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A Closer Look

Refinement of our benchmarks reveals some surprises about the relative speeds of 80386- and 68020-based machines.

YTE started benchmarking the relative speeds of the new crop of 80386- and 68020-based machines within days of getting our hands on them. We presented the preliminary—and controversial—results in the July issue: The 80386-based machines were faster. We presented additional tests in the August issue, with much the same results.

However, our preliminary benchmark tests weren't ideal (some, in fact, contained outright errors, which I'll detail later). It's no small task to produce reliable benchmarks for systems with new architectures, especially when fundamental software-development tools (such as compilers) are few or in very early release.

So for this month's New Generation segment, I corrected problems in the original benchmarks and ran the improved code on the following lineup of hardware: the Mac SE, the Mac SE with General Computer's HyperCharger and Levco's Prodigy, the Mac II, the Arete 1100 supermicro, the Definion DSI-780, the IBM PC AT, the IBM PS/2 Model 80, the Kaypro 386, the ALR 386/2, and the Compaq 386.

You will find statistics for most of these entrants in our July and August New Generation articles.

Levco's Prodigy for the Mac SE is a 68020 with a 68881 math coprocessor, both of which run at 16 MHz. It includes 1 megabyte of RAM. The Definion DSI-780 is a coprocessor board for the IBM PC XT or AT (we plugged our DSI-780 into an 8-MHz AT) with a 16.67-MHz 68020 and 68881 and 4 megabytes of RAM. Both the Kaypro 386 and the ALR 386/2 use a 16-MHz 80386, but the ALR can accept a 10-MHz 80287 while the Kaypro (for reasons described later)

could not use a math coprocessor.

The July issue also contains source code listings for the benchmarks. Listings are also available on BIX and BYTE-net, and on disk. (Order the July 1987 listings disk for the original benchmarks and the September disk for the corrected versions. See the card following page 256. For BYTE-net listings, see page 4.)

Sort and Float

Our Quicksort benchmark (SORT.C) was unreliable; it produced a list that was only "sort of" sorted. The cure was to change the outer for loop in the quick() function to read:

```
for (i=lo, j=hi, pivot=base[hi];  
    i<j;)
```

I've simply changed the initialization portion of $j=hi-1$ to $j=hi$. Recall that the Quicksort algorithm operates by dividing the array being sorted into pairs of partitions such that one partition contains all elements greater than or equal to a given number (the "pivot"), and the other contains all elements less than or equal to the pivot. These partition pairs are again subdivided, and the process continues until the number of elements in each partition is 1. This is where the old SORT.C bombed; since j had been initialized to $hi-1$, the termination expression $i<j$ would not allow the for loop to execute.

All the times you see reported in tables 1a and 1b for the Sort benchmark were generated by the corrected program.

Next, we learned that optimizing compilers had a field day with the Float benchmark: I ran the original Float through MetaWare's 80386 HighC compiler and set its switches so I could view the 80386 assembly language that the compiler was generating. As it turned out, the compiler discovered that Float

consisted of repetitious instructions and could be optimized if the results were kept in registers and simply moved into memory as required. The compiler resolved the last six multiply instructions into simple MOVE instructions.

To get around this, I recoded Float so that the loop enclosed only a single multiply and a single divide, and I boosted the loop count to 70,000 to make up for the six pairs of assignment statements I had removed. I also borrowed a technique from the Dhystone benchmark and added code to factor out the looping time (by timing an empty loop and subtracting this value from the total elapsed time). Consequently, the new version of Float should give a better picture of the time it takes a math coprocessor to execute floating-point multiplications and divisions.

Flotsam and Jetsam

Running these benchmarks on such a diverse array of hardware gave me a chance to uncover all kinds of interesting tidbits: • MetaWare's HighC compilers (I used two versions, one for generating 80286 code and one for generating 80386 code) provide a floating-point software switch that you can set to enable or disable the generation of in-line floating-point coprocessor code. They also come with two libraries: one that supports a math coprocessor, and one that performs floating-point operations using emulation code.

You would think that turning off the floating-point switch and linking with the emulation library would be enough to ensure that the .EXE file you were creating would ignore any floating-point unit (FPU) that might be present in the machine. Not so. There is an environment variable in MS-DOS called N087, which you set according to whether or not you have a coprocessor on-board. The upshot is that even if you have created a program using the emulator library, when you run it on a machine with a coprocessor and the N087 variable set to a null value (i.e., you have executed the DOS command SET N087=<return>), the program runs faster than if there was no coprocessor.

Clearly, the emulation library must be carrying coprocessor code with it, and the program brings this code into action if it finds an FPU. (Actually, this technique makes sense. It allows you to create code that runs on systems with or without FPUs; and if a system has an FPU, it gets a boost.) This means that you have to be careful about setting the compiler flag and the N087 variable when benchmarking. All the figures you see in table 1b for 80386 machines are from machines with an FPU (unless specified otherwise).

