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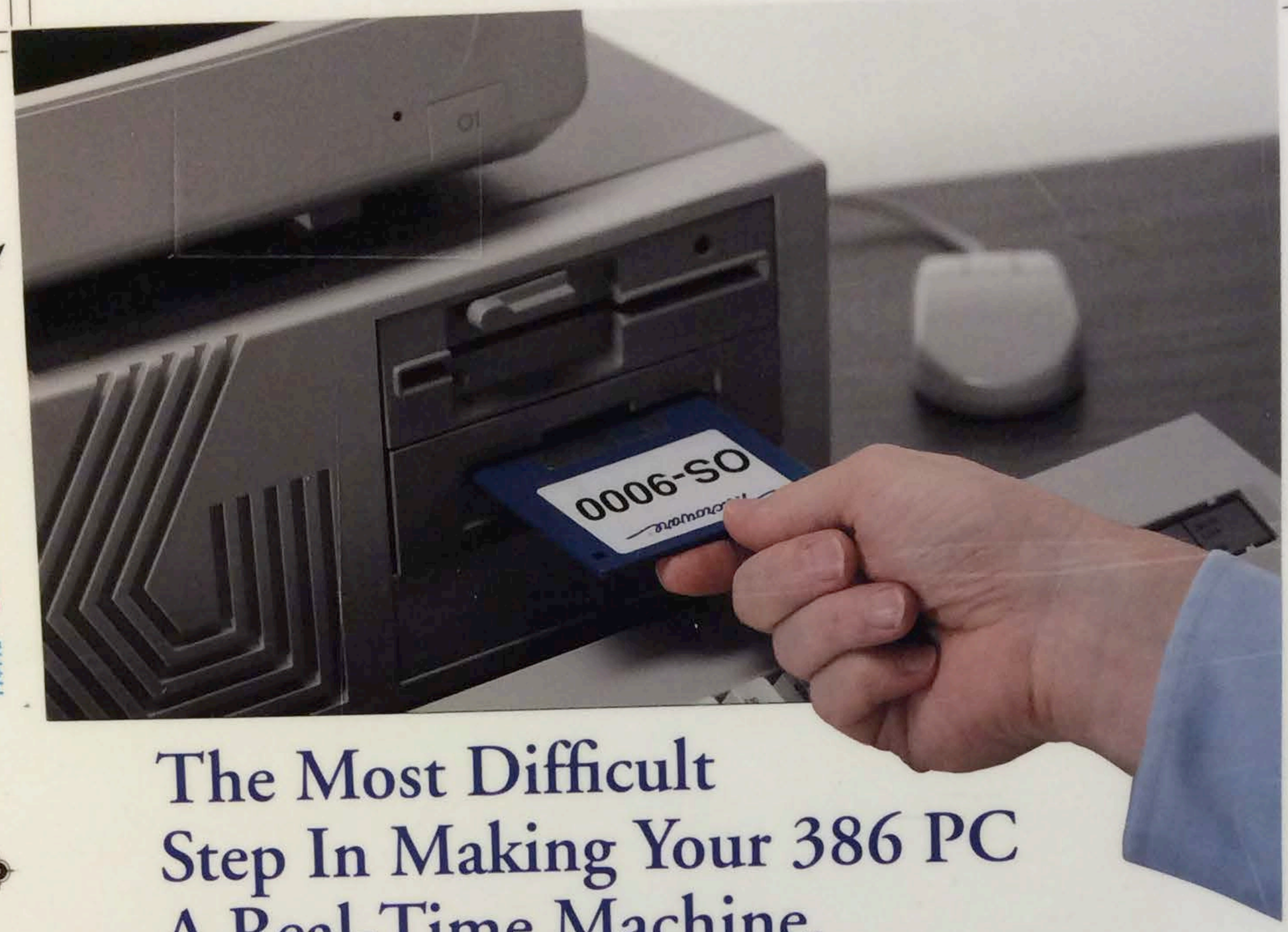
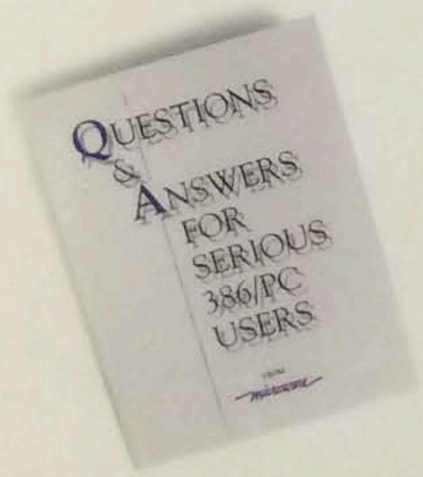


The Most Difficult Step In Making Your 386 PC A Real-Time Machine.

By simply inserting this diskette into your PC, you turn your 386 into one of the most powerful real-time development and application platforms available to engineers. OS-9000® makes it that easy! That's because OS-9000's powerful real-time features turn your 386/PC into a real-time machine. And that means real time in no time for you.



CRITICAL FEATURES CHECKLIST
Compact (53K), fully ROMable, pre-emptive real-time kernel
Uses UNIX process and I/O models
Complete UNIX and resident development environments
Optimizing ANSI C compiler, assembler/linker/source level debugger
Run DOS applications under OS-9000
Robust I/O (hard and flexible disk, tape, SCSI Common Command Set, support for PC-DOS format disks)
Industry-standard networking (optional) • Ethernet (IEEE 802.3) • NFS Version 2 (client/server)
Powerful graphics support (optional) • X Window System V11R4 running on VGA hardware (client/server) • OSF/Motif Version 1.1.1 running on VGA hardware (client/server) • RAVE for real-time graphics and multimedia

Get All The Answers.

Still have questions? Call our toll-free number to receive your free copy of *Questions & Answers for Serious 386/PC Users* to find out how you can have real time in no time. Or call Microware® to order your complete "plug-and-play" OS-9000/386 package for only $995.

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WHO DO YOU CALL WHEN YOUR DEBUGGER WON'T DEBUG?

The problem with most real-time operating systems is simple, they're not an integrated solution. You end up dealing with a multitude of suppliers for languages, compilers, debuggers and other important development tools. And when something does go wrong, it can be a frustrating experience trying to straighten out the mess.

Why Not Try the Microware One-Stop Total Solution?

Microware's OS-9 Real-Time Operating System is a total integrated software system, not just a kernel. We offer an extensive set of development tools, languages, I/O and Kernel options. ***And this total integrated solution is entirely designed, built and supported by the same expert Microware team.***

Modularity Lets YOU Choose Just What You Need.

The modular design of OS-9 allows our Operating System to adapt as your requirements change. OS-9 can support a complete spectrum of applications — from embedded ROM-based code in board-level products all the way up to large-scale systems.

The OS-9 Success Kit

A Total Integrated Solution for Your Next Project

Development Tools:
- C Source Level Debugger
- Symbolic Debugger
- System State Debugger
- uMACS Text Editor
- Electronic Mail
- Communications
- Super Shell

Kernel Options:
- MMU (Security Protection) Support
- Math Coprocessor Support

Languages:
- C*
- Basic
- Pascal
- Fortran
- Ada**
- Assembler*

I/O Options:
- SCSI, SASI & SMD Disks
- 3-, 5-, 8-inch Diskettes
- Magnetic Tape
- Ethernet - TCP/IP
- Arcnet - OS-9/Net

*Resident or UNIX versions available
**VAX hosted

Support is Part of the Package.

Microware is proudly setting the industry's standard for customer support. You'll find professional and comprehensive technical documentation and a Customer Hotline staffed by courteous and authoritative software engineers.

So stop messing with simple kernels and independent suppliers. Call Microware today and find out more about the "One-Stop Integrated Solution" with OS-9!

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Funabashi City
Chiba 273, Japan
Phone: 0474 (22) 1747

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OS-9000 Gives You A Real-Time O.S. With The Works.

When you're looking for system software to power your 386™ PC, why settle for just a snack? With Microware's OS-9000® Real-Time Operating System you'll enjoy a hearty C development environment that will satisfy even the most demanding embedded applications.

OS-9000 is a multi-user, multi-tasking operating system built around a powerful real-time kernel. But, we didn't stop there. OS-9000 provides you with a sophisticated C language development platform including a source level debugger, and a macro assembler and linker. And because OS-9000 is a complete operating system, it includes sophisticated I/O extensions for disk and tape support, 80 powerful utilities and the uMacs screen editor. Plus, OS-9000 lets you execute DOS and compatible applications as a task.

And, there's more. Choose from options that let you seamlessly network 386 PCs together and even allow your 386 PC to perform as a hard disk server for other PCs. Or choose industry-standard network packages that transparently connect OS-9000 to other development platforms. And then there's RAVE®, the revolutionary real-time multimedia development environment that incorporates real-world images and sounds into easy-to-use interfaces.

Your "plug-and-play" OS-9000/386 C development system is now available for just **$995**. Call Microware® today to order OS-9000 and to find out how you can add your favorite toppings. We won't let you go away hungry!

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REAL-TIME KERNEL, ROBUST I/O, RESIDENT C DEVELOPMENT AND DEBUGGING, MACRO ASSEMBLER AND LINKER, 80 UTILITIES, UMACS SCREEN EDITOR, DOS EMULATION, AND CISC AND RISC PORTABILITY

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NETWORK FILE SYSTEM, INDUSTRY-STANDARD NETWORK PROTOCOLS, GRAPHICS (RAVE®)

