the software documentation for the H-11 is very good. Most of it is in fact just a copy of the equivalent DEC manuals. It pays to read all the software manuals through at least twice before attempting any programming, as often some small critical point is not fully explained except in the appendices.

A number of debugging facilities are implemented in micro-code within the LSI-11 processor itself. This allows display and alteration of register, memory and peripheral contents.

The LSI-11 has a 16 bit address bus.

However, in order to be able to directly address bytes, address bit 0 is used for byte selection, thus giving a 32K x 16-bit word address space. All peripheral device registers are addressed the same as memory, but by convention DEC allocate the upper 4K words to peripheral addresses, thus allowing 28K words of memory to be used.

It might also be pointed out that the LSI-11 can be fitted with an additional 40 pin ROM which provides the full Floating Point Instruction Set (FIS) similar to the large PDP-11/34 and 11/40. However, the PTS software supplied does not make use of the FIS and unless you can obtain other versions of BASIC or FOCAL which do use it, the chip is not of much value.

There is one other facility which Heath have left out. The LSI-11 incorporates a mains frequency real time clock. This is used by FOCAL for its clock and scheduling functions, however, it must be disabled during the original program loading sequence. A link is fitted on the power supply board to allow enabling/disabling of the clock signal. As this is extremely inconvenient, it was found far preferable to install a small toggle switch on the back panel and connect it to the points on the power supply board where the link is normally fitted.

The basic H-11 back plane has eight double height slots available. The LSI-11 takes two of these, the terminal interface and the paper tape reader punch each take another double slot, and the 4K x 16 bit memory boards each take one double height slot. Into the

remaining slots can be plugged an amazing range of devices from colour graphics interfaces to 64 channel analog-to-digital converter subsystems; from floppy disc to cartridge disc systems. Due to its high popularity, an enormous range of LSI-11 bus compatible devices are available, both from Digital Equipment Corporation and other specialist manufacturers, eg, ADAC, MDB, Analog Devices, Burr-Brown, etc, and these can all be plugged into the H-11.

Heath have indicated that they hope very soon to release an inexpensive floppy disc system for the H-11. As this will most likely support the DEC RT-11 real time operating system which supports FORTRAN and APL in addition to BASIC and FOCAL, the future for these systems looks quite good.

The major application for the H-11 then would appear to be not with hobbyists, but with small laboratories and other professional organisations in data acquisition and control functions, perhaps even front-ending to larger computer systems. In these cases, the slightly higher cost of hardware of the H-11 compared with some of the 8 bit micro systems will be more than offset by its extreme usability and short software development times, due to excellent high level languages and interface capability.

Further information on the H-11 is available from the Australian agents for Heath, Warburton Franki Pty Ltd, with offices in most states.

Footnote:

The views expressed are those of the author and do not necessarily reflect those of the Australian Institute of Marine Science or of the Australian Government, nor do they imply endorsement of any product by these bodies.

Heath H8 gets floppy

Heathkit has released a floppy-disc add-on for its H8 microcomputer system. Designated the WH17, the new unit consists of an interface/disc controller PCB, power supply and drive unit with either one or two 125mm minifloppy disc drives. Hard sectoring is used, giving 102K bytes of storage per disc.

The WH17 comes fully assembled and factory tested, and complete with a disc which contains all required H8 operating systems: the Heath Disc Operating System (HDOS), a console debugging program BUG-8, a text editor HASL-8, and extended Benton Harbour BASIC.

A lower-cost kit version of the unit is predicted soon, also a similar floppy disc unit for the 16-bit H11 computer system.

Further information is available from Warburton Franki Pty Ltd, 199 Parramatta Road, Auburn, NSW 2144.

HEATH DATA SYSTEMS



Now better value than ever.

The recently introduced range of 8 bit and 16 bit computer systems from Heath have now been expanded and represent particularly good value for the hobbyist and professional alike. Key features are expandability, reliability and performance which have made the Heath Schlumberger name famous around the world.

1. **The WH14 Line Printer—Performance, Reliability and Value**

The WH14 line printer is designed for a broad variety of uses in the personal computer field. The microprocessor based WH14 combines speed, flexibility and ease of use with any computer providing standard RS/232 interface connections. It prints the standard 96 character ASCII set (upper and lower case) on a 5 x 7 dot matrix print head. The printer comes complete and ready to operate with cable, paper tray and ribbon and features tractor feed for positive forms handling.