• To run the 80386 benchmarks, I executed the programs using Phar Lap's

RUN386 protected-mode environment (this is the only way you can run programs created by the 80386 version of the HighC compiler—see Matt Trask's review of 386|ASM|LINK 1.1e in the August BYTE). The latest version of RUN386 we had was 1.1e, and it simply locked up the Model 80. (The problem seemed to occur when RUN386 tried to load a benchmark program: The system would freeze and the hard disk access light would remain on.) When I reverted to an earlier version (1.1), it worked.

- The Kaypro 386 machine I tested had a socket for an 80387, but the machine refused to acknowledge an FPU when I plugged one in. The Kaypro uses Intel's 80386 motherboard, and there have been reports that Intel's board is incompatible with an 80387. Looks like there's some substance to those reports.

- I carefully followed Levco's instruction manual for installing the Prodigy board's accompanying software, but the installation disk's contents did not match what the manual led me to expect; specifically, a control desk-accessory file was missing from the floppy. Also, when I tried to run the RAM disk initialization (again, as outlined in the manual) a bomb box appeared. I finally discovered how to set up the Levco software by reading the "Get Info" information associated with the files on the floppy.

Results

First of all, it's easy to see that if your application is floating-point-intensive, then no matter which processor you choose, for heaven's sake, get a math coprocessor. The cost of coprocessors is still a bit high (often as much as or more than the CPUs that run them—as of this writing, you'll pay around \$300 for an 8-MHz 80287 and \$200 for a 12-MHz 68881). But if processing time is money, the coprocessor could easily pay for itself.

In the 68000/68020 arena, it's Definicon's DSI-780 that appears to win out. I say "appears" because the C compiler used with the Definicon board (Silicon Valley Software's C compiler) is necessarily different from the one I used on the Macintoshes (Consulair) and the Arete (its C compiler comes with Unix). Therefore, it is difficult to tell how much of the Definicon's advantage to attribute to the compiler. (Here's an example of a similar case: I also compiled the benchmarks using Lightspeed C version 2.01 on the Mac SE with Prodigy installed. Lightspeed C turned in figures that were 10 percent to 15 percent faster than Consulair's 68020 compiler—except for the floating-point benchmarks, which makes sense once you discover that Lightspeed C does not recognize the 68881.)

Table 1a: Benchmark figures for 68020 machines. All Macintosh benchmarks were generated using Consulair's C compiler version 5.04; I used the 68020 flavor of this compiler for all Macs except the SE. The Arete came with its own compiler. On the DSI-780, I used Silicon Valley Software's C compiler version 2.0.

Test	Mac SE	Mac SE	Mac SE	Mac II	Arete	DSI-780
		with HyperCharger	with Prodigy			
Dhrystone	574	2176	2380	2106	2710	3438
Fibonacci	263.54	71.60	71.45	83.72	69.86	47.89
Float	230.23	4.06	2.61	2.63	2.90	2.24
Savage	1921.00	8.86	5.22	5.42	24.70	5.65
Sieve	64.56	14.92	14.83	16.72	12.40	4.89
Sort	103.82	20.55	20.41	23.20	13.20	6.74

Table 1b: Benchmark figures for 80386 machines. I used MetaWare's HighC 386 compiler version 1.3 on all machines except the AT, on which simply used the same compiler with no 80386 support. Phar Lap's 386|LINK was the linker (again on all machines except the AT, for which I used Microsoft's LINK version 3.51). I used RUN386 version 1.1e for the 80386 machines (as required by HighC) except for the Model 80—see text for the reason.

Test	IBM PC AT	Model 80	Kaypro	ALR 386/2	Compaq	Compaq
	8-MHz 80287	16-MHz 80387	386 No FPU	10-MHz 80287	386 8-MHz 80287	386 16-MHz 80387
Dhrystone	1590	3626	3271	3283	3748	3748
Fibonacci	126.22	57.26	64.65	64.66	53.12	53.11
Float	10.98	1.62	40.42	5.30	6.80	1.43
Savage	37.30	9.49	355.29	17.97	21.53	8.95
Sieve	24.60	6.45	6.81	7.41	5.99	5.98
Sort	43.17	7.74	8.35	8.55	5.58	5.58

If money's no object and you're out for raw power, a Compaq 386 with an 80387 installed is your best bet in 80386-land. The figures for the 80386 systems are probably more meaningful than those for the 680x0 machines, since I was able to run the same .EXE files on all the 80386 systems. (Of course, I couldn't do this for the AT; even so, at least the compiler on the AT was from the same company as the 80386 compiler—MetaWare.)

