Digital's Professional 300 Series
A Minicomputer Goes Micro

Photo 1: *The Professional 300 Series includes both the Model 325 and the Model 350, the only differences being the number of available slots and the option of a Winchester hard disk.*

Microcomputer architecture must complement the work habits of the people who use computers as tools. Most managers and office workers perform various tasks in a given day and often switch quickly from one to another. People who work as part of a team spend a considerable amount of time communicating with one another. Digital Equipment Corporation designers took these factors into account in creating the Professional 300 Series. They decided that new machines must be able to perform several tasks at once, apply the same user interface to each task, communicate efficiently, and, as an added bonus, use the same software as Digital's popular minicomputers.

The Professional 300 Series consists

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of two models that differ only in storage capability and slot space. The 325 has one dual floppy-disk drive and three option slots and can be upgraded to a 350 model, which has an optional Winchester hard disk and three additional slots.

These personal computers are really desktop-sized versions of the PDP-11, one of Digital's popular minicomputers. Both models share the PDP-11 instruction set and memory management and provide the user with about 90 percent of the through-

put of a PDP-11/24. Both have an operating system based on Digital's RSX-11M+. For the user, this means that software applications developed for more than 500,000 installed PDP-11 and VAX systems are candidates for easy migration to a desktop personal computer.

Three major components—the system unit, the monitor, and the keyboard—comprise the Professional 300 system (see photo 1). The system unit contains the processor, memory options, power supply, and mass storage in a case that measures $23\frac{1}{4}$ by $14\frac{5}{8}$ by $6\frac{1}{2}$ inches. The main logic module contains the F-11 central processing unit, a chip set equivalent to a PDP-11/23-Plus (see photo 2). Its instruction set includes 87 instructions

and eight addressing modes of either 16-bit words or 8-bit bytes. Although the system works with 16-bit addresses, providing for 64K bytes of logical address space, the Memory Management Unit (MMU) constructs 22-bit addresses that allow up to 4 megabytes of RAM (random-access read/write memory).

Two memory modules totaling 256K bytes of RAM connect to the main system logic module with 40-pin connectors without occupying an option slot (see photo 3). The standard configuration also includes 16K bytes of ROM (read-only memory) and 32K bytes of RAM for bit-map control. Options requiring extra memory include the necessary additional RAM on the option module. A nonvolatile clock and RAM use a rechargeable nickel cadmium battery to maintain the time and date even when the system power is turned off. Each Professional System also includes a unique 47-bit identification ROM that is readable from software and can be used for either system verification or as part of a piracy-protection scheme.