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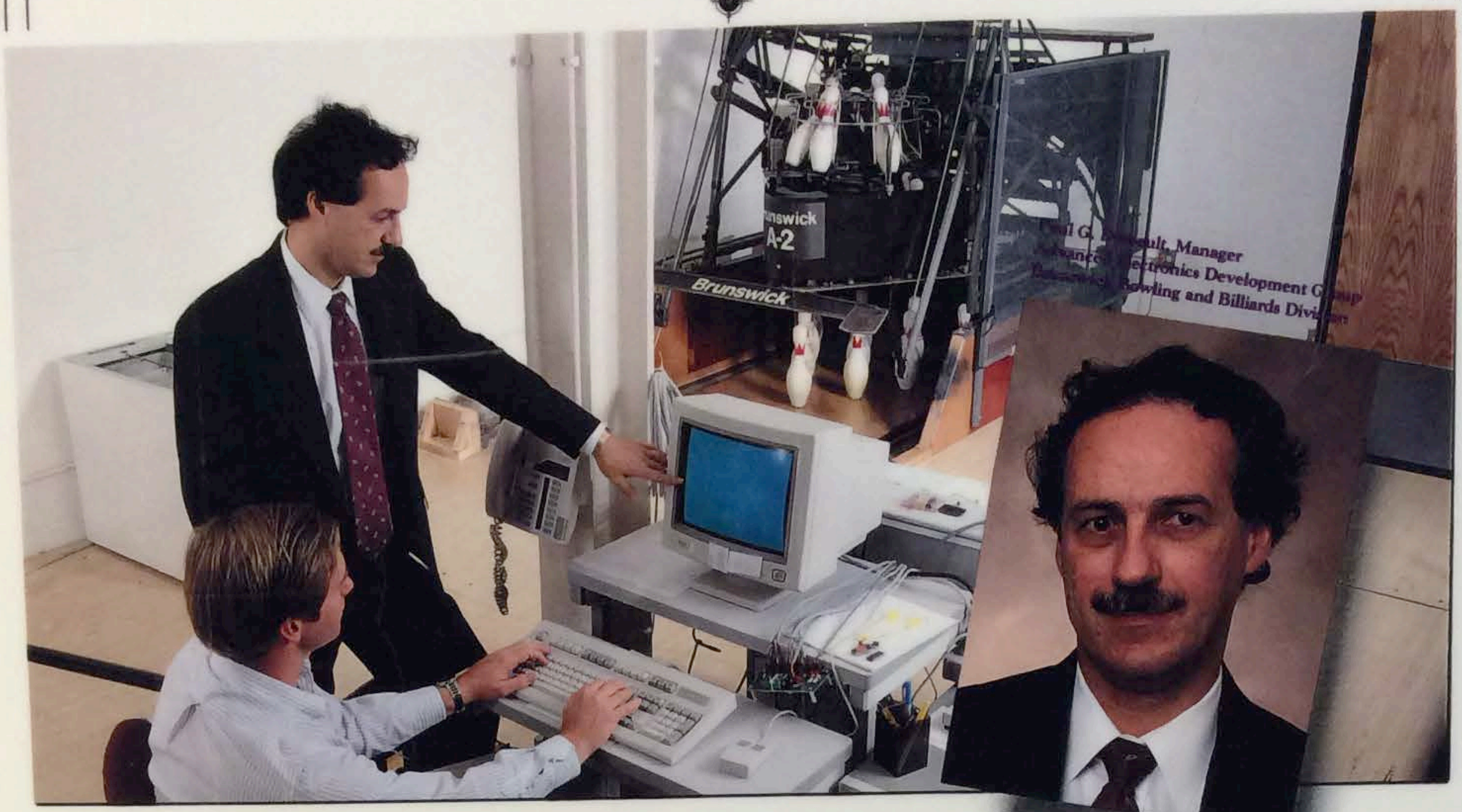

"To give our BowlerVision® system the greatest flexibility, we needed a full-function operating system. Microware's OS-9® gives us the ability to develop a real-time system right on the target hardware."

Brunswick Corporation is a 145 year old company whose business includes the design and manufacture of consumer recreation equipment, as well as defense contracting. Brunswick's Bowling and Billiards Division developed BowlerVision, a fully-integrated control and supervisory system for bowling centers.

"Microware's OS-9 Real-Time Operating System provides the functionality to easily incorporate new hardware."

As the heart of Brunswick's BowlerVision, OS-9 controls more than 25 processes, including communicating with the individual pinsetters and monitoring cash registers. Plans for BowlerVision called for the ability to add new features as the product evolved, as well as customizing systems to meet customers' needs.

Brunswick needed a ROMable real-time operating system with I/O capabilities allowing field upgrades. "OS-9 is built around a powerful, ROMable real-time Kernel. But, no simple kernel can match the suite of sophisticated development tools and inherent I/O capabilities available under OS-9. These tools give us the ability to easily write device drivers to efficiently add new hardware to existing systems."

"As an intelligent product for consumers, BowlerVision had to be transparent to the bowler. The speed and reliability of OS-9 helped us achieve this transparency."

"Even though the BowlerVision system puts powerful features at the hands of bowling center proprietors, these people don't have to be software engineers. OS-9 was the natural choice. The system lets center proprietors concentrate on their customers and their profits, not solving system problems."

OS-9 and its comprehensive suite of real-time development tools provided a total solution for Brunswick. Find out how Microware can put OS-9 to work for you. Call us today to order a FREE copy of the OS-9 Catalog (your complete guide to the OS-9 Operating System).

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So Much Real-Time Power. Such A Small Package.

Pick up these ROMs and you're in touch with the world's most powerful real-time 680X0 system software solution—OS-9®. But OS-9 is so much more than just a powerful real-time kernel. Check out this *Critical Features Checklist* to find out how OS-9 can give you "Real Time In No Time."

CRITICAL FEATURES CHECKLIST

Real-Time Operating System Features	Robust Development Environment Features	Sophisticated I/O Features
Compact (28K), high-performance real-time kernel for demanding applications Uses UNIX process and I/O models Multi-user, multi-tasking, pre-emptive scheduler Modular architecture User-installable system calls Interprocess communication facilities: • semaphores • pipes • signals • events • shared memory	UNIX-hosted development (UniBridge) PC-DOS-hosted development (PCBridge) Complete 680X0 development capabilities: • highly-optimizing ANSI C compiler, assembler/linker • C source level and system level debuggers • PVCS source code control system • advanced shell interface (MShell)	Hard and flexible disk support, SCSI Common Command Set Tape support WORM support Networking: • Ethernet (IEEE 802.3) • NFS Version 2 • ARCNET (SMC Data Point) Graphics: • X Window System V11R4 • OSF/Motif Version 1.1.1 • RAVE for real-time graphics and multimedia

Also, ask us about OS-9000® for 386/486 and RISC processors.

Grab the Power.

So get your hands on these ROMs that have been proven in thousands of specialized and demanding 680X0 applications. Call Microware® today to put OS-9 to work for you.

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We wrote the books on real-time.

When it comes to real-time system software, Microware Systems Corporation leads the way. Now, we offer two books that provide you with complete real-time solutions — the *OS-9* and *OS-9000 Catalogs*.

Microware offers the broadest range of real-time solutions in the industry. Data sheets and flyers just weren't enough to tell our story, so we wrote these books to tell you about our real-time operating systems. These catalogs are chock-full of more than 330 pages of useful information about our operating systems including networking, graphics, language compilers and productivity tools.

OS-9 is the world's leading real-time operating system for 680X0-based systems. OS-9 has been designed into thousands of embedded applications from industrial automation to consumer electronics.

OS-9000 is a portable real-time operating system written in C for advanced CISC and RISC processors. The ability to port OS-9000 to various hardware platforms "future-proofs" your real-time software investment through the 1990s.

Put the world's real-time leader to work for you today.

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When you're looking over the lot of system software to power your 386™ PC, why settle for an econo-box? With Microware's OS-9000® Real-Time Operating System you'll be in the driver's seat of a fully-loaded C development environment that will put power back in your embedded applications.

OS-9000 is a multi-user, multi-tasking operating system built around a powerful real-time kernel. But, we didn't stop there. OS-9000 provides you with a sophisticated C language development platform including a source level debugger, and a macro assembler and linker. And because OS-9000 is a complete operating system, it includes sophisticated I/O extensions for disk and tape support, 80 powerful utilities and the uMacs screen editor. OS-9000 also supports DOS emulation to let you run your favorite DOS applications.

And, there's more. Choose from options that let you seamlessly network 386 PCs together and even allow your 386 PC to perform as a hard disk server for other PCs. Or choose industry-standard network packages that transparently connect OS-9000 to other development platforms. And then there's RAVE®, the revolutionary real-time multimedia development environment that incorporates real-world images and sounds into easy-to-use interfaces.

Call Microware® today to order your ready-to-drive OS-9000 C language development system for just **$995**—and you'll be in the driver's seat with real-time power!

OS-9000

STANDARD FEATURES:	AVAILABLE OPTIONS:
REAL-TIME KERNEL	NETWORK FILE SYSTEM
ROBUST I/O	INDUSTRY-STANDARD NETWORK PROTOCOLS
RESIDENT C DEVELOPMENT AND DEBUGGING	GRAPHICS (RAVE*)
MACRO ASSEMBLER & LINKER	* CONTACT MICROWARE FOR MORE INFORMATION ON RAVE, THE INDUSTRY'S ONLY REAL-TIME MULTIMEDIA INTERFACE AND DEVELOPMENT TOOL.
80 UTILITIES	
UMACS SCREEN EDITOR	
DOS EMULATION	
CISC AND RISC PORTABILITY	
$995	

TASKING SWITCH SPEED†		INTERRUPT LATENCY†
55 µSEC	REAL-TIME INFORMATION	14 µSEC

† TIMINGS PERFORMED ON 33 MHz 80386 PC COMPATIBLE. ACTUAL PERFORMANCE MAY VARY BASED ON SYSTEM PERFORMANCE, APPLICATION OR OTHER FACTORS.

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OS-9 • ATOMIC OS-9 • ULTRA C

Great Embed.

Software Product	Target CPU*	Performance
OS-9 V. 3.0	68040	5.9 µs Interrupt Response
Atomic OS-9	68040	3.0 µs Interrupt Response
Ultra C V. 1.1	68040	42,440 Dhrystones V. 2.1/sec.

*MVME 167, 25 MHz 68040, zero wait state, cache enabled.

Our exciting, new products offer total performance for unbeatable real-time solutions.

Introducing the most powerful family of operating systems, microkernels and compilers for embedded 68XXX real-time design. Bar none.

New OS-9® Version 3.0 brings raw speed to next generation technologies like ISDN, MPEG and X.25, as well as advanced industrial applications. OS-9 also delivers determinism and preemption across the entire OS-9 architecture, including kernel and I/O systems. For even greater performance and reduced size, the Atomic OS-9™ microkernel brings the power of OS-9 into new hyper-embedded environments. Ultra C™ ties it all together by generating lightning fast code perfectly matched to OS-9 and Atomic OS-9. And, Ultra C is available for your engineering workstation, whether it's OS-9, Unix or DOS.

To learn more about Microware's new family of embedded products, call 1-800-475-9000 for the comprehensive *OS-9 V. 3.0 Performance Brief*.

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"Reliability is essential when we're designing systems for military aircraft. Microware's track record with real-time system software made OS-9 our logical choice."

Systems Research Laboratories (SRL), a leading defense contractor, designs and builds avionics systems for the military. These systems include heads-up and heads-down displays, digital scan converters and electronic warfare equipment.

"Microware's OS-9 Real-Time Operating System provides the reliability we need to develop sophisticated avionics systems."

SRL had tried other systems, including "dumb" kernels, but none provided the reliability needed for their demanding military applications. Then, SRL turned to Microware's OS-9 Real-Time Operating System. "We looked at Microware's track record, as well as evaluated OS-9's performance in our units."

"Microware consistently develops and designs quality software products... Their OS-9 Real-Time Operating System was the logical choice for SRL."

Before SRL's systems are installed on military aircraft, every system is put through its paces. "Our products are found in the most sophisticated military aircraft. We've designed Microware's OS-9 into our critical avionics systems because of its reliability and functionality."

