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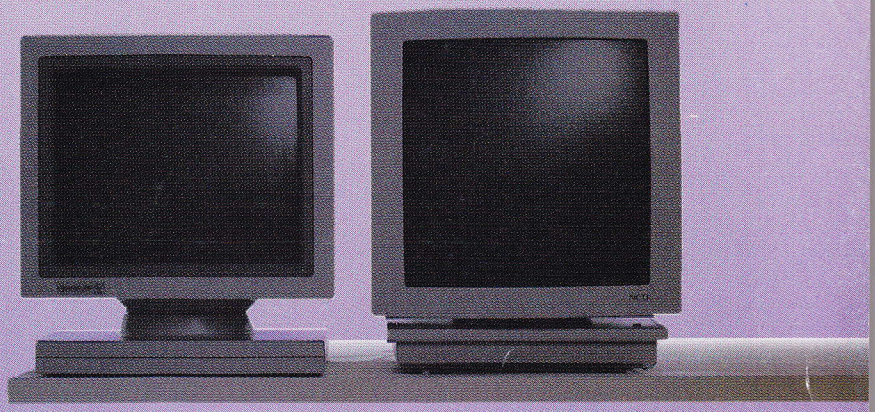
BUYING THE RIGHT X TERMINAL



PLUS

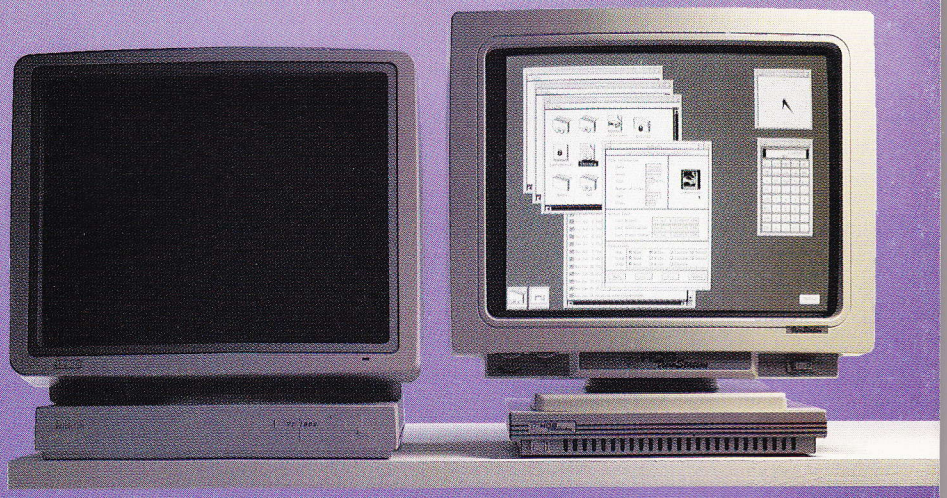
How to choose X terminals vs. diskless workstations

REVIEWS

- 3 PC-UNIX products for multitasking access
- PI's DOS/UNIX editor for programmers