A 208-watt power supply that comes with an integral fan handles a Professional 350 equipped with all available options. The disk-drive units are easily accessible from the front of the chassis. Both Professional Series systems come with an RX50 dual-disk subsystem that is capable of storing up to 800K bytes of formatted data in fixed-length blocks on two 5¼-inch floppy disks. This subsystem includes a separate single-board controller module and extensive internal self-testing and diagnostic firmware. An optional 5-megabyte Winchester disk is available for the 350 model. The 350's module cage contains six slots for the addition of peripherals. In the standard configuration, one slot is occupied by the floppy-disk controller and another is taken by the video controller. The back panel of the system unit enclosure has connectors for a serial printer port, the video monitor port, an RS-232C/423A serial-communications port, AC power, the telephone-management interface, and a 16-pin Ethernet plug.
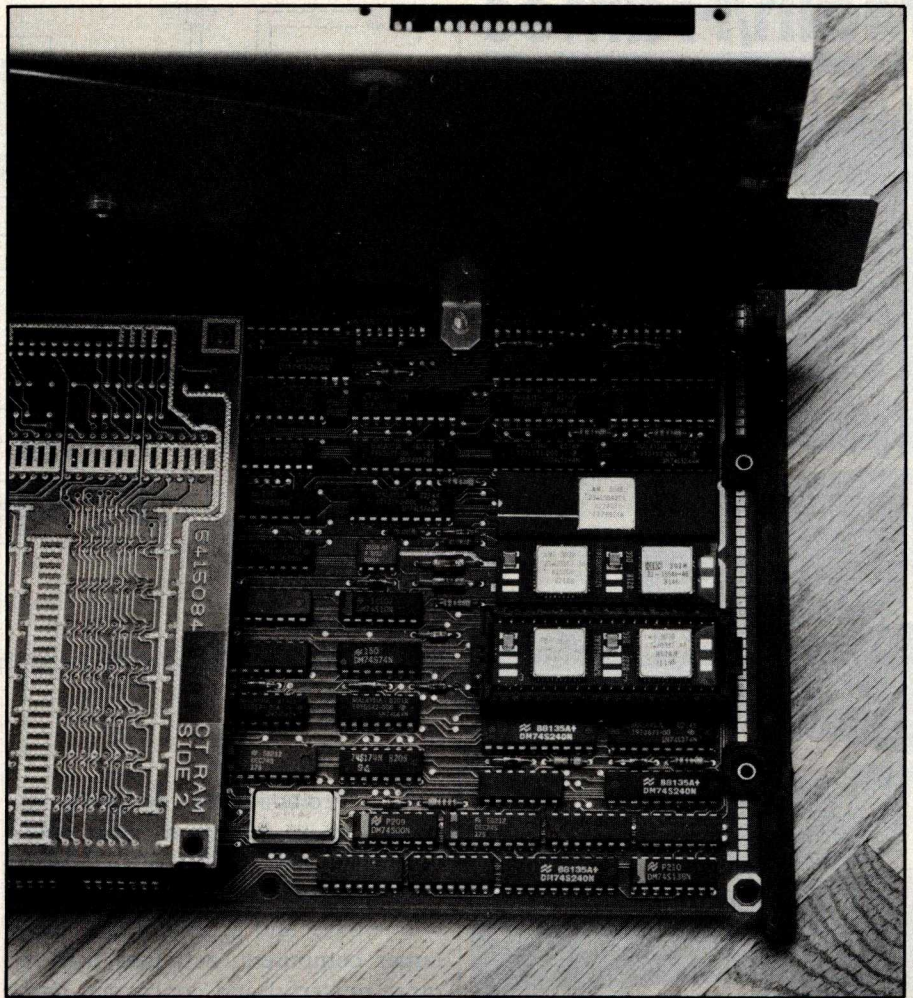

Photo 2: *The F-11 chip set provides users with the power of a minicomputer in a microprocessor-based desktop computer.*
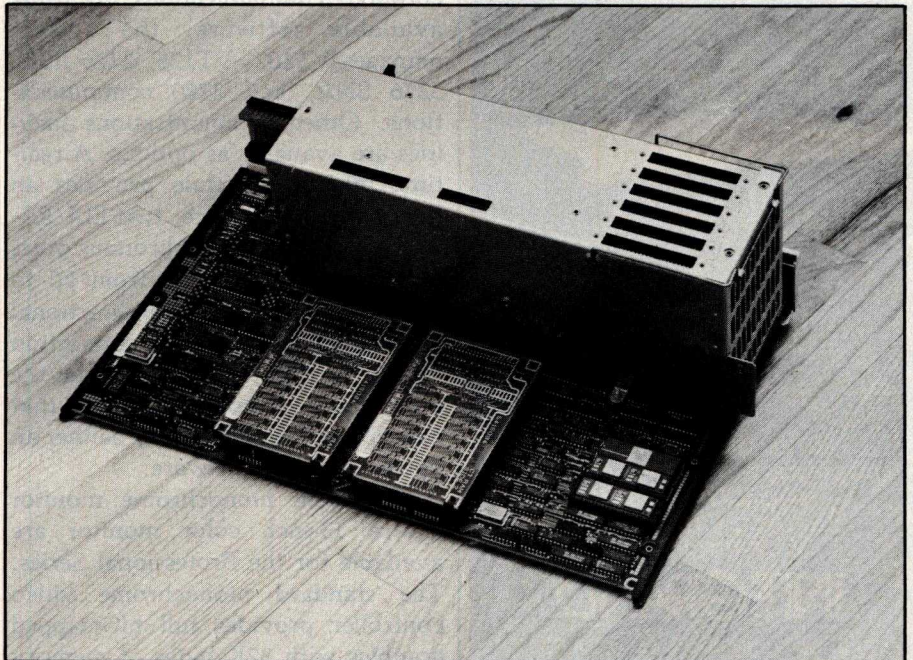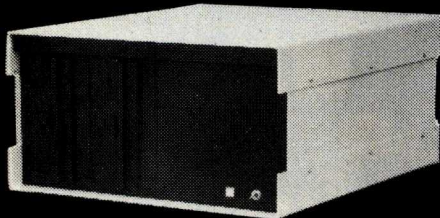