"We put every embedded OS-9 system to the test."

OS-9 and its comprehensive suite of real-time development tools provided a total solution for Systems Research Laboratories. Find out how Microware can put OS-9 to work for you. Call us today to order a FREE copy of the OS-9 Catalog (your complete guide to the OS-9 Operating System).

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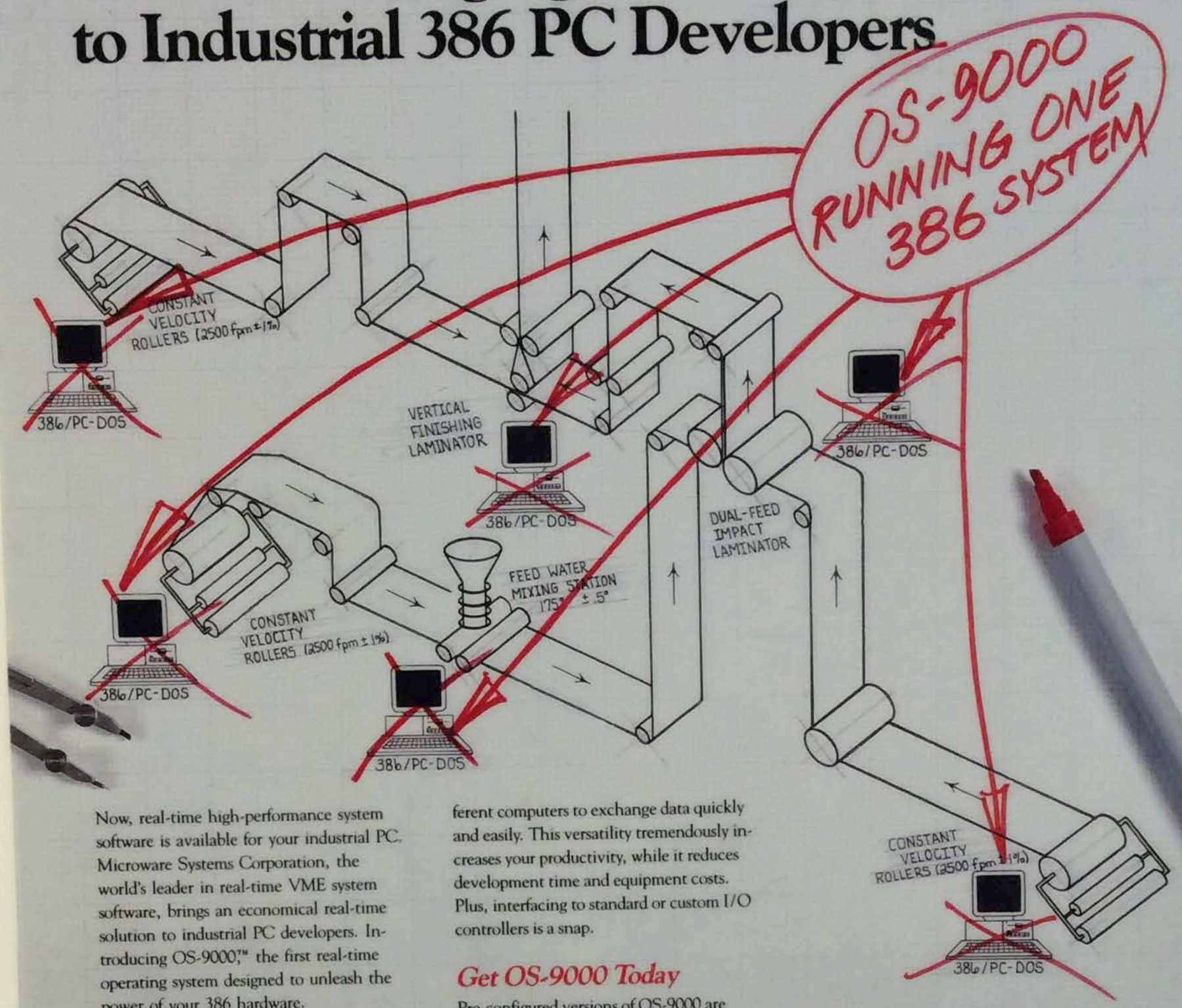
OS-9000. Bringing Economy of Design to Industrial 386 PC Developers



Now, real-time high-performance system software is available for your industrial PC. Microware Systems Corporation, the world's leader in real-time VME system software, brings an economical real-time solution to industrial PC developers. Introducing OS-9000,™ the first real-time operating system designed to unleash the power of your 386 hardware.

Real-Time Response To Control Multiple Tasks

Why waste the power of your 386 by letting it control only one function at a time? Unlike PC-DOS, OS-9000 is a true multi-user and multi-tasking real-time operating system. Now you can utilize a single PC as a powerful time-sharing system able to control multiple processes simultaneously. And by using industry-standard protocols (like Ethernet and Arcnet), OS-9000 allows PCs to be interconnected and connected to different computers to exchange data quickly and easily. This versatility tremendously increases your productivity, while it reduces development time and equipment costs. Plus, interfacing to standard or custom I/O controllers is a snap.

Get OS-9000 Today

Pre-configured versions of OS-9000 are now available for your 80386 PC-compatible hardware. These systems include integrated development tools such as a "shell" user interface, over 70 powerful utilities, a superlative C compiler, a C source-level debugger and a screen editor. Your full-featured, "plug-and-play" OS-9000/386 system is now available for just $995.

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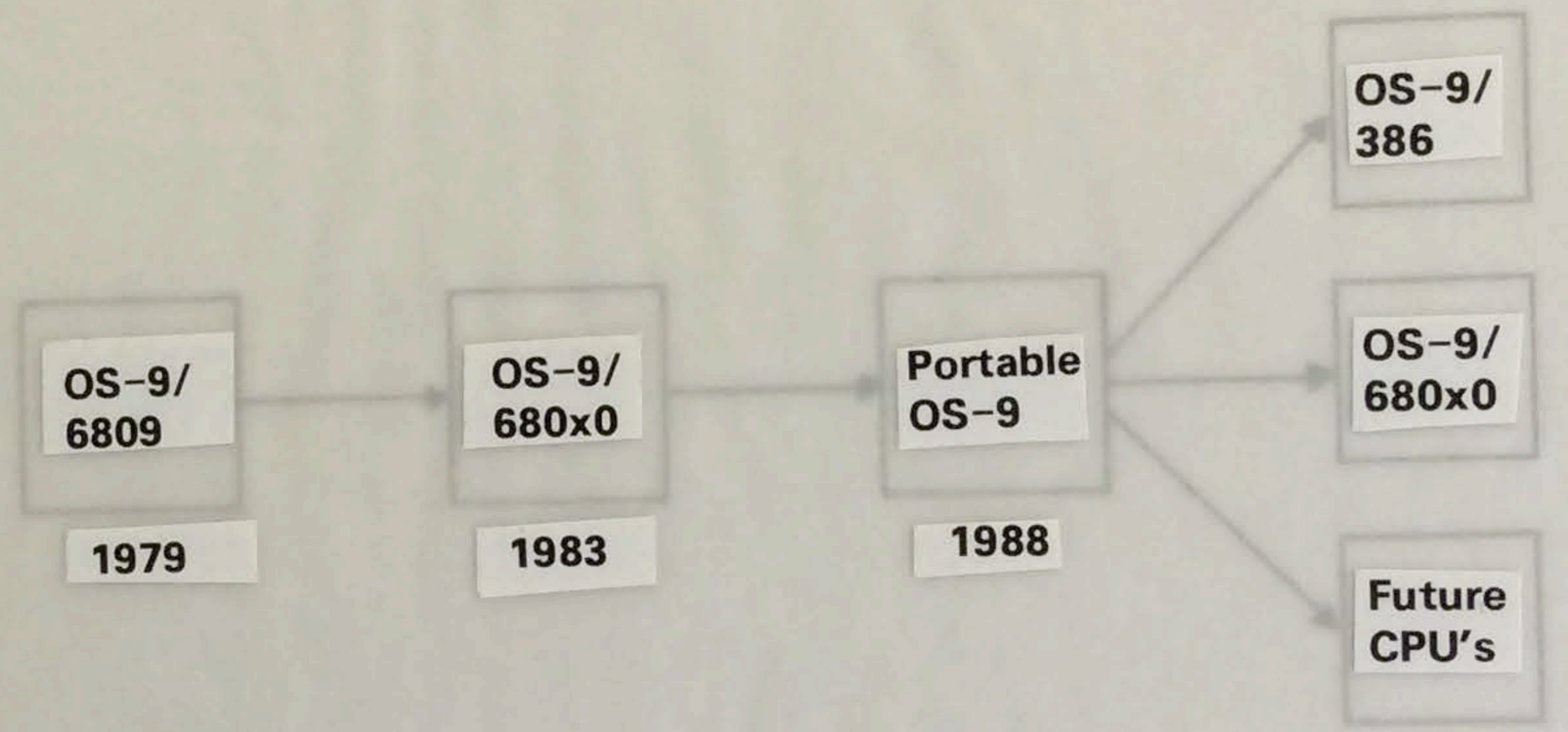
OS-9 EVOLUTION



* 8/16-bit

* 16/32-bit

* Advanced 32-bit
* Mulitprocessor

HOTTEST REAL-TIME DESIGN WIN

Microware's OS-9 for interactive television

Microware's OS-9 Real-Time Operating System is the acknowledged leader in real-time system software for industrial and intelligent consumer electronics applications. Now, OS-9 is firmly established in the exciting new industry of interactive television.

OS-9 — AN EMERGING STANDARD

OS-9 is becoming the standard in interactive television through its acceptance and use by:

- Set-Top Box Manufacturers — More than 20 major manufacturers are building OS-9-based set-top boxes.
- Network Providers — OS-9's flexibility handles all sizes of networks, ranging from small-scale "private" systems to telephone- or cable-based WANs.
- Video Server Providers — Both low-end and high-end server platforms can target OS-9.
- Content Providers and Application Developers — Can choose OS-9-based development software from Microware and allied third parties.

OS-9 FOR ANY PROJECT

While interactive television is its most visible design win, OS-9 also powers applications and environments ranging from robotics to medical instrumentation, traffic control and aerospace engineering. OS-9's high-performance modular architecture, broad I/O support, tightly integrated development environment and unsurpassed technical support make it the obvious choice for your next development project.

PROVEN QUALITY

In over 4,500 products, designers have relied on Microware's quality solutions for their demanding applications. Microware's recent ISO 9001 certification reflects our total commitment to quality and reliability in our products.

Learn how Microware can handle your real-time design challenges. Call Microware toll-free at 1-800-475-9000 for more information.

