Using the Heath H11 for reaction time experiments and computer-assisted instruction

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This paper compares the highly similar PDP-11-compatible microcomputer systems sold by DEC and Heath (also Heathkit). Heath now offers software and factory-assembled hardware at 20%-40% less than DEC's lowest priced floppy disk microprocessor system. The first author started a reaction time laboratory with factory-assembled components. The second author built a similar system from kits and adapted CAI programs developed on a conventional PDP-11 minicomputer. Both experiences are reported in this paper.

A year ago, Aaronson (1979) reported results of a survey on the increasing use of DEC-compatible products. This paper continues that theme. Our explicit purpose is to compare Digital Equipment Corporation (DEC) and Heath Corporation (Heath) LSI-11-based microcomputer systems. A second, implicit purpose is to encourage comparison shopping for the price advantages offered by the many non-DEC sources of DEC and DEC-compatible products.

This paper is intended for individuals who are about to make purchasing decisions. Experiences reported here are based on systems purchased in mid-1979. One assumption is that the potential buyer is interested in the PDP-11 line of computers but may be intimidated by some of the DEC single-quantity prices. It is beyond the scope of this paper to compare different microprocessors, but the advantages of the LSI-11 include the system software for program development and the software developed for psychology.

This paper discusses products that were not available 1 year ago (e.g., Heath factory-assembled products, the H27 floppy disk system, and the new H19 CRT). Since purchasing decisions can only be made or evaluated with respect to specific requirements and situations, we begin with descriptions of two sets of criteria. Then the hardware and software of Heath and DEC systems are compared and the advantages and disadvantages of buying from Heath or DEC are summarized.

TWO SETS OF CRITERIA

The first author needed a programmable clock for millisecond timing, already had a CRT, wanted nothing to do with kits, and started with a budget of less than \$6,000. Also, because of isolated residential placement,

hobbyist stores and field service representatives were not available to help with maintenance. Finally, a local shortage of good programmers made it important to consider the availability of applications software.

The second author has had electronic technical experience, wanted a portable system for sales demonstrations, and wanted low-cost hardware to market with a computer-assisted instruction (CAI) package originally developed on a PDP-11 minicomputer.

HARDWARE COMPARISONS OF HEATH AND DEC

Hardware Similarities

The same DEC-manufactured processor board is used in systems supplied by Heath or DEC. This CPU board is the LSI-11/2, or DEC KD11-HA. The microprocessor executes the full PDP-11 instruction set containing over 400 instructions. This module occupies one dual slot and has no memory or memory-refresh circuitry on the board.

The interfacing and bus structure are functionally equivalent. The bus is not advertised as a Q-bus, and Heath representatives admit that they have made changes to make the backplane easier to kit. Thus, while it is technically incorrect to say that the backplanes are identical, any module designed to be plugged into the LSI-11 bus can be used on the Heath system. We have heard no exceptions to this generalization and are successfully mixing boards manufactured by Heath, DEC, Monolithic, CRDS, and Chrislin, including the quad-width DEC KKV11-A.

The Heath floppy disk system (H27) includes a controller, interface module, and two 8-in. drives (Memorex 550s) in a single-density single-sided format of 256K bytes/disk. This system is hardware and soft-

ware compatible with the DEC RX01 system. DEC's RT-11 operating system can be run on the Heath system without hardware or software modifications.

Hardware Differences

DEC offers a choice of backplanes. With Heath, only the 4 by 4 backplane is available. It is similar to the DEC H9270, which allows for a maximum of eight dual modules. The Heath backplane will not support the DEC RL01 interface.

The DEC power supply is slightly larger. The DEC H780 power supply provides 18 A at the 5-V level; the Heath supply provides 15 A. At 12 V, this DEC supply provides 3.5 A; the Heath supply provides 3.0 A.

DEC provides more disk options and can supply several hard disks or a double-density floppy disk system with DMA. Heath currently offers only the single-density floppy disk with no DMA. However, several manufacturers provide hard disk systems that plug directly into the Heath backplane. Among the most interesting is the Corvus 10-Mbyte 8-in. Winchester disk system. The Corvus interface for this system is compatible with the Heath or DEC H9270 bus and "looks" to the computer like two RL01 disks.

The Heath floppy disk system is faster than the equivalent RX01. Perhaps this advantage is due to the Memorex 550 drives or to the Z80 microprocessor. Using DEC's formula for the RX01, average access time is 488 msec; using the same formula, the average access time for the Heath disks is 329 msec. Another comparison that favors Heath is that their disk system includes a formatter; the RX01 does not.