Photo 3: *By using daughter boards for additional memory, the designers were able to avoid occupying an expansion slot.*
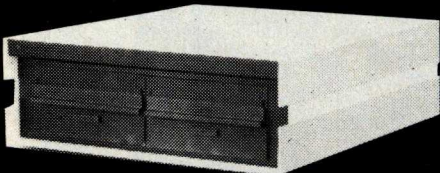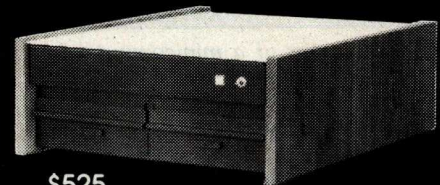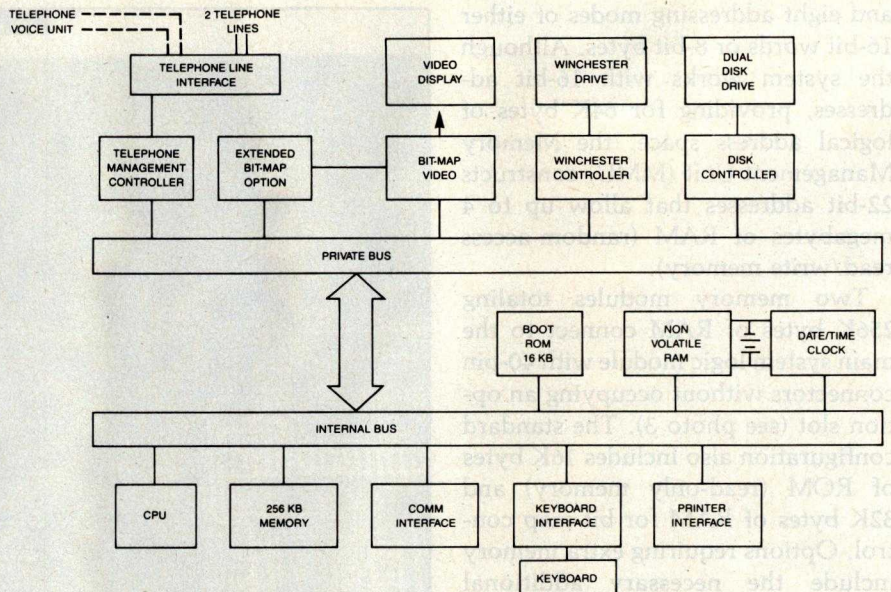
Figure 1: *A block diagram of the Professional 350 system.*

The Professional's designers assumed that managers and office workers rarely work alone. Instead, they spend their time communicating with others and accessing data from larger computers, activities that require powerful and concurrent communications facilities. The standard communications port on the Professional handles asynchronous or synchronous communications. By using available software, the system manages VT102, VT125, 3276 BSC, 3276 SNA, and 3780 communications. Other communications facilities are available as options. A real-time interface module provides an IEEE-488 bus interface, two EIA RS-232C-compatible asynchronous ports that are programmable from 50 to 9600 bps, and a 24-bit bidirectional parallel port. An Ethernet connection is also provided at the rear of the system unit, although currently that connection is supported by neither an option card nor software.

A 12-inch monochrome monitor and a 13-inch color monitor are available for the Professional Series. The standard monochrome video controller provides full bit-mapped graphics with 32K bytes of memory on the board, supporting a 960 by 240 pixel (picture element) display. An extended bit-mapped option provides memory for two additional bit planes as well as RGB (red-green-blue) control for the color monitor. Both monitors are designed to be as small as possible to keep the computer system's footprint—the size of the surface it occupies—as unobtrusive as possible.