Turbocharge your 386 on a budget

Update on UNIX accounting



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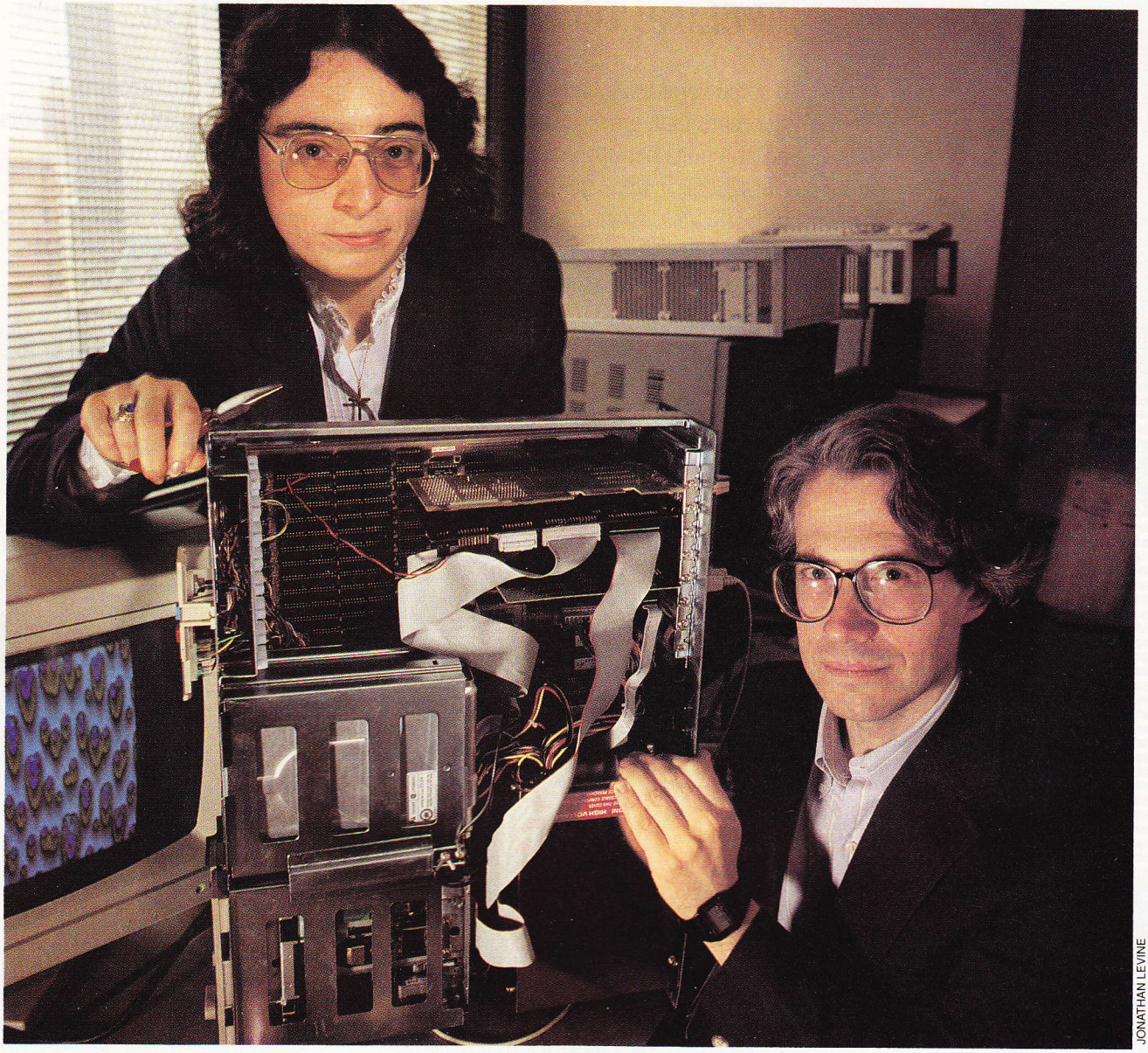
Given a budget of around $8000, Francis Marchise and Jean Coppola (left) of Pace University created an AT-based 386 workstation with exceptional floating-point performance.



JONATHAN LEVINE

TURBOCHARGING YOUR 386

Build a 386 from scratch, or increase performance on a budget

By Jean F. Coppola and Francis T. Marchese

You've bought a 386 machine running UNIX, and you want to improve its performance and add some neat features. However, you have a limited budget, so you want the best price/performance available.

Where do you start? Whether you're upgrading your 386SX or building your own system from modules, you first have to set priorities. As small systems analysts at Pace, a New York university, our particular goal was to build a 25-MHz system that was as powerful as a workstation, reasonably priced, yet easily maintained.