Summary of Hardware Comparisons

The processor is identical in both systems. The interface, bus, backplane, and disk are all hardware and software compatible. But the type of compatibility discussed here goes far beyond being able to eventually make something work. For example, several companies make different types of programmable clocks that will all work on the LSI-11 bus; however, if you change from one to another, changes in software are necessary. The phrase "hardware and software compatible," as used here, means register-for-register compatible so that products may be swapped from one system to another without new programming—in short, it means interchangeability.

In practice, Heath's smaller power supply and backplane may not be important limitations. This is especially true if you buy a new 32K memory board. The board usually saves backplane space, power, and money. Of course, if you already have four 8K memory boards, it is more likely to be a problem (although we have been told that the Heath system with an expansion backplane functions exactly like other LSI-11 systems).

A user's satisfaction with the Heath disk system probably depends on previous experience with other disks. Most RX01 users would be pleased with the faster

speed of the Heath system. Most double-density or hard disk users would be frustrated.

SOFTWARE COMPARISONS

Heath supplies a disk operating system (HT-11) that sells for \$350. This system is remarkably similar to DEC's RT-11 single-job monitor, Version 2C. The current DEC release of RT-11 is Version 3B, which sells for a list price of \$2,760. RT-11 Version 4, which supports multitasking, should be released by late 1979 or early 1980. The Heath software package includes BASIC, which costs an extra \$600 from DEC. FORTRAN is available from Heath for an extra \$250; DEC's FORTRAN costs \$880.

An important word of caution in these software comparisons is that there is an asymmetry in the interchangeability of software across hardware systems. The Heath disk has a front panel switch that alters a single input bit to the Z80 disk controller. This feature in conjunction with a modification of the disk-resident code permits HT-11 execution only on the Heath computer. This special hardware design has been used to protect software licenses. There is no problem in the reverse direction; DEC software can be run without modification on Heath hardware.

In addition to BASIC and the option for FORTRAN, HT-11 provides a collection of utilities. There is a file maintenance and transfer program (PIP) with commands for moving, copying, deleting, and renaming files and other common file operations. There is a debugging aid called ODT. The assembler supports a macro library using a file named SYSMAC.SML. Other system software includes a character-oriented editor, a program called SRCCOM to compare two files, and other programs LINK, CREF, DUMP, PATCH, and LIBR. HT-11 includes one pleasant feature absent from RT-11: The most recently entered date is retained on disk rather than only in RAM. Hence, if the system is rebooted multiple times in a single day (undebugged programs can crash HT-11), the date does not have to be reentered each time. A program SAMPLE.MAC is supplied with an intentional bug to be used in a step-by-step tutorial to teach use of the assembling and debugging procedures. Heath maintains a fine reputation for documentation.

The BASIC interpreter supports variable length strings, sequential files, random-access files treated as virtual memory arrays, chaining, overlay capabilities, and a desk-calculator mode useful for debugging. Although this BASIC interpreter does not support all the features of some hobbyist systems featuring BASIC as their only language, it is a good but not a great BASIC system.

ADVANTAGES AND DISADVANTAGES OF HEATH AND DEC

Advantages for Heath

Heath list prices are sometimes 40% or more below DEC single-quantity list prices. Prices are compared in

Table 1
Starter Systems from Heath in Assembled and Kit Forms

Item	Description	Assembled	Kit
H11A	LSI-11/2 CPU, 4 by 4 Backplane, Power Supply, and Box	\$1,895	\$1,095
H11-5	Serial Interface (RS232)	150	105
WH11-51	Cable (CRT to H11-5)	15	15*
WHA11-32	32K 16-Bit Word Random Access Memory	995	995*
H27	Dual Floppy Disk System (single density, RX01 compatible)	2,595	1,895
H19	CRT	995	675
HT-11	Disk Operating System with BASIC	350	350*
	Total List Price	\$6,995	\$5,130
	Total Price Less 5% System Discount	\$6,646	\$4,874

DEC Starter Systems

DEC PDT/150.	\$8,695
All-in-one system (not expandable) including LSI-11/2 CPU, serial interface, CRT, 60K-byte memory, single-density floppy disk system, and modified operating system (RTT).	
DEC PDP-11V03-L	\$11,300
Includes LSI-11/2 CPU, four-port serial interface, choice of printing terminal or CRT, 64K-byte memory, double-density dual floppy disk system, large cabinet (backplane with eight Q-bus slots and four interconnect bus slots), and RT-11 operating system.	

*Item not available in kit form.

Table 1, but DEC packages keep changing, so there is a bit of comparing "apples and oranges" in these examples. Heath's delivery times are shorter than DEC's. Our assembled system was received exactly 30 days after the purchase order was sent (the DEC bid claimed 120 days after receipt of order).