The keyboard was designed to meet three major criteria: it must conform to international standards, accommodate Digital's multinational character set, and provide user-defined function keys. Using these criteria and basing their work on ergonomic studies, the designers provided 105 keys and separated them into four logical groups. A main typing array of 57 keys conforms to the international touch-typist layout. Immediately to the right of the main keyboard are the editing pad and the cursor-control keys. The most commonly used editing keys—Find, Insert, Remove, Select, Next Screen, and Last Screen—are located just to the right of the main array. The cursor controls are arranged in an inverted T, the most efficient configuration for touch-typists. To the right of the cursor controls is an 18-key numeric pad that makes it possible to enter large amounts of numeric data
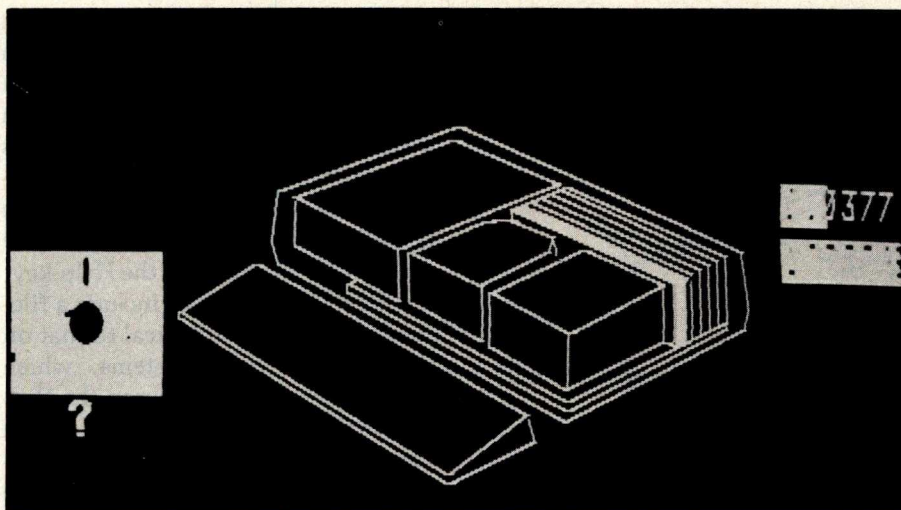
Photo 4: *The use of graphic error messages is another example of the designers' goal of reducing the confusion and complexity often associated with computers.*

logic run first and are followed by a segment that detects which options are installed. Then diagnostics on each module transfer to RAM to be run by the central processing unit. Error messages take advantage of the machine's bit-mapped graphics by drawing a picture of the system and highlighting the failing component in reverse video (see photo 4). All the system's modules can be replaced and can be removed either with fingers or a ballpoint pen. These features reflect Digital's belief that a user who has to call a technician soon becomes convinced that the computer is complex and difficult to use.

Software Availability

Digital's design goals are further evident in the company's three-pronged software effort: the Professional Operating System (P/OS), the Professional Developer's Toolkit, and third-party application programs.

The operating system is derived from Digital's RSX-11M+, an event-driven multitasking software system. The design team regarded multitasking capabilities as mandatory. As the personal computer becomes an integral part of the professional's working patterns, the designers reasoned, the machine must function in the same manner as its user, which means working at multiple tasks.

Throughout the design process, the goal of a consistent user interface was cardinal. Today, some operating systems force users to have as many different interfaces as they have application packages. Digital believed that a continual proliferation of interfaces would impose a major constraint on the perceived usefulness of personal computers. P/OS removes that constraint by making it simple for programmers to work with a consistent user interface that controls every application on the system. The combination of multitasking, the user interface, and published standards, tools, and guides for application is a design that responds to the needs of the Professional's market.