Originally we thought we were allotted $12,000 for a complete UNIX workstation, enough to buy a low-end Hewlett-Packard or Sun. In the end, however, our actual budget was reduced to $8000–a real challenge, but we accomplished it by comparison shopping and evaluating price/performance. After careful thought, we decided to design and implement our own generic UNIX workstation because:

- The system can be easily maintained and upgraded. Local vendors could supply parts for in-house service, and a service contract would not be needed.
- The AT-bus hardware is compatible with the majority of the existing machines in the university, and could be swapped out in an emergency.
- The 386 will not become obsolete for several years, and it could provide service for word processing and spreadsheets in a departmental office when it is replaced.
- The machine can be designed at a reasonable cost while providing exceptional floating-point power for computationally intensive applications such as ray tracing, cellular automata, and molecular modeling.
- We would have complete control over all the components in the system. If we would have bought a preconfigured system, it would not be customized to our particular needs, nor would we be assured of the quality of each component.

Two further considerations: we chose to stay with the AT-bus architecture because the Industry Standard Architecture (ISA) is still the current standard and most widespread bus currently in use, whereas the percentage of MicroChannel Architecture machines is still small, and the Extended Industry Standard Architecture (EISA) has not caught on yet. We also chose the 386 Intel processor because Pace's Motorola 68020-based workstations have had several problems, not to mention a high-cost service contract. Here's why we chose what we did.

Co-processors

Our primary design objective was to have exceptional floating-point performance, so we chose the Weitek mW3167 Abacus numeric co-processor. Weitek claims its co-processor is capable of floating-point speeds 50 times faster than an Intel 8087 chip and 4 to 5 times faster than an Intel 80387, thus approaching the speed of a VAX 8600.

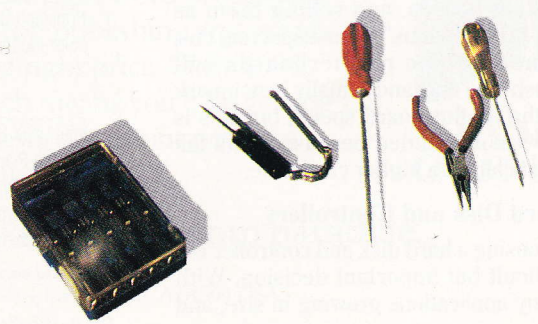
The Abacus chip provides full 32- and 64-bit floating-point operation and conforms to the IEEE standards for floating-point arithmetic. However, it requires a special 121-pin socket on the motherboard specifically made for this chip, and the software must be Weitek compatible to recognize it. When writing your own code, this is not a big problem because compilers are available that support Weitek.

Although the Weitek was excellent for our in-house intense floating-point applications, we also needed a fast numeric co-processor for commercial non-Weitek-supported applications, and possibly parallel computations. A daughterboard, with sockets for both chips, can accomplish this task, and both chips can reside in the same system to accommodate any co-processor-specific application. Although a daughterboard is needed for the majority of the motherboards, some manufacturers have installed both sockets directly.

Instead of installing an Intel 80387 chip, for almost the same price (see table), we purchased a Cyrix FasMath numeric co-processor–which is fully Intel-compatible. Cyrix claims this co-processor has a greater precision in division, and is faster on single-precision and double-precision computations than Intel's. Furthermore, the Cyrix is especially good for high performance on transcendental functions, and meets all IEEE specifications. In the near future, look for a new chip from Cyrix that is Weitek compatible, competitively priced, and faster than the Weitek.

Motherboard

The most difficult decision was selecting a motherboard. Though there are many manufacturers and models of 386 motherboards, not all support the Weitek. These included (but were not exclusive to) specific models from ALR, AMI, Dell, Everex, Intel, Micronics, Mylex, and Zenith. Other manufacturers such as AST, Compaq, HP, and



Hauppauge also have versions that are Weitek compatible, but also have two sockets on the board to accommodate both the Weitek and a math co-processor.