Overall, it appears that—and I know I'll catch a lot of flak for this—the 80386 machines outperform the 68020 machines. Of course, the reasons for this could well go beyond the possibility that one processor is simply faster than the other; I'm using different C compilers, the hardware is different, the software I've used represents only a tiny subset of all the applications users can expect to run, and so on. But let's look at some facts: The C compilers I used were the only shipping 68020 and 80386 compilers available at the time I ran these

benchmarks (Manx's Aztec C 68020 compiler might be shipping by the time this issue reaches press, as might Computer Innovations' C86+ 80386 compiler—we'll include these in future New Generation stories), so, for now, these are the compilers available to you for your development work. Also, it makes no sense to benchmark the processors independently of the systems that incorporate them: You don't buy just a processor, you buy a complete system—and the systems I tested are the same ones you can buy. So what we're looking at are the hardware and software configurations that the world has made available to you so far. ■

[Editor's Note: The table in this article is a condensation of a vast array of benchmark figures that were compiled. For the complete set of figures—especially if you're interested in floating-point performance without an FPU—see the super-micro benchmark topic on BIX.]



The Kaypro 386

Ray Duncan

*A solid contender
in the high-performance PC AT-
compatible arena*

The Kaypro 386 is an entrant in the newly emerging class of high-performance IBM PC AT compatibles. These machines have the general architecture of a PC AT but are based on an Intel 80386 32-bit microprocessor. In addition to a normal PC AT-compatible expansion bus, they also have a nonstandard 32-bit memory bus for increased performance.

The Kaypro 386's exterior appearance is similar to that of a PC AT, with the keylock, 1.2-megabyte floppy disk drive, disk- and power-indicator lights, connectors, and power switch all in their familiar locations. The computer is currently available in two models. The Model A (\$4495) comes with 512K bytes of RAM and no hard disk drive. The Model E comes with 2.5 megabytes of RAM and either a 40- or a 130-megabyte hard disk drive. The two configurations sell for \$5795 and \$8095, respectively. At the time of this writing, Kaypro announced that an additional model, the Model N, was expected to begin shipping this summer. It is intended for use as a network server, and it comes with 2.5 megabytes of RAM and either a 240- or a 330-megabyte hard disk drive. Prices for the two configurations are \$14,450 and \$19,450, respectively.

Standard equipment on the Model A and Model E includes a real-time clock, a parallel port, a serial port, a combination floppy disk and hard disk controller board that can handle up to two floppy disk drives and two hard disk drives, and a 102-key keyboard that is similar to the IBM 101-key enhanced keyboard, with 12 function keys across the top, a separate numeric keypad, and arrow and paging keys. The case has room for up to five half-height storage devices. The power supply is switch-selectable between 110



and 220 volts and is rated at 215 watts.

All three models of the Kaypro 386 use the same motherboard, the Intel iSBC 386 AT, which has a 16-MHz 80386 microprocessor and 512K bytes of 120-nanosecond RAM. [Editor's note: *The motherboard is similar in design to the ALR Access 386's motherboard, another Intel-derived design. For more information, see "The ALR Access 386 and the Compaq Deskpro 386" by Stanley J. Wszola and Curtis Franklin Jr. in the February BYTE.*] You can slow down the Kaypro 386's microprocessor to the equivalent of 6 MHz under software control (by inserting wait states) or by entering a special key sequence for use with timing-dependent programs. For expansion, the machine has two 8-bit IBM PC-compatible slots and four 16-bit PC AT-compatible slots, as well as two 32-

bit slots that can accept either 8-bit boards or special 2-megabyte 16-bit memory-expansion boards built by Intel and available from Kaypro for \$665; 8-megabyte boards may be available in the future. One of the Kaypro 386's 16-bit slots is occupied by the disk-controller card.

The expansion bus runs at 6 MHz for compatibility with older boards, except for the two 32-bit slots, which you can configure with jumpers on the motherboard to make them run at 16 MHz when 32-bit memory cards are present. A 68-pin grid-array (PGA) socket is present on the motherboard for installation of a 16-MHz 80387 numeric coprocessor (not yet available from Kaypro) or an Intel Math Coprocessor Module piggyback board (\$495), which adapts a 10-MHz 80287 40-pin DIP chip with some support circuitry to the 80387 PGA socket.

Two video display adapters are available as options for the Kaypro 386. One is the Kaypro Multi-Video Board, which can emulate the IBM Monochrome Adapter, the IBM Color Graphics Adapter, or the Hercules Monochrome Graphics Card. The other is the Kaypro Enhanced Graphics Adapter, which is based on the Chips and Technologies four-chip EGA set. Two optional monitors are available for the Kaypro 386: a 12-inch monochrome monitor and a 14-inch enhanced graphics monitor.

continued

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Kaypro 386

Company

Kaypro Corp.
533 Stevens Ave.
Solana Beach, CA 92075
(619) 481-3900

Size

21¼ by 16½ by 6½ inches; 42 pounds

Components

Processor: 32-bit Intel 80386 running at 16 MHz, switchable to 6 MHz; socket for Intel 80387 numeric coprocessor

Memory: 512K bytes on system board; optional 2-megabyte Intel MEM020 plug-in expansion board, expandable to 16 megabytes