In the initial release of the operating system, a single menu-tree structure, help-message handler, error-message handler, and a common file
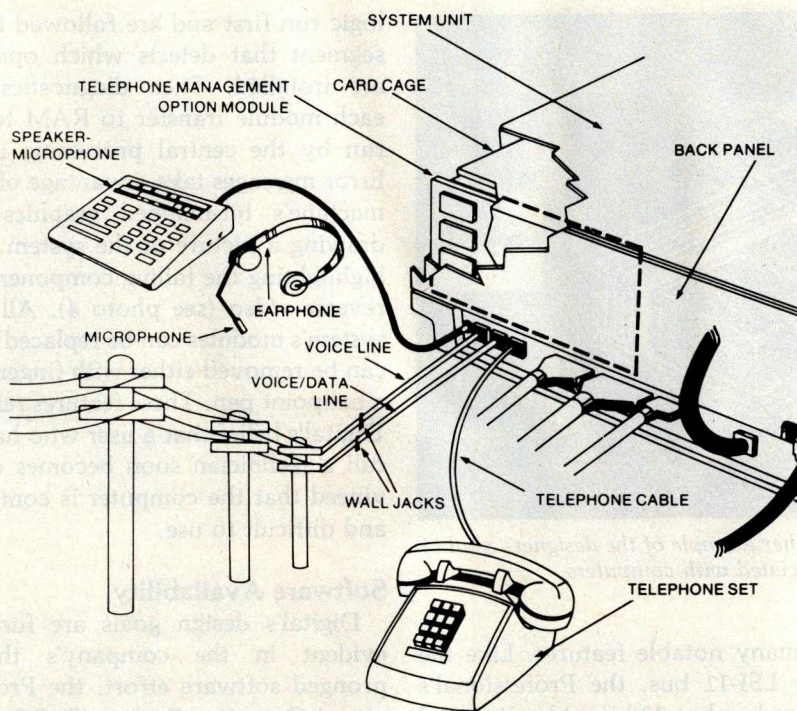
quickly. The pad layout is compatible with all existing software dependent on Digital's VT100 keypad arrangement. Across the top of the keyboard is a row of 20 function keys. Applications programmers can program all but four of these keys. Digital's designers also provided a special windowed area at the top of the keyboard for key labels. Digital did extensive tests with computer novices to help ensure that the functions of the keys are obvious from their labels.

User Interface

Digital made a concerted effort on the design of the user interface for this family of personal computers. In all aspects, from installation and maintenance features to the operating system, the designers anticipated prospective users' habits and needs. A novice user can install the hardware, the operating system, and application software and do minor maintenance without technical help. The system components assemble quickly. For example, you simply connect the keyboard to the monitor with a cable, connect the monitor to the system unit in the same way, plug the power cord on the system unit, insert the Winchester disk, plug into an AC power outlet, and hit the switch. The option cards were designed with zero-insertion-force connectors and install on a system bus designed to eliminate the need for switches and jumpers.

The Professional's CTI system bus

has many notable features. Like the older LSI-11 bus, the Professional's system bus has 22-bit addressing and multiplexes addresses and data by combining 16-bit data signals with the 22-bit address signals on 22 signal lines. Each option module installed on the bus generates two different hardware-interrupt signals with an associated register indicating the memory location of the interrupt-handling routine associated with this signal. The design of the interrupt-handling hardware makes the interrupt priority independent of the slot position.

When the user installs a module, an option-present signal alerts the main system logic module. Because each option contains identification information in ROM, the system easily locates and identifies all installed options. Each bus slot has a fixed address, and an option card assumes the address of the slot it occupies. And except for the hard disk and the floppy-disk controllers, any option card works in any slot.

The installation of the operating system is equally simple. A series of copies from floppy disk to hard disk with software prompts guide the way. Application programs use a similarly simple procedure under control of an automatic installation utility. The Professional 350 also offers diagnostics both in ROM and on disk that run every time the system boots. The diagnostics for the main system

Figure 2: *The Telephone Management System incorporates voice and data communication through telephone connections.*

Application	Product; Company
Word processing	Prose, Prose Plus; Digital Equipment
Calendar/tickler	Executive Desk Set; Cortex
Spreadsheet	Advanced Visicalc; Visicorp
Graph	Visiplot/Visitrend; Visicorp. Corgraph; Cortex
Decision support	MAPS; Ross Systems
Project management	micro/MAPPS; Structural Programming Inc.
Data management	Visifile; Visicorp. NPL; Desktop Software
Statistics	SPSS; SPSS Inc.

Table 1: *Professional Series users have access to these application software packages, which incorporate the consistent user interface.*

structure characterize the user interface. While the hardware architecture makes it possible to take advantage of windowing and various cursor-positioning schemes such as mice or bit pads, the software design team felt that the first priority should be establishing a consistent interface. The other options will evolve as users demand them.