Most motherboards have similar throughput performance. We chose the Micronics because it is cleanly engineered, relatively inexpensive, and is sold by local vendors. Our local vendor had a Micronics compatible that met all of our requirements, and came with a one-year warranty. Though we purchased this board, in retrospect, we recommend that you purchase a major brand name, such as those mentioned above, unless you have a dealer with a good track record that will give you the support you need.

Other features to look for when investing in a motherboard are maximum memory capacity, processor speed, wait states, number and type of expansion slots, and type of RAM. Because most versions of UNIX require a minimum of 4 megabytes of memory, the maximum expansion ability of the motherboard is important. Also, check the maximum amount of memory that can go directly on a motherboard–and if and how much memory can go on a daughterboard.

When deciding upon the speed of the system, we chose a speed of 25 MHz instead of 20 or 33 MHz because the price/performance ratio was the best when compared to others, especially when considering it would cost thousands of dollars more to add the faster Weitek, Cyrix, and RAM for a 33-MHz machine. It was only a few hundred dollars more for a 25-MHz than a 20-MHz.

Most boards will have the option of one or zero wait states, but the RAM has to be fast enough to meet that particular manufacturer's specifications if it is to run at zero wait state. A good number of expansion slots is about eight, which allows for future growth. If you are replacing an existing system board, make sure there are enough of the right size bit (8, 16, 32) slots.

When you purchase a motherboard, be sure that the Intel 386 chip speed is the same as the advertised speed of the motherboard. For example, many dealers are installing 20-MHz chips on 25-MHz system boards, and selling them as "25-MHz systems" to unsuspecting customers. Some motherboards will "push" the chip and actually benchmark at the motherboard speed, but this is not recommended because it will fail erratically at a higher clock rate.

Hard Disk and Controllers

Choosing a hard disk and controller is a difficult but important decision. With many applications growing in size, and

System Components

Description	List Price / Purchase Price	Vendor
SOYO Micronics compatible 386-25 8 megabytes of RAM installed (expandable to 16 megabytes); slots include: 1 32-bit, 5 16-bit; 2 8-bit; Weitek compatible; minus cache; AMI BIOS	N/A / $1598	JoinData Systems 14838 Valley Blvd., #C City of Industry, CA 91746 818-330-6553
Weitek co-processor 3167-25 MHz	$2495 / $995	Weitek Corp. 1060 E. Arques Ave. Sunnyvale, CA 94086 408-738-8400
Cyrix numeric co-processor 25 MHz	$814 / $600	Cyrix Corp. 1850 N. Greenville Ave., #184 Richardson, TX 75081 214-234-8387
Daughterboard for Weitek and 80387	$220 / $200	MicroWay Inc. P.O. Box 79 Kingston, MA 02364 508-746-7341
Turbo cool power supply 250 watt	$205 / $169	PC Power and Cooling 31510 Mountain Way Bonsall, CA 92003 619-723-9513
TEAC 1.2-megabyte 5 1/4-inch floppy disk drive TEAC 1.4-megabyte 3 1/2-inch floppy disk drive	N/A / $69 N/A / $79	TEAC Corp. of America 7733 Telegraph Rd. Montebello, CA 90640 213-727-7682 508-683-8322
Lark Associates 16-bit 20-megabit/sec 1:1, 2 floppy/2 hard disk controller	$199 / $150	Lark Associates 4046 Clipper Ct. Fremont, CA 94538 415-657-5275
Hewlett-Packard 340-megabyte 17-ms ESDI FH hard drive (5-year warranty)	$1890 / $1709	Hewlett-Packard 3000 Hanover St. Palo Alto, CA 94304 415-857-1501
ArchiveVP Tape Backup 60-megabyte internal DC600A cartridge compatible	$975 / $545	Archive 1650 Sunflower Ave. Costa Mesa, CA 92626 800-537-2724 714-641-1230
Paradise VGA Professional Card 512K 256 colors at 600-by-480 resolution	$649 / $269	Western Digital Imaging/Paradise 800 E. Middlefield Rd. Mountain View, CA 94043 415-960-3353 800-356-5787
Princeton Graphics Systems 16-inch color multisynch monitor	$1375 / $822	Princeton Graphics Systems 1100 Northmeadow Pkwy., Ste. 150 Roswell, GA 30076 404-664-1010
Intel UNIX System V/386 Version 3.2 System Platform Set Limited Software Development Set Intel System Platform Manual Kit Intel System Development Manual Kit	 $595 / $357 $565 / $339 $100 / $60 $100 / $60	Intel Corp. (formerly Bell Technologies) 3065 Bowers Ave. Santa Clara, CA 95051 408-765-8080