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PRODUCTS

Development software helps create user interfaces

No code required to build graphics, video, audio, and customized menus

TODD EARLES
Microware Systems Corp

The Rave multimedia development tool is an extension of Microware's OS-9 real-time operating system that simplifies the design of realistic user interfaces for instrumentation and process-control systems.

Rave (real-time audio/video environment) enables you to combine high-quality audio and video, computer-generated graphics, and customized menus to build easy-to-use interfaces and control panels. The interfaces and panels contain real-world sounds and images that represent an actual control environment.

By contrast, most user interfaces for factory-floor applications are difficult to use and intimidating. Those interfaces typically consist of noninteractive displays or light boards; the best ones are based on black-and-white graphics drawn on conventional CRTs.

Rave enables nonprogrammers to create custom audio/visual interfaces without writing a single line of code. The indicators, controls, and menus needed to configure an interface are available as library components, to which you gain access through Rave's interactive, menu-driven presentation editor. If you want to add components that are not available in the library, you can build them by combining geometric primitives in the library. As an alternative, you can digitize photographic images of actual components. You can also input audio segments directly into the Rave interface.

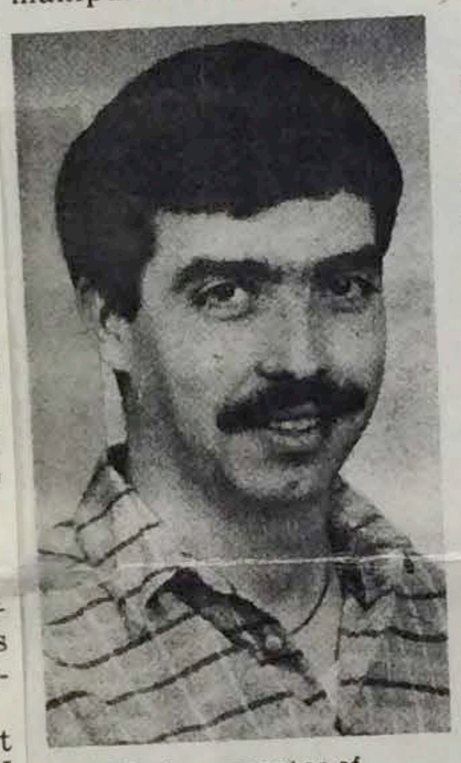
Rave consists of three packages: a graphics file manager (GFM), a graphics support library (GSL), and a presentation editor. The GFM and GSL, together with the OS-9 operating system, provide the platform on which the user interface and application run. The presentation editor supplies the tools with which you develop the user interface.

Graphics file manager

The GFM supports the input, video, and audio drivers needed to create the user interface.

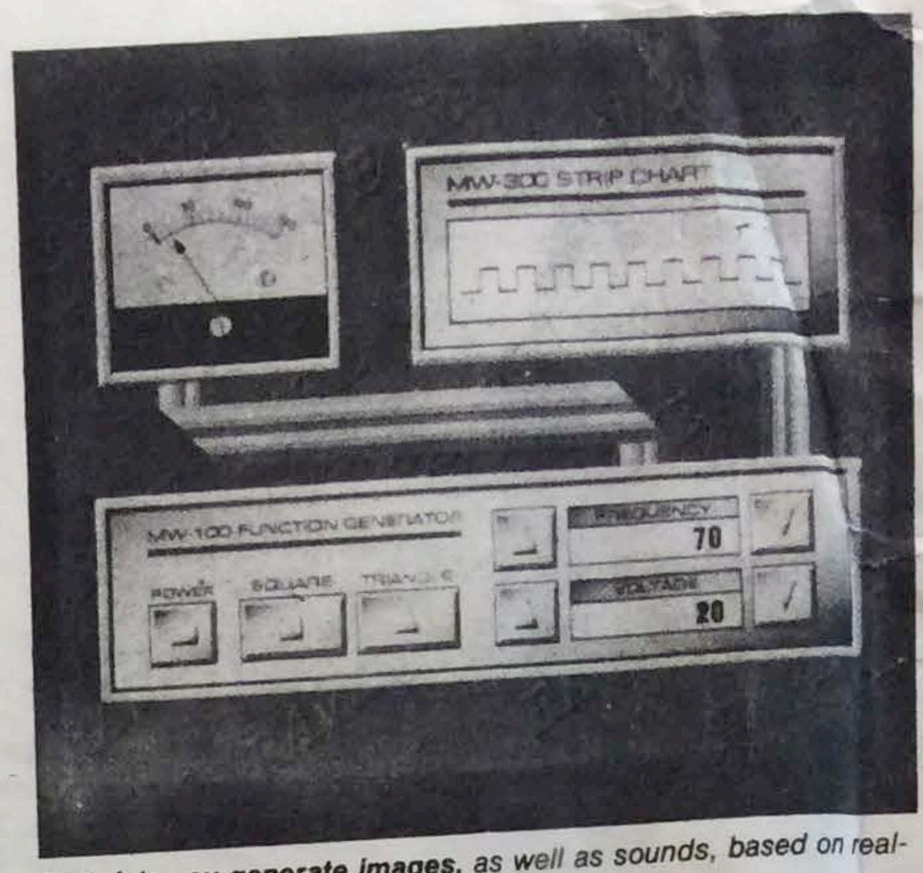
The input drivers support any keyboard from an IBM PC-compatible unit to a custom keyboard designed for a specific application. The drivers also support a pointing device, such as a mouse, touch pad, or touch screen, or any pointing device that supplies X/Y coordinate information.

The video driver, in addition to supporting the monitors, provides the drawing and block primitives used to build more complex functions in the GSL and presentation editor. You can draw lines, rectangles, polygons, circles, ellipses, and rectangles with rounded corners, as well as manipulate text. Dashed lines, patterns, variable-size pens, or any combination of these may be used.



Todd Earles, manager of multimedia products at Microware Systems Corp.

With Rave's audio tools, you can capture, edit, and play back audio segments. Audio may be input from any external source, such as a microphone or cassette. The audio quality is limited only by the hardware. You can combine the audio with video images to complete the man-machine interface.



***Rave lets you generate images,** as well as sounds, based on real-world phenomena from a control environment.*

The GSL builds upon the GFM to create the more complex concepts required for an application. These include controls, which are objects on the display that mimic the behavior of switches, and indicators, which are objects on the display that mimic the behavior of output devices. The library provides a number of controls and indicators; you can build additional ones using customizable menu templates. Both controls and indicators can be implemented either by generating computer graphics or by digitizing an actual image of the device.

The menu templates allow you to work with both simple text and complex images. You can display these menus either constantly, with a menu bar or a menu of icons, or only when they are needed, by using pop-up or pull-down menus. In addition, the GSL provides a number of housekeeping functions that simplify the development of an application, such as a message-handling utility and a clip board.

Application builder

Rave's third package, the presentation editor, draws upon the GFM and GSL to provide an interactive, menu-driven development environment for building applications. With the presentation editor, you can manipulate the controls, indicators, and menus supported by the GSL.

You operate the presentation editor with a keyboard and a mouse. You enter audio information directly through a microphone or from a disk. You can enter video images in three ways:

- By choosing an image from the clip-art library, which is included as part of the presentation editor. This library contains more than 40 images, such as meters and pushbuttons.
- By using an external paint-box package. Rave includes an interchange-file-format specification for transferring images from other packages into Rave.
- By using a camera to digitize the image.

The presentation editor also comes with its own paintbox graphics package that allows you to modify either computer-generated or digitized real-world images.

Though Rave lets you develop an applications inter-

GSL CONTROLS AND INDICATORS

CONTROLS	INDICATORS
Pushbutton (eg, on/off and fire buttons)	Linear meter (eg, VU meter on an audio mixer board)
Multistate (eg, the source selector on an amplifier)	Level (eg, fluid level in a tank)
Slidebar (eg, volume control)	Strip chart (eg, EKG readout)
	LED meter (eg, record level in a cassette deck)
	Numeric readout (eg, frequency on a frequency generator)

face without writing a single line of code, it makes provisions for those who wish to supplement Rave's capabilities. Rave defines a simple interface for linking programs or functions written in C. It also provides a template for controls, indicators, and menus, thus simplifying the development of these objects.

Rave runs on top of OS-9, which is available for most VMEbus CPU boards. The operating system supports a complete development environment on OS-9 target boards, as well as on a variety of remote hosts linked by either backplanes or LANs. OS-9 includes a full-function, real-time kernel and independent file managers. Because OS-9 is modular, you can use only those modules that are required for your application. This feature enables you to reduce the size of your application and conserve memory.

Devices that currently support Rave include Prima Graphics' Virtuoso video board and the OKI audio chip. To port Rave to hardware, you only need to port the low-level graphics, audio, and input drivers.

Prices for Rave are $300 for the GFM, $175 for the GSL, and $995 for the presentation editor.

For more information on Rave,

Circle No 254

Todd Earles is manager of multimedia products for Microware Systems Corp, 1900 NW 114th St, Des Moines, IA 50322. Phone (515) 224-1929.