Mass storage: One 1.2-megabyte high-density floppy disk drive (all models) and one 40- or 130-megabyte hard disk drive (Model E) or one 240- or 330-megabyte hard disk drive (Model N)

Keyboard: 102 keys; 12 function keys

I/O interfaces: Eight slots: two 8-bit IBM PC compatible; four 16-bit PC AT compatible; two 32-bit slots for special Intel MEM020 memory boards; one serial port with DB-9 connector; one parallel port with DB-25 connector

Software

Microsoft MS-DOS 3.21; GWBASIC 3.20; Quarterdeck Office Systems' QEMM-386 1.0; Storage Dimensions' SpeedStor hard disk utility package

Options

- 2-megabyte 16-bit memory-expansion board: \$665
- 2-megabyte 32-bit memory-expansion board: \$1145
- Kaypro Multi-Video Board: \$210
- Kaypro Enhanced Graphics Adapter: \$295
- 12-inch monochrome monitor: \$145
- 14-inch enhanced graphics monitor: \$595
- 360K-byte floppy disk drive: \$145
- 40-megabyte hard disk drive: \$1398
- 80-megabyte hard disk drive: \$1750
- 133-megabyte hard disk drive: \$3595
- Kaypro 386 Technical Manual:* \$125

Documentation

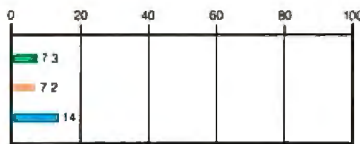
160-page *Kaypro 386 User's Guide*; 500-page *MS-DOS 3.2 User's Guide and Reference Manual*; 310-page *GWBASIC 3.1 Interpreter Manual*; 64-page SpeedStor operations booklet; 8-page QEMM-386 brochure

Price

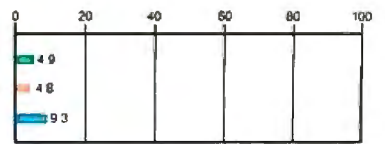
- Model A (does not include a hard disk drive): \$4495
- Model E (with 40-megabyte hard disk drive): \$5795
- Model E (with 130-megabyte hard disk drive): \$8095

DISK ACCESS IN BASIC (IN SECONDS)

WRITE

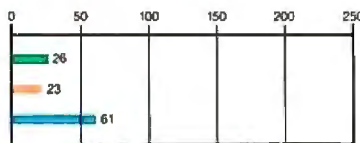


READ

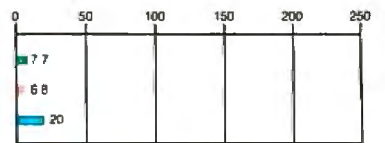


BASIC PERFORMANCE (IN SECONDS)

SIEVE

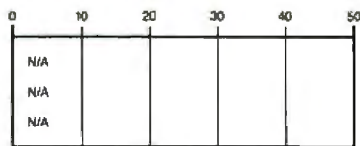


CALCULATIONS



SYSTEM UTILITIES (IN SECONDS)

40K FORMAT/DISK COPY



40K FILE COPY



SPREADSHEET (IN SECONDS)

LOAD



RECALCULATE



■ KAYPRO 386 ■ DESKPRO 386 ■ IBM PC AT (8 MHz)

The graphs for Disk Access in BASIC show how long it takes to write and then read a 64K-byte sequential text file to a hard disk. The Sieve graph shows how long it takes to run one iteration of the Sieve of Eratosthenes prime-number benchmark. The Calculations graph shows how long it takes to perform 10,000 multiplication and 10,000 division operations using single-precision numbers. The 40K Format/Disk Copy benchmark was not performed because the computers had only one floppy disk drive. The 40K File Copy graph shows how long it takes to copy a 40K-byte file from one location on the hard disk to another. The Spreadsheet benchmarks show how long it takes to load and recalculate a 100-row by 25-column spreadsheet in which each cell equals 1.001 times the cell to its left. (For the program listings, see BYTE's *Inside the IBM PCs*, Fall 1985, page 195.) All benchmark tests were run without any extended memory management, hard disk-driver, or disk-caching programs. Tests on the Kaypro 386 were done with MS-DOS 3.21 and GWBASIC 3.20; tests on the Compaq Deskpro 386 were done using Compaq DOS 3.1 and Compaq BASIC 3.11; and tests on the IBM PC AT were done with PC-DOS 3.2 and BASICA 3.2. All spreadsheet benchmarks were done using Multiplan 1.06.

Other options include additional 1.2-megabyte and 360K-byte floppy disk drives; 40-, 80-, and 133-megabyte hard disk drives; and internal and external 60-megabyte tape-backup units.