N/A—not available

most UNIX systems taking up a minimum of 20 megabytes, with 40 megabytes recommended, hard disk space gets used up rapidly. In addition, you may choose to also have a DOS partition. We decided on a large hard disk–more than 300 megabytes.

Moreover, the UNIX you choose must be compatible with the type of hard disk that you purchase. For example, many UNIX operating systems don't have drivers for SCSI drives (one exception is SCO V/386 UNIX), and even those systems have very few drivers and are therefore incompatible with most SCSI adapters. Almost all 386 UNIX systems come with ESDI, MFM, and RLL drivers; however, although SCSI seems to promise more power and flexibility in the future, we chose a Hewlett-Packard ESDI 340-megabyte 17-millisecond (ms) drive because of extensive compatibility, and performance reliability (150,000 hours MTBF–mean time before failure–and a five-year warranty!).

The I/O performance of a drive is an important factor because UNIX is disk intensive. During disk-intensive operations, bottlenecks can slow down system throughput tremendously. Additionally, I/O speed for the hard drive, despite the access time, is determined mainly by the controller which determines interleave, and may or may not have intelligence and/or cache memory.

With these features in mind–and knowing that a decent intelligent caching controller is $1200 and up–we decided on the Lark Associates' 20 megabits per second (mbps) combination hard/floppy controller. The other ESDI controllers that were compatible with the HP hard drive were Ultra-Stor (8K cache, upgradable to 32K) and DPT (512K cache). The Western Digital and Adaptec 15-mbps controllers that were being tested at the time had performance problems.

Support for Windows

In UNIX, X Windows is the standard window environment, and we wanted a system to properly support it. Two issues to consider when implementing a window environment are pixel resolution and monitor size. Most UNIX window systems are implemented on frame buffers with about 1K-by-1K resolution, while Windows under MS-DOS are found on 640-by-480 displays. Consequently, more than three times more pixels can be placed on a workstation screen than a PC, resulting in improved character display and better graphics. PC monitors are typically 12 to 14 inches while workstations are usually 19 inches diagonal. A UNIX window environment would produce windows and text that are difficult to read on a standard PC monitor.

Our analysis led us to a VGA adapter by Paradise Systems that provides 640-by-480-by-8 and 800-by-600-by-4 resolution. We chose this VGA board over comparable boards because it was supported by the X Windows software we intended to purchase, and our UNIX software. We coupled it with a 16-inch multisync color monitor by Princeton Graphics Systems. We chose the Princeton monitor because of the company's history of high-quality products, support, reasonable prices, and our favorable past experiences with their other models.

Because the VGA card has an extended resolution of 800-by-600 and the monitor is 16 inches, Princeton provides a reasonable compromise over the higher-priced system. The 16-inch monitor is large enough for most window applications and the 800-by-600 frame buffer provides half the resolution of the 1K-by-1K displays at one-fifth the cost of the VGA card and color monitor.

Whether you are upgrading your system or building one, think twice about throwing just any power supply into your machine.

Power Supply

All systems require a power supply, yet all are not built nearly the same. Whether you are upgrading your system or building one, think twice about throwing just any power supply into your machine. There are many features to look for, including agency approval, cooling capability/fan rating, power output, reliability, and warranty. Secondary features consist of noise, hold-up time, overvoltage/overcurrent protection, and operating temperature.