For an example of how the user interface works, consider what happens when you want to use a new application package on the Professional system. First you insert the disk and call the automatic application installation utility, which copies the program into the program library. At the same time, the utility copies the error messages into the appropriate library, puts text in the help library, integrates the application's menu into the menu tree, and places the name of the application package in the main menu. During this process you can also rename that application program or position it at a particular place in the menu tree. All of the application programs Digital developed use this same installation approach. One advantage of a consistent user interface is that you can get online help at any time simply by pressing the Help key.

Other P/OS features include a file-structure protocol identical to that on PDP-11 and VAX systems, which makes file transfers between the Professional and those systems much easier. A set of file services, print services, disk utilities, and a memo editor called PROSE are included with the operating system. The designers also furnish an interactive BASIC interpreter, PRO/BASIC, to meet the user's everyday programming requirements. PRO/BASIC is a compatible subset of Digital's BASIC-Plus-2 and VAX-11 BASIC, the only exception being that the PRO/BASIC has additional graphics commands. Features of the language include 31 character variable names, extended IF. . .THEN. . .ELSE statements, single and double precision, program chaining, and online help.

Development Tools

For special applications that require the user to design custom software, Digital has provided the Professional Developer's Toolkit. This package of tools lets a programmer use the power and resources of a VAX or PDP-11 minicomputer to write programs for the Professional Series microcomputers. The Toolkit supports seven languages (see box on page 102) and contains programming utilities RMS (Record Management System), FMS (Forms Management System), and CGL (Core Graphics Library).

In a typical development scenario on the Professional, a programmer enters and edits source code using PROSE. Then the programmer uses the communications utilities provided with the Toolkit and takes advantage of the identical file structure protocols to pass the source code to a larger PDP-11 or VAX system. The minicomputer compiles the code and transmits the result back to the Professional system, where the program-

mer uses an interactive debugger to refine the program. Later, the programmer uses the frame-development tools to create menus and error messages for the program. Additionally, an application-builder program creates floppy-disk copies for distribution. Finally, the programmer may develop algorithms that use the identification number located in ROM to combat software piracy.

A Toolkit style guide helps programmers maintain the consistency of the user interface. For example, execution of a command should be initiated by pressing the DO key rather than Enter or Return. Digital's design goal is that end users will get some applications programs from Digital, some from their own programming staff, and some from third-party vendors, but all the programs will look and act as if they came from the same programmer. Already, Professional Series users have access to software that has been developed with the consistent user interface (see table 1). Much of this application software is also available for both the Professional and Digital's larger systems, and the common file structure provides an easy migration path to established minicomputer software.

Telephone Management

In another example of designing a personal computer around the work habits of the user, Digital introduced a Telephone Management System (TMS) option (see figure 2). A potential user of the Professional system probably spends at least 20 percent of the day on the telephone. That time can be made more productive by using TMS, which lets the computer maintain a personal directory of numbers, dial calls, log and file messages, and answer the phone when necessary. Additionally, TMS can provide facilities for dictation and transcription. Perhaps most impressive is that the TMS hardware will support *composite documents*, which combine text, graphics, and voice—which are necessary components of the automated office.

The TMS has three components: a controller board that fits into the option-card cage of the system unit, an attachment plate that goes on the rear of the system unit, and an accessory box designed to resemble the keyboard. The controller board contains most of the TMS logic, including the modems, DTMF transceiver, tone-detection circuitry, and Codec, a voice encoding and decoding chip.

Bell Laboratories' 103J/212A equivalent modems provide the user with 300- or 1200-bps (bit-per-second) data communication over standard telephone lines, and Touch-Tone signals can be transmitted with the DTMF transceiver. The tone-detection circuitry detects dial, busy, and ring-back tones. Analog voice signals from the telephone line or voice unit are converted into digital signals by the Codec circuitry. These signals can then be stored on the Professional's Winchester disk, on a file server, or on a larger system. The process also reverses to reconstruct analog signals from transmission on the phone line or voice unit. A CVSD (continuously variable slope delta modulation) 32K-bps encoding scheme maintains high-quality voice playback.

A plug-in attachment on the back of the system provides modular-jack connections for two telephone lines, allowing the user simultaneous voice and data connections. Additionally, this attachment provides the necessary connections for the user's telephone and the optional voice unit, which contains a full telephone dial pad, conference phone buttons, and dictating-machine control keys. The unit also has a speaker and a microphone.