My review unit was a Model E with 2.5 megabytes of RAM, a Kaypro Enhanced Graphics Adapter and monitor, a 1.2-megabyte floppy disk drive, and a Priam ID40 42-megabyte hard disk drive with a rotary voice-coil head positioner and a claimed 30-millisecond average access time. The CORE International Coretest Disk Performance Test program recorded a data-transfer rate of 164K bytes per second, an average seek time of 24.8 ms, and a track-to-track seek time of 4.4 ms for the Kaypro 386's hard disk system. The disk-controller card uses Western Digital chips.

Essential Software

The Kaypro 386 comes with Microsoft MS-DOS 3.21 and GWBASIC 3.20. In addition, the computer comes with a setup program for system configuration that is easy to use; Quarterdeck Office Systems' Expanded Memory Manager (QEMM-386) 1.0, which allows you to configure extended memory above 1 megabyte according to the Lotus/Intel/Microsoft Expanded Memory Specification (EMS); and Storage Dimensions' SpeedStor 4.02a hard disk utility package. SpeedStor includes the HARDPREP and PARTED programs, which are used to format and partition the hard disk, and HARDRIVE.SYS, an installable device driver that configures the partitions of a larger-than-32-megabyte hard disk drive for use as multiple logical volumes.

The Printed Word

The *Kaypro 386 User's Guide* describes the standard features and options of the computer's various models, unpacking and setting up the system, and configuration of the system for various options. It also covers the keyboard and use of the editing keys, some introductory material on MS-DOS commands and management of files, and instructions for using some of the Kaypro utility programs. Appendixes include an MS-DOS bibliography, a table of the extended character set, and charts of the system board jumpers and the pin-outs of the various connectors.

Also included with the Kaypro 386 are an *MS-DOS 3.2 User's Guide and Reference Manual* and a *GWBASIC 3.1 Interpreter Manual*. In addition, the Kaypro 386 comes with an 8-page glossy brochure about Quarterdeck's QEMM-386 1.0, which contains installation and operating instructions and a license and disclaimer of liability. The SpeedStor disk comes with a 64-page instruction booklet

from Storage Dimensions.

My review unit also came with an 84-page preliminary copy of the *Kaypro 386 Technical Manual*. This book contains some general descriptive material and a block diagram and jumper settings for the system board, pin-outs for the various connectors and power supply, a list of the interrupt numbers assigned to the BIOS functions and hardware controllers, and a fairly detailed summary of the disk controller's registers and commands. The preliminary manual has no schematics or BIOS listings.

Compatibility

To evaluate the Kaypro 386's hardware compatibility with the IBM PC and PC AT, I loaded the machine with various combinations of expansion boards, including Hercules and Vega EGA video adapters, an Intel Above Board/AT with 2 megabytes of RAM, a 3COM Etherlink network card, a Microsoft Mouse (bus version), a Hayes-compatible 1200-bit-per-second internal modem, and a Hitachi CDR-1502S CD-ROM drive and adapter. The Kaypro 386 worked flawlessly with all these boards.

To assess the machine's software compatibility, I tried running a broad variety of popular application packages, utilities, and programming tools on it. The software I tested included Morgan Computing's Trace86 debugger 2.00, Microsoft's SYMDEB 4.00 and CodeView 1.11 debuggers, Chris Dunford's ProCED command-line editor 1.02L, Datastorm's ProComm 2.4.2 (a telecommunications program), Revolution Software's Cruise Control 2.15 (a keyboard enhancer), Microsoft Word 3.1, MicroPro's WordStar 3.30, Microsoft Windows 1.03, Fifth Generation Systems' Fastback 5.13, Laboratory Microsystems' UR/Forth 1.01, Microrim's R:BASE System V 1.1, Quarterdeck's DESQview 1.3, and Lotus 1-2-3 2.0.

The only program that did not work as expected at 16 MHz was Lotus 1-2-3, which did not recognize its key disk. When I slowed the processor to 6 MHz by pressing Control-Alt-1, the copy-protection scheme functioned properly and the program loaded. I then resumed 16-MHz operation with the Control-Alt-2 key sequence.

Reliability and Performance

I used the Kaypro 386 for one month on a daily basis in my office along with a Compaq Deskpro 386 on a local area network for normal programming and word-processing tasks. During this time, the machine proved completely reliable, and I encountered no problems.

The results of the BYTE benchmark

tests show that the hard disk access times for the Kaypro 386 and the Compaq Deskpro 386 are basically equivalent. The floppy disk access times varied, with the results slightly favoring the Kaypro 386. This discrepancy may be because the Deskpro 386 automatically slows down to 8 MHz when accessing a floppy drive to provide automatic compatibility with most copy-protection schemes.

The BASIC Sieve and Calculations benchmarks and the Spreadsheet Recalculate test demonstrate a consistent 7 percent to 10 percent advantage in execution speed for the Deskpro 386. Since the microprocessor in both machines runs at 16 MHz, the speed difference seems to be due to the Deskpro 386's static memory chips and the more sophisticated 32-bit memory bus's access to those chips, in contrast to the Kaypro 386's dynamic RAM board.