BEHIND THE DESIGN

From CDI players to the factory floor

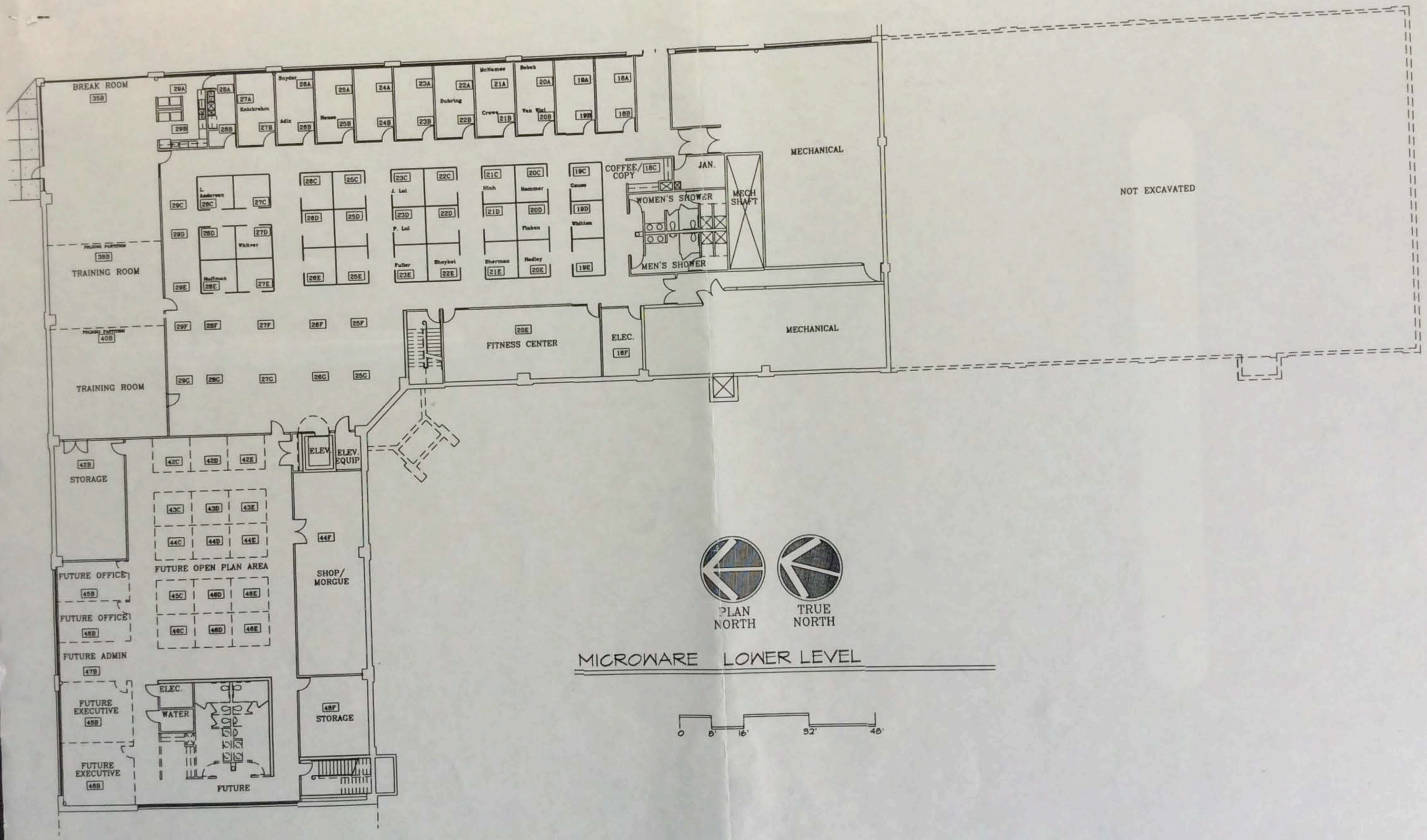
Rave originated from Microware's involvement with compact disc interactive (CDI) technology. CDI permits the combination of computer programs with digital audio and video to form an interactive environment.

In 1986, Philips Consumer Electronics was evaluating 40 to 50 operating systems for its CDI player and chose Microware's OS-9. Microware then developed software based on OS-9 for the software portion of the CDI Greenbook, a standard for CDI players. Todd Earles was a coauthor of the software.

While working on the Greenbook software, Earles had to keep in mind that the average CDI end user was nontechnical. The user interface for Philips' product therefore had to be intuitive. Microware decided to incorporate real-world images and audio to make the software as easy to use as possible. Working with the French company Thomson, Microware developed Rave.

At first Rave was just a run-time support system for consumer electronic products like CDI. But then Microware realized that its typical customer, an end user working in industrial environments, also typically lacked programming experience and might benefit from Rave.

Before marketing Rave to industrial users, Microware added features to eliminate time-consuming and repetitive work. Earles headed development of the presentation editor, which generates all code for the user interface, including graphics, audio, and user interaction. The editor frees the user from having to develop such code. He or she can then devote full attention to code for the application.



PLAN NORTH

TRUE NORTH

MICROWARE LOWER LEVEL

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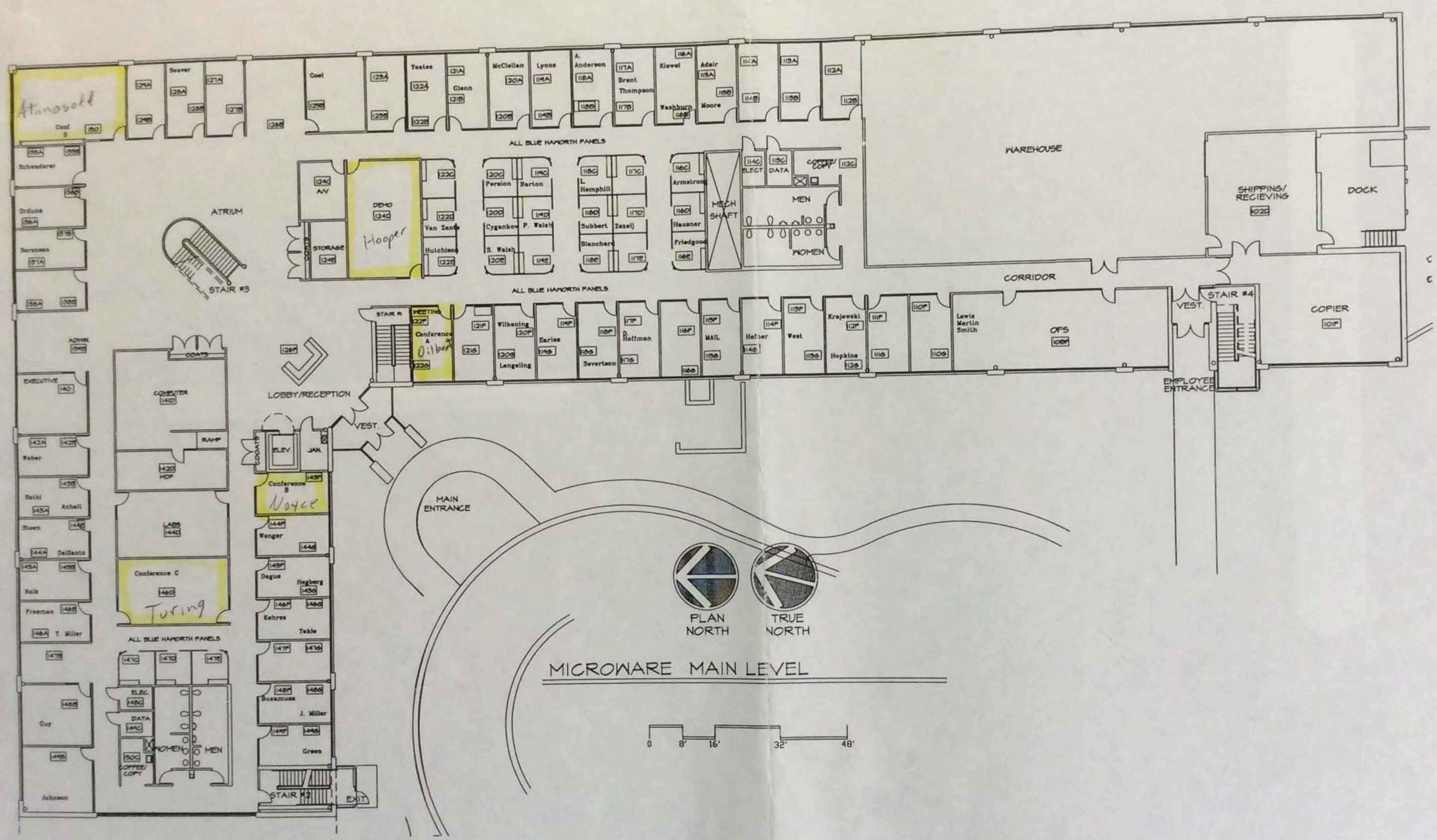

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8-5-99 2ND FLOOR SEATING

BLUE TOOP

BRIAN E.
PATTY S.
MARK R. } OFS OFFICE MAIN FLOOR

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NOT TO SCALE

0 8' 16' 32' 48'

Harry 223
Chris 219
Zach/Mark 214
Phil 209
Gregg 213
~~Kristi~~?
Staging 206

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Real-Time System Software Evaluation Form

OS Evaluated: MICROWARE's OS-9

FEATURE	Yes	COMMENTS (please type)
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I/O	✓	Tightly unified I/O system that easily supports virtually any device (disk, tape, network, WORM, SCSI Common Command Set, DOS file system, etc.).
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Development Tools Language Debugging Productivity Tools	✓	Highly-optimizing ANSI C compiler, Assembler/linker. C source level debugger, system level debugger. PVCS source code control system, advanced shell interface (MShell).
Networking	✓	High-performance TCP/IP (802.3) implementation. Remote booting across a network (BootP). Complete implementation of NFS Version 2 (client/server). ARCNET (SMC Data Point) and serial support.
Graphics	✓	X Windows V11R4 (both client and server). OSF/Motif Version 1.1.1. RAVE (Real-Time Audio/Video Environment) for real-time graphics and multimedia.

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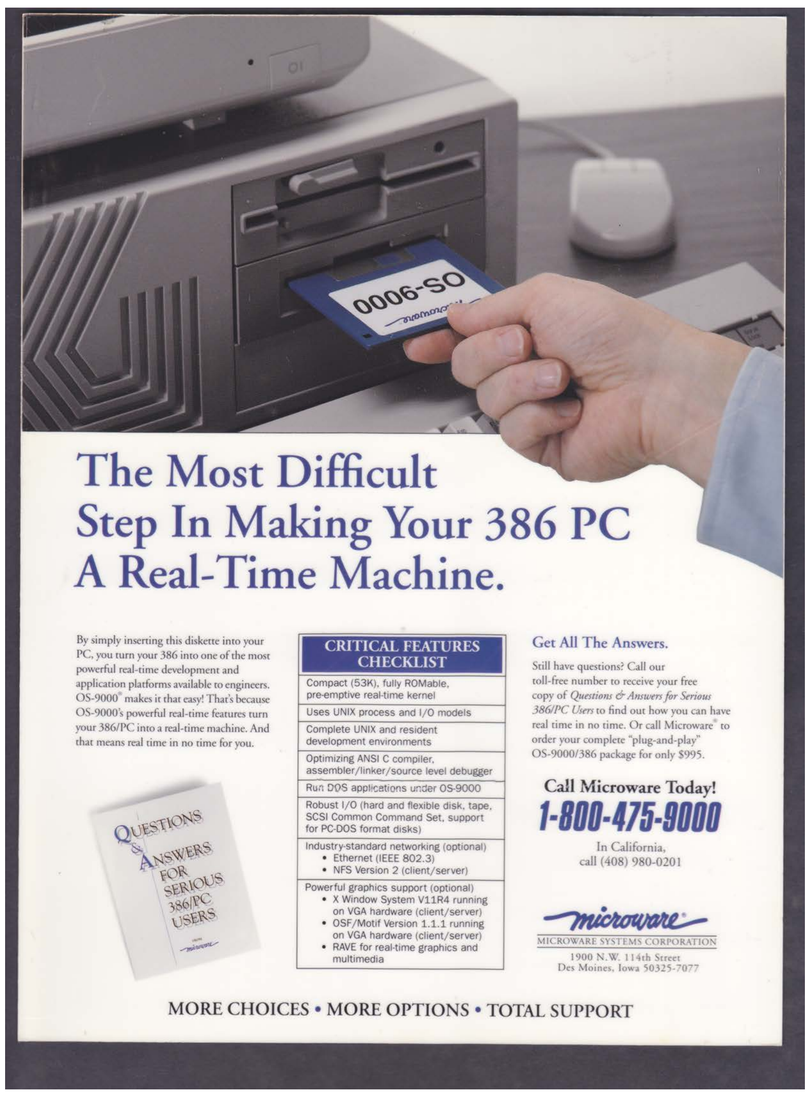
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Optimizing ANSI C compiler, assembler/linker/source level debugger
Run DOS applications under OS-9000
Robust I/O (hard and flexible disk, tape, SCSI Common Command Set, support for PC-DOS format disks)
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• NFS Version 2 (client/server)
Powerful graphics support (optional)
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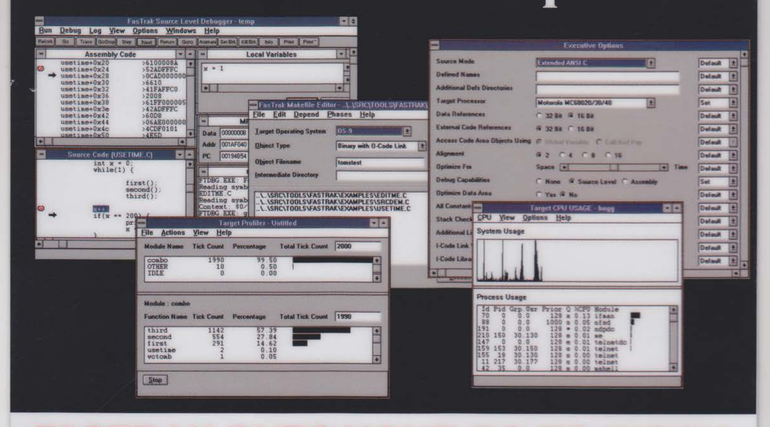