The TMS hardware operates through a standard handset or an external speaker. In combination with an optional communication-services software package, the user can maintain a personal calling directory and automatically invoke dialing of either voice or data calls. The communications software also provides for VT102 and VT125 terminal emulation using the TMS modems and permits file transfer between other Professionals as well as to RSX and VMS systems. The hardware's potential, however, still remains to be reached,

A DEC on Every Desk?

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The VT180

The Rainbow 100

The DECmate II

The Micro/PDP-11

Digital Equipment Corporation has developed an entire line of microcomputers to meet the needs of a variety of users. In addition to the Professional Series, the following machines are available:

• The VT180, an 8-bit microcomputer based on the CP/M operating system and floppy-disk drives
• The Rainbow 100, a dual-processor 8-bit and 16-bit microcomputer based on CP/M, CP/M-86, and MS-DOS operating systems with an optional hard disk
• The DECmate II, a 12-bit microcomputer with an optional hard disk; compatible with Digital's vintage line of workhorse PDP-8 minicomputers
• The Micro/PDP-11, a 16-bit multiuser microcomputer with a built-in hard disk, also compatible with Digital's line of PDP-11 minicomputers; runs six of the PDP-11 operating systems (see table 1 for a comparison of the Digital lineup).

The VT180

The VT180 Personal Computing Terminal is Digital's entry-level microcomputer and has been available since early last year. Actually, the name VT180 is an unofficial designation for the combination of a standard VT100 terminal with the VT18X option. Although the VT100 is a "smart" terminal, it is not user programmable in terms of applications software. The VT18X option for the VT100 terminal consists of two circuit boards that fit inside the terminal and a pair of 5¼-inch floppy-disk drives in a separate low-profile enclosure.

The resulting VT180 contains a standard Z80 microprocessor running at 2 MHz with 64K bytes of RAM (random-access read/write memory).

Each floppy disk has 180K bytes of storage, and the system can access up to four drives in two enclosures.

The Rainbow 100

The Rainbow 100 is a dual-processor model featuring both the 8-bit Z80 and the 16-bit 8088 microprocessor chips. This machine's distinctive appearance is highlighted by the long, very thin, detached keyboard and a video display in a truncated pyramid barely larger than the monitor tube itself.

The unit also has an overgrown attaché case, which doesn't always appear in the ads. The system unit contains the processors, memory, disk drives, power supply, and slots for three option cards in a case that measures 19 by 14.3 by 6.6 inches. The unit can be mounted horizontally on a desktop or, even better, vertically on a floor stand to save valuable desktop space.

The Rainbow 100 uses Digital's special CP/M 86/80 operating system. This system automatically senses whether an application program has been written in CP/M-80 (for the 8-bit Z80) or in CP/M-86 (for the 16-bit 8088) and then executes the program on the appropriate microprocessor. MS-DOS, from Microsoft, will also be available and will offer the possibility of running software developed for the IBM Personal Computer.

The standard Rainbow 100 starts with 64K bytes of main memory, expandable to 256K bytes. The dual floppy-disk drive stores 400K bytes on each disk and uses one spindle motor to spin both disks. And the size of this package is identical to a standard single-disk drive. A second dual-disk drive as well as a 5-megabyte Winchester hard-disk drive may be installed in a separate cabinet. Color and bit-mapped video graphics options are also available.