I ran all the benchmark tests with no programs running in the background and with the extended memory management program, QEMM.SYS, and the program for use with the 40-megabyte hard disk drive, HARDRIVE.SYS, disabled. Thus, the benchmark results in the graph on page 240 reflect the performance of the raw hardware.

I tested these two 80386 machines further by writing two highly optimized assembly language implementations of the Sieve of Eratosthenes algorithm popularized by Jim Gilbreath. [Editor's note: *For more information, see "Eratosthenes Revisited: Once More through the Sieve" by Jim and Gary Gilbreath in the January 1983 BYTE. The listings are available on disk, in print, and on BIX. See the insert card following page 256 for details. Listings are also available on BYTEnet. See page 4.*]

The first implementation, SIEVE86, uses only 8086 instructions and can run on the Intel 8086/8088 or 80286/80386 microprocessors in real mode (i.e., the 8086 emulation mode used by these processors when running MS-DOS). I assembled and linked SIEVE86 into an .EXE file with the Microsoft Macro Assembler (MASM) and the Microsoft Object Linker, respectively. The second implementation, SIEVE386, uses the 80386's 32-bit registers and operations throughout. I assembled, linked, and debugged the program with Phar Lap's 386|ASM, 386|LINK, and MINIBUG 80386 programming tools. I then ran it for timing purposes under the control of the Phar Lap 386|DOS-Extender, which provides a 32-bit protected-mode runtime environment for programs. The 386|DOS-Extender tool loads a 32-bit application into extended memory (above

continued

the 1-megabyte boundary) for execution, leaving lower memory undisturbed and switching back to real mode as needed to perform MS-DOS function calls.

The Kaypro 386 ran the SIEVE86 and SIEVE386 programs in 48 and 56 seconds, respectively, while the Compaq Deskpro 386 ran each of the programs in 41 seconds. This confirms the Kaypro 386's significantly slower throughput in the BASIC benchmarks and demonstrates that the Kaypro's extended memory is slower than its conventional memory. This finding contradicts the statement in

the *Kaypro 386 Technical Manual*, which says that the access times to memory on cards in the 32-bit expansion slots are the same as the access times to the 512K bytes of RAM on the motherboard. When I called the company, Kaypro admitted that the access times for the 32-bit memory board are slower. [Editor's note: *The reason for the slowness of the memory board is that the memory is organized into two banks of 1 megabyte each, with one bank containing the even addresses and the other containing the odd addresses. Accessing successive odd and even*

addresses will usually cause one wait state per access.]

Picking Some Nits

The Kaypro 386 has some flaws, particularly when compared to the Compaq Deskpro 386. For example, the various option jumpers on the motherboard are spread from one end to the other instead of being centralized in one location as they are in the Deskpro 386. Similarly, the socket for the 80387 in the Kaypro 386 is buried under the edges of the hard disk drive and power supply in such a manner that it would be nearly impossible to add a numeric coprocessor chip or module without disassembling the computer.

The portions of the documentation that originate with Kaypro (i.e., the *Kaypro 386 User's Guide* and *Kaypro 386 Technical Manual*) are barely adequate. The user's guide is poorly organized, inconsistent, and often omits important information or provides information that is inaccurate or misleading. For instance, the key sequence to increase the volume of the key clicks is not documented; I discovered it to be Control-Alt-+ by trial and error. The procedure for making the hard disk bootable is located in Chapter 2 under "Hardware Installation," while the section in Chapter 3 entitled "Loading MS-DOS onto the Hard Disk" describes only how to copy MS-DOS files from the distribution floppies to drive C. The entire "Getting Started" section is oriented toward floppy disk-based systems, even though the typical 80386 system is hard disk-based. The page entitled "Redirecting Screens" discusses redirection of the standard output device; redirection of the standard input device is not mentioned at all.

Final Thoughts

The Kaypro 386 is a reliable personal computer that delivers two to three times the performance of the IBM PC AT. Its compatibility with standard 8086- and 80286-based PCs and software is excellent. Its performance is similar to that of the Compaq Deskpro 386. The deficiencies in its documentation and other minor inconveniences, such as the position of the jumpers on the motherboard and the layout of the keyboard, will be no great obstacles to experienced users.

If you need to run software applications at the fastest possible speed, or if you are prototyping 80386 software, the Kaypro 386 is perfectly suitable. As a slightly more economical alternative to the Compaq Deskpro 386, whether for software development or for crunching data, the Kaypro 386 appears to be a good buy. ■

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In the Chips

Jerry Pournelle

Fast Kat gets even faster with a math coprocessor, DESQview, and VOPT.

It was almost a quiet month. Of course, we did have to go to Atlanta for Spring COMDEX. Then there were publicity arrangements for *Janissaries III: Storms of Victory* and the new Niven/Pournelle/Barnes book *Legacy of Heorot*, and Niven and I have been hard at work on *The Moat Around Murcheson's Eye*, and we got a new puppy and had to persuade the cat not to leave home; but all in all, nearly quiet.