We chose PC Power & Cooling Systems' Turbo-Cool 250-watt power supply. This power supply is UL-approved and contains two fans (with adjustable speed) to promote heat dissipation under loads which provides 30 to 60 percent extra cooling. In the area of reliability, this power supply has a MTBF rating of 40,000 hours to maintain power integrity. Also, it comes with a one-year warranty, and the noise is rated at 50db(A), about the noise level of a standard PC.

Floppy Drives

Floppy drives are heavily used system components, and because they're mechanical, they're usually the quickest to fail. However, they are also relatively inexpensive and are replaced easily. We chose a high-density 1.2-megabyte 5 1/4-inch drive as the "A" drive, and a high-density 1.44-megabyte 3 1/2-inch as the "B" drive. One of each type was compatible with all types of media. The higher-quality drives are direct drives, as opposed to the older technology belt-driven drives. Because of the nature of a belt, the older drives are not as accurate and reliable. Direct drives usually cost a little more–but are worth it.

Tape Backup

A streaming tape drive is required for system backup and file transfers. In choosing a tape backup system, you may want compatibility with your existing systems, or access to other machines so you can exchange data. Other constraints are whether the UNIX you are using contains the necessary drivers, and whether the drive is a streaming tape system or a slower stop/start mechanism. In our case, we needed compatibility with existing Sun workstations that used DC600A cartridges. Our UNIX had drivers for Wangtek and Archive drives. Archive drives cost less than Wangtek because operation is less automatic. However, we did not believe it would be heavily used–and the price fit within our total system cost.

Operating System

If you use the Weitek floating-point accelerator, the UNIX system and its compilers have to support it. Bell Technologies, now owned by Intel, and Interactive Systems sell versions that support the Abacus chip. Recently, The Santa Cruz Operation (SCO) has added this feature to its product. We also wanted the operating system to be XENIX compatible so it would work with pre-existing software from other departments. AT&T and Microsoft merged UNIX and XENIX into one product and sell it as UNIX System V/386 Release 3.2. As a result, any UNIX system that adheres to this standard will run XENIX applications.

We decided on Intel's UNIX after lengthy discussions with their technical support team and analysis of independent reviews. We were reminded of the inherent instability in the computer market with Bell Technologies' friendly

takeover by Intel and the acquisition of Microport. We decided to purchase from a firm we expected would maintain a commitment to the future. Intel's UNIX was compatible with all our other hardware, and Intel gave an exceptional educational discount, which brought the price substantially below SCO's.

When selecting an operating system, check the hardware requirements like minimum and recommended hard disk storage space and memory requirements. Consider how many users the license is for and pricing to upgrade to unlimited users.

We designed our system with the best possible price/performance ratio in mind. However, as individual needs vary, so should each UNIX workstation. Computer system assembly from preconfigured hardware and software modules places significant constraints

The entire design process lasted four months, working on it part-time.

on the final system structure. Moreover, the design process is complicated because hardware assembly implies bottom-up and software assembly top-down design. Thus, the process may become very iterative, with many successive refinements, because of hardware/software incompatibilities.

In all, the entire design process lasted four months, working on it part-time. We originally believed our project would be similar to constructing a DOS-based 286 system. We were partially right, but with the complexity of UNIX, its system-dependent features, and the multiplicity of versions, it prolonged the decision-making process.

Moreover, searching for the best vendor for each component and communicating with each manufacturer about product specifications required patience and large blocks of time. Now that we're done, however, we feel confident about our system because we had full control over the selection of every component and knowing the machine literally piece by piece from the motherboard up. We'd even consider doing it again. □

Jean F. Coppola teaches, consults, and manages small systems support for Pace University in New York. Frances T. Marchese is associate professor of computer science and director of the computer graphics laboratory at Pace University.