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- Optimizing ANSI C compiler, assembler/linker/source level debugger
- Run DOS applications under OS-9000
- Robust I/O (hard and flexible disk, tape, SCSI Common Command Set, support for PC-DOS format disks)
- Industry-standard networking (optional)
  - Ethernet (IEEE 802.3)
  - NFS Version 2 (client/server)
- Powerful graphics support (optional)
  - X Window System V11R4 running on VGA hardware (client/server)
  - OSF/Motif Version 1.1.1 running on VGA hardware (client/server)
  - RAVE for real-time graphics and multimedia

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OS-9™ 9/85

User Notes

By: Peter Dibble
As Published in 68 Micro Journal

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Information for the BEGINNER to the PRO, Regular or CoCo OS9

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Circle 34

THE WALL STREET JOURNAL.

VOL. LXXV NO. 203 ★★★ MIDWEST EDITION MONDAY, AUGUST 1, 1994 DES MOINES, IOWA

...ow from the network's principal owners, Comcast and Liberty Media.
(Article on Page A2)

* * *

Merck's ulcer drug failed to win an FDA panel's approval as a nonprescription heartburn remedy. The decision followed similar rejections for Upjohn and SmithKline Beecham.
(Article on Page B6)

* * *

America Online holder Paul Allen, frustrated in his effort to gain management control of the firm, sold more than half his stock in the on-line service, for a profit of about $27 million. The stock fell 8.25% on the news.
(Article on Page B6)

Two software firms, Macromedia and Microware Systems, are set to unveil technology that may ease a key barrier to the information highway.
(Article on Page B6)

TVX and Kinross plan a $1.6 billion joint offer for Lac Minerals. The move will create a three-way contest for the gold producer with rival suitors Royal Oak Mines and American Barrick.
(Article on Page A3)

* * *

Canadian corporate profits rose sharply in the second quarter, but the pace of growth is expected to weaken in the second half.
(Article on Page A4)

* * *

Markets—

Stocks: Volume 269,538,220 shares. Dow Jones industrials 3764.50, up 33.67; transportation 1587.26, up 2.64; utilities 186.40, up 2.51.

Bonds: Lehman Brothers Treasury index 5193.87, up 82.30.

Commodities: Oil $20.30 a barrel, up 53 cents. Dow Jones futures index 154.31, off 0.65; spot index 145.29, off 0.19.

Dollar: 99.89 yen, off 0.28; 1.5830 marks, off 0.008.

WSJ Monday, 8/1/94

Firms to Unveil Process to Boost Interactive TV

By Jim Carlton
Staff Reporter of The Wall Street Journal

One of the main barriers to developing the information highway, the difficulty in modifying multimedia personal-computer programs to run on interactive television networks, may be eased by a technology-sharing deal between two small but respected software companies.

Macromedia, a San Francisco maker of tools for developing multimedia PC programs, and Microware Systems Corp., a Des Moines, Iowa, supplier of operating software for emerging interactive television networks, are expected to announce today technology that will automate the conversion of PC programs to run on the networks. Larger competitors are in hot pursuit of the same technology.

Right now, a developer of a multimedia program such as an electronic encyclopedia or restaurant guide might have to spend as much as $500,000 and a year of work to rewrite that program for interactive television. Because interactive television is a nascent market, developers are reluctant to expend such effort. So companies planning to test the interactive television concept in about a dozen major trials are starved for content other than movies and home shopping.

Potential Benefits

Macromedia and Microware asserted the proposed technology would cut the time required to convert PC programs to about a month, at a fraction of the cost. Macromedia said it will start working with multimedia software developers next month to bring their CD-ROM programs to interactive television quickly. Some developers who have previewed the technology say they hope to use it.

"It [the technology] makes it practical for us to make a transition into that [television] world without making an enormous commitment to engineering," says Drew Huffman, president of Drew Pictures Inc., San Francisco-based maker of the hot-selling Iron Helix CD-ROM game.

Macromedia makes a development kit called Director that allows programmers to write a multimedia program combining video and sound that will run on different kinds of computers, such as Macintoshes from Apple Computer Inc. and ones using Intel Corp.'s microprocessors and Microsoft Corp.'s operating system. Microware has licensed its operating system for multimedia networks to about 20 manufacturers of the TV set-top boxes that will channel programs through interactive television, including International Business Machines Corp., Korea's Gold Star and Philips Electronics NV of the Netherlands. The system is also being used in some interactive trials, including those on the East Coast by Bell Atlantic Corp.

Shooting for March

Macromedia and Microware said their partnership will finish by next March a set-top version of Director that allows the server computers that act as network hosts to recognize and run multimedia PC applications. It would run on Microware's OS-9 operating system.

Bruce Ryon, a multimedia analyst for Dataquest Inc., San Jose, Calif., said the Director technology will be best suited for "intermediate to simple" multimedia programs, not the most complex ones. A competitor, Oracle Corp., said automatically converted PC programs might not be physically appealing to TV viewers, and another competitor, Microsoft, said it is working on similar software and intends to be "a player in all ends of the market."

But Microware has so far shown an ability to stay ahead of Microsoft in multimedia operating systems. And analysts such as Mr. Ryon say that multimedia developers need help now. "It's like the square peg in a round hole thing," he says. "Now they have a peg that can be placed anywhere."

PCWEEK

THE NATIONAL NEWSPAPER OF CORPORATE COMPUTING • AUGUST 8, 1994 VOLUME 11, NUMBER 31 $3.95

Macromedia to provide tools for digital studios

BY ERICA SCHROEDER

As part of a drive to expand its end-user editing tools, multimedia software company Macromedia Inc. has brought out a set of digital studio tools.

The company, which plans to provide a complete suite of tools for the digital studio, is expected to ship its Director multimedia authoring tool for the Windows platform next week, and last week penned a deal with cable set-top box maker Microware Systems Corp. to develop tools for interactive cable television, according to officials of the San Francisco company.

"It's a great step. Macromedia is very well-positioned to take the step [to become a digital studio provider]," said user Drew Huffman, president of Drew Pictures, in San Francisco.

"They're good at guaranteeing compatibility, and going into the video-editing market makes sense because that's all part of the [multimedia] editing process," Huffman said.

Compatibility across platforms

Director for Windows allows both corporate users and professional developers to create multimedia presentations, kiosks, and applications. Both versions—one each for Windows and the Macintosh—will provide users with binary file-format compatibility, as well as the same interface and tool set, said officials.

The Microware deal will result in testing of Macromedia software and Microware's Digital Audio/Video Interactive Decoder cable-box system software, in trials being conducted by telecommunications providers, including Bell Atlantic Corp. and NYNEX Corp.

Macromedia is also planning to expand its product offering to include digital video-editing and graphics-editing tools, said officials. Those products will be added either through acquisition or in-house development.

Macromedia can be reached at (415) 252-2000. ◘

Telemedia Week
THE INTERACTIVE WORLD OF VOICE, DATA AND VIDEO

Interactive

Microware creates de facto operating system for interactive TV

By Mark Berniker

Microware Systems Corp. is the first company to develop a real-time multimedia operating system to be used in set-top boxes for interactive TV applications.

"By being first, we are getting a lot of experience working with different servers, set-tops and application developers enabling us to address the primary compatibility issues," says Eric Miller, director of multimedia for Microware Systems.

Miller says Microware is working with 20 different companies that are manufacturing set-top boxes of varying degrees of sophistication.

"The issues of complexity are being taken to a whole new level, when you consider all the compatibility issues on the table," Miller adds. Those issues include the presentation of video images, graphics formats, communication between the server and set-top and the dynamics of transferring video, graphics, audio and text over the network at the same time.

But while several major computer companies hastily are trying to create operating systems and software packages for interactive television, Microware's OS-9 real-time operating system and DAVID (Digital Audio/ Video Interactive Decoder) software are being shipped.

Bell Atlantic will be the first to use the system in its digital set-top box at its recently approved interactive service trial in New Jersey.

Meanwhile, Microware is about to announce deals with third-party developers for authoring tools to create interactive television applications. Miller says several PC and Mac authoring tools will be available later this year. One of the companies expected to be involved is

CD-ROM

HBO, Warner Music form Inscape to produce multimedia CD-ROMs

The Residents' 'Bad Day on the Midway' to be first

By Mark Berniker

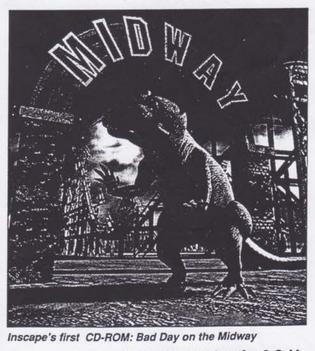
Home Box and Warner Music Group are joining forces to produce and market multimedia CD-ROM titles.

Inscape is the name of their joint venture company. It will be headed by multimedia producer Michael Nash, who was instrumental in creating the *Freak Show* CD-ROM for The Voyager Co. that featured the musical group The Residents.

Nash's first title for Inscape also will feature The Residents. *Bad Day on the Midway* will combine elements of comic books, music videos and video games with the offbeat nature of the San Francisco band. Nash says Inscape will produce at least two more CD-ROM titles by the end of 1995, but would offer no details.