Fast Kat

It's official: the main machine at Chaos Manor is now Fast Kat. For the record, Fast Kat is a Kaypro 386 with built-in EGA color. Mine has accessories: the Intecolor Megatrend 19-inch EGA monitor, a DataDesk Turbo-101 keyboard, Xerox PC TypeRight in-line spelling checker box, and Amdek CD-ROM reader. They work together fine, and the system is *fast*. While I was changing over from Zelda the Zenith Z-248 to Fast Kat, I did some rearranging. My desk is now completely surrounded by computers. One of these days I'm going to design some computer furniture; nothing I've seen makes really efficient use of the limited space near a desk.

Otherwise, I don't have a lot to report about Fast Kat that I didn't say last month. Once in a while I think I've found PC-compatible software Fast Kat won't run, but every time that has turned out to be my fault.

We did make one improvement since last month; we managed to install a math chip. It wasn't easy.

Math Chips

Last month's column featured a new round of tests with my matrix benchmark program. Examining the results gave me a surprise: no matter what the basic speed of the machine, for math-intensive programs like matrix operations, the really dominant factor is the presence of a math chip. There are differences between the 8087, 80287, and 80387, but they are

nothing compared to the difference between having a math chip and not having one.

Fast Kat didn't come with a math chip, but once I started playing with benchmarks, it became obvious he'd need one.

Intel makes a small adapter board about 3 inches square to adapt the 80287 math chip so that it can work with an 80386 CPU. The Intel people were kind enough to send me several of them for the various machines we have here. First to get one was the CompuAdd Standard 286-II with the Cheetah Adapter/386 board.

On opening the machine I found a minor problem: Cheetah makes its own adapter to accept an 80287. The solution was to pry the 287 from the Intel adapter. I'd heard the 287 doesn't have to run at the same speed as the 386 chip, and this seemed a good time to test it. We dropped the 6-megahertz 287 into the adapter in the Cheetah. It worked fine. For the past couple of weeks, Dave Moore has been using this as the development machine for fixing up FTL Modula-2, so the system has been getting a heavy workout; no problems.

After that, it was Fast Kat's turn. Since Intel makes the Kaypro 386's motherboard as well as the 287 chips and adapters I had, this should have been a snap, but it wasn't. Because of the geometry of the hard disk and power supply installations on the Kaypro 386, you physically cannot install the standard Intel 287 adapter.

A quick call to the Kaypro technical-support people established that Kaypro has a special version of the adapter board, and that they'd send me one. In a couple of days there appeared a box that was prominently marked Intel Singapore

Limited. The label said it was a "Single Board Computer," but actually it contained an adapter board with circuitry identical to the standard 287 adapter, but laid out differently; basically, all the components were rotated

90 degrees.

Now it'll be easy, I thought. The little chip assembly goes next to the power supply and under the hard disk cage; it looked like a tight fit, but I thought that would only be a matter of moving things.

Hah. It was no trouble to remove the front clips holding the hard disk and slide the disk forward; but then I found that the hard disk's cage doesn't come out. The bottom support of that cage is a piece of steel bent at a right angle; it's bent down far enough that it was impossible to slide the chip board under the disk cage. It was clear that if I could ever get the adapter board inserted into its socket I'd have plenty of room; but while the pins on the square gate-array socket are considerably more rugged than those on a standard chip, I didn't want to force things.

Eventually I took the vise grips to the cage-support bar; by bending that angle bracket so that it's about 60 degrees instead of 90 degrees, I haven't weakened it much (as all Kaypro stuff is, it's strong enough to resist 7.5 on the Richter scale); and that made just enough room to slide the assembly under the cage. I'd previously lubricated the pins with Stabilant (what I used to call Tweek), and it dropped right in.

After that, things went fast. Reassembly was no trouble, and everything works fine. A few days later, while talking to the Kaypro technicians about setup software, I mentioned the problem I'd had getting the math chip in.

"Gee," one said. "We didn't think you

continued

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future.

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its window. Unlike the SideKick editor, there's no way to set colors for the notepad itself.

Then, too, if I invoke the notepad first (and thus get the screen colors The Norton Utilities set for me on boot-up), odd things can happen. At least once I brought Fast Kat up in DESQview, opened the notepad as one window, opened Crosstalk as another, and connected to BIX. I used the Mark, Cut, and Paste routines to do some editing. All worked fine. Then I closed the Crosstalk window and went to bed, leaving the DESQview notepad as the sole surviving job.

The next morning the machine was locked up. I had to reset to get started.

That could, of course, be the result of a mini power failure or some kind of hardware glitch. I'd be more inclined to think so if similar things hadn't happened under DESQview, and not when DESQview was turned off. Of course, most of my problems have been due to insufficient spelunking of the DESQview manual; but some, I think, were just plain bugs.