The DECmate II

The DECmate II resembles the Rain-

Specification	VT180	Rainbow 100	DECmate II	Professional 325	Professional 350	MICRO/PDP-11
Word size	8-bit	8-bit and 16-bit	12-bit	16-bit	16-bit	16-bit
Processor	Z80	Z80 and 8088	DEC 6120	LSI-11/23-Plus	LSI-11/23 Plus	LSI-11/23-Plus
Main memory (bytes)						
Standard	64K	64K	96K (64K words)	256K	256K	256K
Maximum	64K	256K	96K (64K words)	512K	1 megabyte	4 megabytes
Operating system(s)	CP/M	CP/M-86/80 (combined 8- and 16-bit CP/M), MS-DOS (16-bit)	WPS-8, COS-310	P/OS (from RSX-11M-Plus)	P/OS (from RSX-11M-Plus)	CTS-300, DSM-11, RSTS/E, RSX-11S, RSX11-M, RSX11-M-Plus, RT-11, Unix*, others
Optional coprocessor						
Private memory	—	—	Z80 64K	Z80 64K	Z80 64K	—
Operating system	—	—	CP/M	CP/M	CP/M	—
Expansion slots	—	3	3	1	4	6 (dual LSI-11 cards)
5¼-inch floppy disks						
Number (std-max)	2–4	2–4	2–4	2–4	2–4	2
Storage per disk	180K bytes	400K bytes	267K words	400K bytes	400K bytes	400K bytes
Maximum storage	720K bytes	1.6 megabytes	1.1 megabyte words	1.6 megabytes	1.6 megabytes	1.6 megabytes
8-inch floppy disks						
Number (std-max)	—	—	0–2	—	—	—
Storage per disk	—	—	128K words	—	—	—
Maximum storage	—	—	256K words	—	—	—
5¼-inch Winchester disk						
Availability	—	optional	optional	(must upgrade to 350)	optional	standard
Storage	—	5.0 megabytes	5.0 megabytes		5.0 megabytes	10.0 megabytes
Ports						
Serial**	2	2	2	2	2–3	6
External disk	—	—	—	—	—	1
Graphics						
Colors	—	16 or 4 from 8	4 from 8	8 from 256	8 from 256	(via optional graphics terminal and software)
Resolution (characters)	80 by 24	320 by 240 or 800 by 240	320 by 240	960 by 240	960 by 240	
Prices						
Base	$1795 (plus VT100 terminal)	$3495	$3745	$3995	$4995	$10,225 (without any terminals)
5-megabyte Winchester	—	$4200	$4000	(upgrade to 350)	$3500	(10-megabyte Winchester standard)
CP/M module	—	—	$495	$695	$695	—

*Unix and others are available from software houses.
**One serial port is for a printer and a second is for data communications with modem control.

Table 1: *An overview of six microcomputers from Digital Equipment Corporation.*

bow 100 but is a very unique microcomputer in its own right. It uses Digital's proprietary 12-bit 6120 microprocessor, which executes the instruction set of the PDP-8 minicomputer family. The operating systems are Digital's WPS-8 Word Processing System and COS-310 Commercial Operating System, featuring DIBOL (Digital's Business-Oriented Language, similar to

COBOL). With the addition of a Z80 microprocessor on a circuit card, the DECmate II can also run a CP/M program while the 6120 processor runs another application.

Like the Rainbow, the DECmate II comes with a dual-disk drive that stores 400K bytes on each 5¼-inch floppy disk. Another dual-disk drive may be installed in the main cabinet. In

separate enclosures, a 5-megabyte Winchester hard disk and a pair of 8-inch DEC-compatible (RX02) floppy-disk drives may be included in the system. The 8-inch drive controller permits direct transfer of information to and from the earlier DECmate I machines. A graphics option of four

converted to digital signals and transmitted across Ethernet to a secretary's Professional Series system.

● *Transcription:* Using the earphone and foot pedal, which are available as accessories for the voice unit, a secretary can transcribe the dictated text.

● *Voice annotation on text:* Text being read from the video screen will be annotated simply by positioning the cursor where the comment is to occur. When the Comment key on the voice unit is depressed and the comment has been dictated, it will be converted from analog to digital signals and imbedded in the text. The technique can, of course, be used to edit text prepared by a typist.

● *Voice messaging:* The Telephone Management System, with proper application programming, will be able to accept and digitize voice messages. This ability permits the caller to dictate a message that can be appended to a text header prepared by the secretary. Under proper program control, the TMS system can alternately provide a complete telephone answering service.

Conclusion

The Digital Professional Series family was designed to meet the needs of the modern business organization. Whether the need is for desktop computing power, personal computer clusters, or system-to-system communications, the 325 and the 350 offer functionality with ease of use. Perhaps most important is the Professional's ability to expand capabilities within a consistent user interface. ■

and the Professional's design ensures additional uses. The following applications can be expected in the near future:

● *Dictation:* A dictation wand can be obtained as an accessory for the voice unit. Using the wand, a manager will be able to dictate text, which can be