2. **The WH19 Video Terminal—One Of The Smartest Buys You Can Make In An I/O**

The WH19 features a powerful Z80 microprocessor and a heavy duty professional keyboard designed for daily use. The 12", high resolution CRT gives you a clear, easy to read screen image. The smart Z80 microprocessor makes the WH19 capable of a multitude of high speed functions, controllable by keyboard or software and an addressable blinking cursor lets you edit or make corrections anywhere on the screen.

3. **The WH27 Floppy Disk Drive—Adds Power and Versatility to WH11's**

The dual drive WH27 floppy disk unit gives you enormous storage capacity for data and programmes. The 8" disks have 512K bytes of storage area, more than enough to hold entire files. Disks are IBM compatible. The WH27 features a Z80 microprocessor-based controller for high speed access and programmes can be loaded in seconds. The operating system for the WH27 was developed in conjunction with DEC and supports BASIC, FORTRAN and ASSEMBLER LANGUAGES—all available from Heath Schlumberger Data Systems.

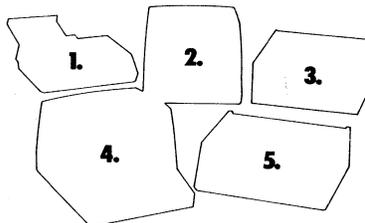
4. **The WH89 All-In-One Computer**

The all-in-one computer brings you all the power and built in peripherals needed for any business computer task. Easy to programme, easy to operate, it can save you money in many ways.

The smart video terminal has its own Z80 microprocessor so it never shares processor power with the computer, making the terminal capable of a multitude of high speed functions. Floppy disk storage makes this a true all-in-one computer with enormous storage capacity for programmes and data. Each 5¼" diskette has more than 102K bytes of storage area, enough to hold entire files. All terminal functions can be controlled by keyboard or software and programmes can be loaded in seconds from the keyboard. The system comes with 16K RAM expandable to 48K and memory diagnostics are built in for fast, easy memory checks.

5. **The WH11A 16 Bit Computer—Professional Performance At Hobby Prices**

The WH11A gives you the 16 bit capacity to run complex programmes. It uses the same powerful microprocessor and runs all software designed for the DEC PDP-11/03. You can choose from scores of practical programmes that can reduce your clerical costs and increase efficiency of data management. The WH11A gives you the flexibility to configure exactly the system you require. 7 plug-in slots let you add any combination of I/O's and a maximum of 60K bytes of memory. To date the computer has found wide use in education, industry and small business areas.



For further information contact:

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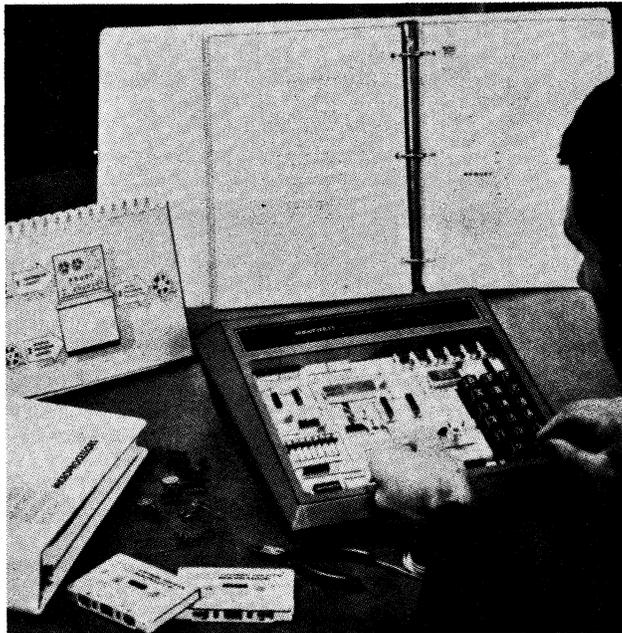
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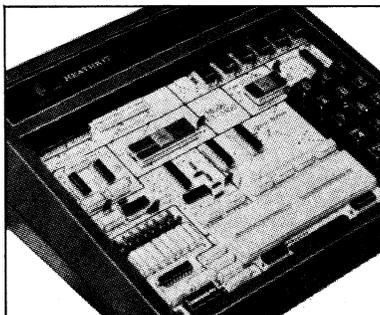
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- 256 bytes of RAM
- Breadboarding socket for prototyping

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Covers microprocessor basics, computer arithmetic, programming, interfacing and much more

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Course EE-3401

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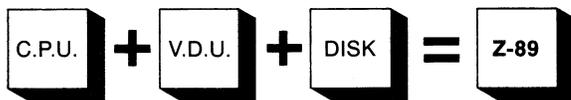
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