The kit system reported here was "delivered" immediately off the shelf at the Frazer, Pennsylvania, Heath store. Because there is a separate cabinet for the disks, the Heath system is more portable than DEC systems.

Heath owners can join two user's groups: DECUS (the DEC User's Society) and HUG (the Heath User's Group). There are two monthly newsletters for Heath owners: REMark (published by Heath) and BUSS (published independently). The Heath disk system is faster than the DEC RX01, and it provides a disk formatting capability. Heath's documentation is very good, and phone technical assistance is friendly and helpful.

Advantages for DEC

Heath offers no on-site maintenance, whereas DEC offers local field service in most places. In a single-backplane system, expansion of a Heath system is limited to eight slots, although extension backplanes can be easily interfaced to either system. The power

supply on most DEC systems is about 20% larger. DEC software configuration is a superset of the older software offered by Heath, and DEC offers several disks that are faster, with larger capacities than the Heath H27 disk system.

REACTION TIME LABORATORY

The hardware configuration currently in use at the University of Arkansas is summarized in Table 2. The major application software consists of a generalized package for reaction time experiments with verbal stimuli originally written by Jerry Forshee of ICR Systems and Indiana University and first used by George Potts at the University of Denver. This software package includes set-up and data collection programs that make use of a list of files for the series of verbal displays that are presented according to a series of display parameters to control location, timing, response collection, and feedback.

CAI CONFIGURATION

The hardware configuration currently used by Advanced Interactive Systems, Inc. (AIS) for a por-

Table 2
Hardware Configuration for Reaction Time Lab

Item Description	Backplane Slot
Chrislin 32K Memory	1
Heath H11A with 4 by 4 Backplane, Power Supply, Box, and DEC LSI-11 CPU	2
DEC KVV11-A Programmable Clock	3 and 4
Heath H27 Dual Floppy Disk System	5
DEC DLV11-J Serial I/O (four RS232 lines)	6
ADDS Regent 200 CRT	
Teletype Model 43 Printing Terminal	

Table 3
Hardware Configuration AIS, Inc., Demonstration System

Item Description	Backplane Slot
Monolithic 32K Memory	1
Heath H11A with 4 by 4 Backplane, Power Supply, Box, and DEC LSI-11 CPU	2
Heath H27 Dual Floppy Disk System	3
DEC DLV11-J Serial I/O (four RS232 lines)	4
CRDS Disk Formatter (Disks 3 and 4)	5 and 6
Heath H11-5 Serial Interface (one line)	7
DEC VT-100 CRT	
Diablo Hytype 1 Printing Terminal	

table demonstration computer is summarized in Table 3. AIS has developed AVID, a general-purpose multiuser system for CAI first reported in this journal 2 years ago (Scholz & Snow, 1978). The Heath system was chosen as our first demonstration machine due to its ready portability, low cost, and reliability. Since the disk and CPU are packaged separately, a single salesperson can readily transport the system to client sites with relative ease. The AVID software package supports multiple independent users on the H-11 using either RT-11 or HT-11.

SOME SHOPPING ADVICE

Discounts

Heath offers a 5% system discount. In addition, local stores bid against the factory and against each other. In many states, Heath works through independent educational distributors who can give additional discounts, pay shipping (a nontrivial item on a 69-lb assembled disk or 43-lb assembled main frame), and (for assembled systems) extend the 90-day warranty to 1 full year. Factory representatives can advise on an educational distributor for your state.

Other Options

Heath is not the only source of low-cost DEC-compatible systems. Although Heath was, in our opinion, the lowest priced in the summer of 1979, people shopping in the 1980s should check other system houses (e.g., Chrislin, MDB, General Robotics, and Charles River Data Systems). In late 1979, a few of these

approached Heath assembled prices (excluding software, but including double-density floppy disks). Palya (1978) supplies an excellent listing of LSI-11 systems and products. Many of the sources listed by Palya have expanded their offerings since the list was compiled. For example, Chrislin is no longer just a memory supplier; it now sells and discounts most of the DEC LSI-11 product line.

Another way to cut costs is to not buy an entire system from one company, but to shop for components individually. The Palya (1978) lists can help. Note that neither of our configurations includes memory from Heath or DEC.

The Future of the Heath-DEC Connection

Heath's financial stability has gone from good to better with the recent sale of the company to Zenith. Soon Heath assembled products will be marketed as Zenith Data Systems. Zenith may stress H11 assembled business systems, and it may announce a hard disk and a possible processor upgrade to the DEC LSI-11/23.

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