Inscape is considering developing CD-ROM titles from various HBO shows, including *Tales from the Crypt*, *The Larry Sanders*

continued on page 34



Inscape's first CD-ROM: Bad Day on the Midway

OptImage. The company has authoring tools on the market for the CD-I platform and has said it is developing tools for interactive TV.

Microware owns a minority stake in OptImage (Philips is its majority owner). Other potential interactive authoring tool vendors are Macromedia, Apple and possibly others.

But while Microware has emerged as the leader in the rapidly evolving interactive TV market, the small Des Moines-based company can't rest on its laurels. Microware surely will face intense competition in the coming months, with a variety of computer giants creating their own operating system for interactive television. Among firms expected to enter the operating system competition are Microsoft, Silicon Graphics and The 3DO Co.

But Miller is optimistic that Microware will prevail. He says Microsoft is "a year or so back," while SGI's system being developed for Time Warner's Full Service Network in Orlando, Fla., is too expensive and will never make it to market. (The set-top, Miller says, is estimated to cost $5,000-$10,000.)

Miller says 3DO's proprietary system for US West in Omaha is a closed-in system, which is not conducive to standards. And he adds that Kaleida, the joint venture between Apple and IBM, recently "pulled the plug because the powers that be said 'we need another operating system like we need a hole in our head.'

"We would like to develop a functional model for interactive television with a software package that allows manufacturers a lot of flexibility in set-top box design," Miller says.

In addition to Bell Atlantic, other companies deploying network architectures and working with Microware are Cox Cable, Nynex, Hong Kong Telecom, SIP of Italy, Korean Telecom and Telecom Australia.

First-generation digital set-top box manufacturers that are supporting DAVID include Philips, IBM, EURODEC, GoldStar, Zenith, CLI, Kyocera, Samsung, ICTV, Divicom and Adaptive MicroWare. Video server manufacturers who are backing it include Digital Equipment Corp., NCube, IBM and Hewlett-Packard.

Miller says most of the interest in Microware OS and software has come from the telcos, but recently several traditional cable set-top manufacturers have expressed greater interest. He said Microware is actively involved with Zenith and is at "various levels of discussions" with General Instrument and Scientific-Atlanta, the two leading cable set-top manufacturers.

The second generation of digital set-top boxes is not expected to arrive until late 1995 or early 1996. These interactive decoders will contain RISC processors, such as the PowerPC chip, featuring MPEG-2 decoding of full-motion video, decryption/conditional access, a PCMCIA accessory interface and a high-performance graphic accelerator.

Despite the optimism surrounding the potential of interactive television, Miller says the "issue of doing this economically is not a simple question. The crux of the discussion is that you have two diametrically opposed ideas: price and function."

Miller says that while everyone is talking about a highly functional set-top box with nothing short of a mini-computer inside, the economics won't allow it to be priced at less than $200; $200 often is cited as the maximum price telcos and cable operators are willing to pay for the next generation of set-tops. ■

Woodstock '94: Hightech reunion

PolyGram, Philips plan interactive pavilion for music festival

By Mark Bernker

Woodstock '94 is being billed as the music event of the summer, if not the biggest concert since the seminal event on Max Yasgur's farm 25 years ago.

But though the New York State Thruway might have been closed 25 years ago, the information superhighway will run through the new Woodstock, with the concert available on demand to millions and a range of new interactive technologies on display.

"This is going to be a blockbuster event that is going to be made available first live on pay per view, and then later as a film and home video," says Jeff Rowland, vice president of Polygram Diversified Entertainment, which is coordinating Woodstock '94.

The festival will take place on an 848-acre farm in Saugerties, N.Y. Rowland says the permit for the festival allows Polygram to sell up to 250,000 tickets. Aerosmith, Metallica, Red Hot Chili Peppers, Alice in Chains, Bob Dylan and Peter Gabriel are among the musical artists who will perform during the Aug. 13-14 event.

"Pay per view is the perfect medium to present the whole festival," Rowland says. Based on initial feedback from cable operators, he expects the buy rate will be more than 2%, which would translate to orders from nearly 450,000 households and generate more than $22 million.

Holly Leff, executive director for original and event programing for Viewer's Choice, one of the companies handling the pay-per-view event, also has "high expectations" for the buy rates for the festival, which will cost $49.95 on pay per view. Leff says the current addressable universe for PPV events is about 23 million.

Aside from the pay-per-view package, MTV is planning live coverage of Woodstock '94 with its music video jocks roving the grounds. But PolyGram Diversified Entertainment, which is overseeing the pay-per-view production, is restricting MTV's live coverage of the performers.

PolyGram and Philips Media also are using the festival to showcase an array of new technologies that will be part of what is being called "Surreal Field," a six-acre interactive village produced by MEGA Interactive Festivals Ltd.

Apple Computer plans to create "Woodstock '94 Nation News," a digital newspaper that will be a combination of world news and information about the festival. Apple will display the twice-daily newspaper on screens on the main stage. Apple also will have a tent devoted to games, music and sports CD-ROM titles. ■

David Versus Goliath

Little Microware has a rock called OS-9 in its sling as it takes on the giants in the battle to own the multimedia set-top box. By Stephen Jacobs

In case you hadn't noticed, everyone's talking interactive TV these days. Product trials, broken deals, mergers, start-ups – there's a rash of ploys to make your boob tube brilliant by hooking a computer to it. To many in this country, the word computer is still wedded to images of Silicon Valley and Microsoft, the company that strides the personal computing landscape like a Goliath. Chairman Bill Gates has said Microsoft is spending a cool US$100 million a year on developing software for multimedia, interactive television, and the information superhighway. The popular wisdom says that what Bill wants, Bill gets. Yet some of the hottest developments in software for interactive television are happening nowhere near Silicon Valley; they're happening thousands of miles away in the Midwest.

Microware President Ken Kaplan, left, with Vice President Larry Crane. "I don't think Microsoft's going to be a player. It's just too late."

Des Moines, Iowa, is not the city that most of us would pick as the site of a burgeoning industry revolution. But then, Des Moines surprises. Sure, it's a small Midwest town surrounded by flat and well-farmed land, but that's not all there is to it. There's a Thai restaurant whose zillion-page beer list boasts brews from all over the world. There's a monumental modern Civic Center whose concert hall hosts world-class guitarists. And there's Microware Systems Corporation, a 200-employee, privately held corporation that makes an operating system called OS-9.

Microware is headquartered in a 25,000-square-foot building just down the road from the offices of the National Pork Producer's Council. So far, it may not sound like anything to get excited about. OS-9 was created to control manufacturing and robotics applications. The latest addition to its product line, Digital Audio Video Interactive Decoder (DAVID), is a version of OS-9 for set-top terminals, the cable decoder boxes of interactive television.

DAVID is the program that runs "under the hood," the skeleton around which user interfaces will be built by manufacturers of the terminals. It must be a pretty impressive set of bones – it's been licensed to 15 manufacturers of set-top terminals for interactive television, including IBM, Philips, Zenith Corporation, Fujitsu, Mitsubishi, Kyocera, GoldStar, Samsung, Adaptive MicroWare, Divicom, and EURODEC. By the time you read this, more will be on board. Oracle's media servers will communicate with these DAVID-based set-top boxes in Bell Atlantic interactive television trials in New Jersey and Northern Virginia. (A groundbreaking Federal Communications Commission decision in June cleared the way for Bell Atlantic to compete with cable in providing video programming in Tom's River, New Jersey.) Other announced interactive TV trials that are using DAVID include Nynex's Manhattan and Rhode Island trials; Cox Communications's trial in Omaha, Nebraska; Telecom Australia's system; and Hong Kong Telecom's system.

Though Microware's operating system was developed for manufacturing and process control, it also has been used in multimedia for some time. DAVID has its roots in the operating systems for Tandy's Color Computer 3 and Philips CD-I, which are versions of OS-9 with platform-specific modules. Even so, conventional wisdom puts a small, relatively unknown software company at a disadvantage against a major player like Microsoft.

Predictably, Microware President Ken Kaplan doesn't see it that way.

"I don't know what other people think, but I just don't think Microsoft's gonna be a player. I just think it's too late. We've been working on this for two, three years. We've got real product. By the time they figure out how to put Windows on a set-top box, we'll have a couple of million boxes out there and working. At least that's the plan," says Kaplan.

Since 1977, Microware has been developing ROMable (i.e., small enough to fit in the Read Only Memory chips on a system's motherboard) real-time operating systems, and doing quite well, thank you. Microware began when, as Drake University students, Ken Kaplan and Larry Crane (vice president of advanced research) got a grant from the National Science Foundation to write software for first-generation microprocessors. They started with the Motorola 6800 – the precursor to the 68000 series of CPUs that would drive the Macintosh. This work led them to develop RT/68, a small, efficient multitasking operating system for industrial applications. Kaplan and Crane founded Microware to develop and sell RT/68, putting a small ad in *Byte* magazine. Orders began rolling in from around the world. Physicist Rudolf Keil at the University of Heidelberg used RT/68 to control lasers for physics research. More than an early user, Keil was one of the first Microware customers to begin working with the company. He ended up leaving the university to become Microware's German distributor.

Motorola was so pleased with RT/68 that in 1978 the company asked Microware to develop a Basic language for the 6809 processor, the bridge chip between the 6800 and Motorola's popular 68000 series. Microware began developing the Basic and an operating system to go with it. That was the beginning of OS-9. Kaplan and his team modeled OS-9's I/O and process handling after those in Unix, which at the time was a relatively unknown operating system. Microware's decision to use Unix as a model may have been a gamble then, but it has proved to be a fortuitous choice: Unix has since grown to become the lingua franca of the Internet. As a result, the OS-9 of a decade ago was more ready for the information superhighway than many other operating systems are today.

OS-9 is popular in industrial applications worldwide for robotics, telecommunications, or any other type of application that requires a small, on-board operating system to handle a large number of processes extremely quickly. The head of Microware's French office, Nick Rainey, ticked off several applications that have made OS-9 popular in Europe:

"CERN, the particle accelerator; the French pay-phone systems that now run off 'smart cards' – that's OS-9; British Telecom; subway systems. I had a big surprise when I went to open the Russian office. They took me over to see the space flight simulators, and they'd been running the whole system off a version of OS-9 that they'd bootlegged from some Germans somewhere. They were really glad to see us!"

OS-9 made early inroads in Japan, when Fujitsu made 6809-based personal, multi-

"Those in the [interactive TV] industry don't want monopolists dominating their business.

tasking computers for the Japanese market. In the US, OS-9 can be found in NASA simulators as well. Flight simulators, maintenance, and testing equipment for McDonnell-Douglas, Lockheed, and Boeing also run off of OS-9. Microware's sales are pretty well divided into thirds between the US, Europe, and the Pacific Rim.