For all that, I tend to use DESQview more and more. For one thing, Quarterdeck is quite responsive to bug reports; the DESQview you'll be able to buy when you read this will not be the same one I'm running. Also, DESQview has some really neat features, including a very nice keyboard swap and macro program similar to SuperKey. It's possible to build a customized file of keyboard macros that will be "automagically" invoked whenever you bring in the program they're associated with.

For example, when I bring in WordPerfect under DESQview, I also bring in a macro that redefines the backspace to "left-arrow delete left-arrow right-arrow." The "left-arrow delete" business is necessary because DESQview won't let you define a key recursively; and the "left-arrow right-arrow" monkey motion makes WordPerfect reformat the paragraph. I expect that would be a silly thing to do on a slower machine, but on the Kaypro 386, the operation is instantaneous.

The macros are neat, but mostly, DESQview is still the only way to do real multitasking; and that's quite often worth the problems DESQview can cause.

Swaps

I use DESQview a lot, but not always; often, it's just more convenient to have my usual bunch of memory-resident programs. Of course, I want them installed automatically; I also tend to want a different configuration of memory residents

continued

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working with equations, Eureka: The Solver can do your algebra, trigonometry, and calculus problems in a snap." That's pretty well true. I'd add that eventually everyone has to deal with equations and numbers, and when it happens, Eureka will make it a lot easier. I'll go further: programs like this may go a long way toward correcting some of the deficiencies of our school system. A computer can't teach math, but with a PC and this program, you can learn to use math on your own.

Get Eureka. You won't regret it. Highly recommended.

Care and Feeding of Fixed Disks

Hard disks are wonderful, but after a while, reading and writing to them takes longer and longer. What happens is that when you start with an empty disk there's plenty of space available, and your files are written in one long string. As the disk gets full and you erase files, things get patchier and patchier until, finally, the space that's left is all chopped up, so that the disk controller has to keep looking for space, finding it, writing to it, and recording where it wrote it. This makes for a lot of head movement and takes time.

The remedy for that is to repack your disk every now and then. Several disk management programs are available, but

the one I use is Golden Bow's VOPT. This comes with VMAP, which paints a map of which disk sectors are in use and which are empty, and VOPT, which moves the files around so that everything that can be saved is saved in contiguous blocks. VOPT keeps track of how many files it has moved and how long it took; on the Zenith Z-248 and the Kaypro 386, that will typically be some 25 files moved in around 30 seconds.

It makes a real difference. As a test, I let my disk get cluttered and disorganized, then wrote an enormous text file to it, retrieved it, erased it, used VOPT to repack, and did all that again. Retrieving the file took about 16 percent less time after VOPT. Now I routinely use VOPT every couple of days.

VOPT comes with a jazzed-up version of the DOS utility CHKDSK, but for some reason the Golden Bow CHKDSK has never worked on either the Z-248 or the Kaypro 386. It hardly matters: VMAP and VOPT are what's important.

The other program you need is SpeedStor, which I mentioned last month. SpeedStor is a hard disk drive integration and diagnostic program that lets you install virtually any size hard disk in your system. I finally got around to partitioning Fast Kat's 40-megabyte hard disk, of which DOS could find only 32 mega-

bytes. Thanks to SpeedStor, it now has two 20-megabyte logical drives. (VOPT, incidentally, can operate on both of them with no difficulty.)

SpeedStor is especially useful if you're installing your first hard disk in a PC or XT. The manual is detailed, and since the program works automatically in batch mode for most hard disk installations, SpeedStor makes the installation fairly simple.

Winding Down

I'm out of time and space, and I haven't even got started on the pile I set out to write about.

I do want to mention Definicon's 68020 and graphics boards for the PC. Their boards drop into a PC and turn it into the fastest thing this side of a VAX; maybe faster. There's not a lot of software, but there are compilers. My matrix benchmark runs (in C) so fast you can't really measure it. Anyone doing serious software development ought to know about Definicon.

Then there's a flier from the good guys at The Software Toolworks reminding me that Chessmaster 2000 makes a great Christmas gift. I think they have a weird idea of BYTE deadlines, but, in fact, that's the best chess program I know of. There's a pile of stuff I collected at Spring COMDEX, including pc-ditto, which lets you run just about any PC program there is on your Atari ST. There's Borland's new C compiler and a big package of new stuff from Microsoft. It will all have to wait.

The game of the month (other than Sundog for the Atari ST) is Faery Tale Adventure for the Amiga. This has fabulous graphics and a pretty good story line. It's hard to get started—I kept getting killed in the first three minutes, so I never saw much of the scenery—but my son Phillip has definitely mastered the system and is able to romp about bashing bad guys.

The book of the month is Arthur Ferrill's *The Fall of the Roman Empire—The Military Explanation* (Thames and Hudson, 1986). Good reading and plenty of lessons for our time.

With any luck, by next month I'll have written some new text-handling benchmark programs. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

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