Coming into view

Microware seemed to burst into public view from nowhere when Bell Atlantic announced specifications for its interactive services in January 1994. The specs could only be met by terminals running DAVID. This was a surprise, as Bell Atlantic had released a preliminary set of specs several months before that appeared to be based on Modular Windows, Microsoft's now-dead operating system for multimedia. In reaction to the Bell Atlantic announcement, the January 18 *Wall Street Journal* ran a feature story about Microware. Since then, Kaplan and company have been signing set-top box contracts right and left.

Modular Windows is kind of a mystery. Apparently, it was to have been a smaller, faster, trimmer version of the Windows operating system for set-top boxes. It has been replaced by a new system from Microsoft called Tiger. The *Wall Street Journal* piece left the impression that Bell Atlantic ran DAVID and Modular Windows in competition and chose Microware over Microsoft.

Not true, says Microware's multimedia marketing manager Arthur Orduña. "We didn't go head-to-head with Modular Windows because there was nothing to go head-to-head with."

Orduña says Bell Atlantic asked Microware to assemble an OS-9 comparison chart,

something that would list the specifications and merits of several different operating systems. Microware was unable to obtain the information it needed on Modular Windows.

"First I called Microsoft directly, and all I could get was 'Give us your number and we'll call you back.' Then we asked a friend of ours to call Microsoft as a developer and ask about Modular Windows, the normal sort of play-acting shit we get from our competitors. What our friend got for an answer was 'Well ... give us all the specs and information about the system you're developing and we'll call you back.'"

Microware struggled to find someone who knew or would talk about Modular Windows. They finally found a source at Tandy, where Modular Windows was being used in the development of a home entertainment system prototype. (Microsoft wouldn't talk about it with *Wired*, either, but at press time has just announced its Tiger database for interactive set-top boxes.)

"We talked to this technician who worked on their interactive project," says Orduña. "He really didn't have specs either, but he bitched and bitched about the integration process and how difficult it was to implement Modular Windows on a consumer platform. So I called back the project manager at Bell Atlantic and told him 'I'm faxing you back this OS-9 comparison chart, and I really have to apologize beforehand for the gaping holes in there on the Modular Windows part because we don't know them. But, we have the number of this engineer you can call, and he can give you some insight on what it's like to integrate Mod Windows on a consumer platform.' A couple days later they said, 'OK, you're it.'"

As a corporate entity, Bell Atlantic didn't make an agreement with Microware or specify DAVID as *the* operating system for its set-top terminals. It merely published a set of specifications that only DAVID could meet. No deal has been cut between the two companies, allowing each to keep its freedom and avoiding any accusations of monopolistic or restrictive behavior on the part of Bell Atlantic.

Multimedia experts?

CERN and French smart cards may sound far removed from the world of home entertainment systems, but Microware got its foot in that door a long time ago. The company has been slowly building a presence in consumer electronics since the early '80s. That's when Tandy used OS-9 in the Radio Shack Color Computer, fondly remembered by some as the CoCo 3.

"We did the original operating system for the Tandy Color Computer," says Kaplan. "We did a windowing GUI for that called Multi-view. So we always thought that OS-9 would be a good operating system for consumers. No one back in those days was thinking about multimedia."

What they were thinking about was game machines. In the mid-1980s Microsoft announced MSX (Microsoft Extended Basic), a product that was supposed to be an industry standard for computer/game machines like the Commodore 64 and the Atari 800. Microsoft worked with ASCII Corp. in Japan to push the standard to a consortium of manufacturers including Sony, Matsushita, and Yamaha. The plan was to introduce it in Japan and then bring the systems to the states. It was not successful. In January 1986 Microsoft announced its long-term commitment to CD-ROM development. By February 1986 Microsoft and ASCII Corp. had dissolved their relationship.

Meanwhile, Microware's work for Tandy brought the firm to the attention of Philips. Philips had made an early video game system called the Magnavox Odyssey and had asked Microware to collaborate on a new product – originally envisioned as a type of rack-mountable game system. (It eventually evolved into CD-I.) After evaluating systems from 60 other companies, Philips decided to ask Microware to develop CD-I's CD-RTOS, the operating system in every Philips CD-I System.

Microware got the CD-I contract in January 1986, and in the summer of 1986 Kaplan got a phone call from Silicon Valley. Bill Gates wanted to buy the company. Kaplan didn't want to sell but was willing to talk about joint ventures. Gates wasn't. The negotiations ended there before they had started, and Gates's picture earned a place of honor on Kaplan's dart board.

In the meantime, to support CD-I development, Microware formed two joint ventures in the interactive media field. The first is called OptImage. "Both Philips and Microware had to develop software and hardware to make discs," says Kaplan. "It's a chicken-and-egg problem. We needed to make discs to test our software, to test the prototypes. It wouldn't be a core business for either Philips or Microware, but somebody had to do it." Another Microware joint venture called MicroMall has been running CD-I-based shopping and information kiosks in several areas, including Chicago, as a preliminary step in designing shopping services for

Why OS-9?

Why do set-top terminal companies want a robotics operating system for interactive television?

Most personal computing operating systems are large and relatively slow. They still don't effectively multitask or run more than one application at a time. They take up a lot of hard-drive space and memory. The multitasking that systems like Windows and System 7 do is "cooperative." Different applications rarely stop or pause each other; they wait for breaks in CPU usage to have the computer change horses between them without shutting each other down. These systems are almost polite. They have response times of half a second at best.

In robotics or manufacturing systems, operating system needs differ. The scope of the operating system doesn't need to be as broad as that of a computer operating system, and often it must be able to fit into the system memory, right on the circuit board. True multitasking is vital. Different applications, or tasks, need to be able to interrupt each other, and quickly. A response time of half a second is much too slow.

"If a robot arm has reached its position, you probably need to tell it to do something immediately," says Peter Dibble, a research scientist for Microware. "You can't have it just waiting around while another task clears the screen."

Operating systems for set-top terminals must be compact enough not to need a lot of memory or a hard drive, in order to keep the cost of the box down. They must also be fast and multitasking. A half-second response time can give you frozen video or garbled audio.

"There are a lot of things going on in a set-top box at once," says Curt Schwaderer, a principal engineer at Microware. "First, you've got a networking front end that's sending data in at 1.544 Mbits per second. While all this networking stuff is trying to deal with (all this data coming in off the) T1, you've got another piece of the operating system that's taking the data and playing a movie with it. Then there's the third, interactive part, where you press buttons on a remote control. That requires more processing going on inside the box and more networking-type data going back and forth over the serial line so that you can do things like Fast-Forward, Rewind, Stop, Go Back."

OS-9 is modular so that it can fit a wide variety of needs without taking up a lot of system resources. A modular operating system allows designers to pick exactly which parts they will need. The heart of the operating system, called a kernel, fits in only 29 Kbytes of chip memory. DAVID, which is just a specific mix of OS-9, networking, and video modules, will fit all the necessary parts for a set-top terminal OS into about 256 Kbytes of memory while running true multitasking, not cooperative multitasking.

Some set-top box manufacturers are waiting for the development of a video compression scheme more advanced than the current MPEG 1. Not Microware. The first DAVID set-top boxes will use systems that TCI initially passed on.

"I'd rather have something that works this year and see it get better later," says Microware's Dibble. "It would be fun to be able to deliver the set-top box that would start with HDTV and go on from there, the one that wouldn't deliver anything but quadraphonic sound and wouldn't work unless you had broadband fiber. Maybe that will happen. Maybe if we're lucky we will be the people still doing it because we were the ones who delivered the relatively not-so-wonderful stuff."

interactive television. The digital interactive "catalogs" at the heart of the systems use digital stills, audio, and video to display items from J C Penney, Land's End, and others.

Getting on the Net

While he was working with Philips on CD-I, Kaplan began hearing about another form of future multimedia delivery.

"Not long after we got involved with CD-I and understood digital audio and digital video, it became clear that ultimately audio and video could be delivered by a network," says Kaplan. "Maybe it would be even better to deliver it via a network rather than via optical disk, but the transmission technology and the digital video compression weren't quite there yet. I remember back in '86 the Philips engineers said, 'There's a way to do it; we can't make the silicon yet, but in four or five

years we will.' So it was known back then that it was doable."

OS-9's popularity in the telephone-switching world had landed Microware on an advisory committee for Bell Atlantic. At about the same time that Philips was beginning to talk about digital video, the phone companies were talking about it as well. Bell Atlantic was starting to talk about sending digital video over copper wires. Bell Atlantic asked Microware if the OS-9 inventor wanted to participate in some of the research. About two years ago, Microware realized that if it combined OS-9 modules written for phone switching and telecommunications networking with the modules written for digital audio and video, they had all the parts of an operating system for set-top terminals. Soon after that, DAVID was born.

Driving a prototype

Recently, the folks from Microware have found themselves at a lot of trade shows to show off DAVID, either on their own or sharing booths with Oracle or set-top terminal manufacturers. If you walked into these booths, you'd see a demonstration of digital video on demand being driven by a DAVID set-top box talking to a video server. Additional DAVID networking protocols on the set-top box and the server would be handling the communications between the server's operating system and the DAVID system in the set-top terminal. Of course, all this is transparent to you. All you see is the interface designed by the set-top box manufacturer and the video delivered by the server.

At a recent demonstration in Des Moines, Microware used a Kyocera prototype set-top terminal. About the size of a standard cable decoder, the box came with one of those massive, 3,000-button multiremotes that are becoming standard in the consumer electronics industry. What wasn't standard were the cursor-control-style keys in one section of the remote. Those were the ones that drove the interactive part of the terminal.

The video was delivered by one of Microware's prototyping servers, through T1 lines to the local phone company offices several miles away in downtown Des Moines. The remote could perform VCR-type functions on the digitized video quickly and with no sync problems. The system responded instantly, much faster than a VCR. The only downside was the control of the "arrow pointer" via the remote: infrared doesn't seem to be the most effective communications channel between controller and terminal, and scrolling up and down a screen is agonizing.

So what about Microsoft?

Since January there's been a lot of press about Microsoft's plans for interactive TV. From what's being said, Microsoft's model of a delivery system is similar to Microware's.

"We're looking at a switching broadband network," says Karl Buhl, marketing manager in advanced consumer technology for Microsoft. "We'd have four parts to the system: Tiger [Microsoft's current solution] continuous switching at the head end, coax from the head end to the home, a set-top terminal in the home, and a Microsoft software package running the system."

Conventional wisdom says Tiger will blow everything else away. Ken Kaplan doesn't buy it. "Microsoft is coming into this business from a standing start. No one wants them in this business anyway. They're not welcome."

"If Ken thinks we're not wanted here in the industry he should talk with TCI," Buhl counters. He says TCI's trials with Microsoft's Tiger technology will begin in Seattle at the end of the year. (See *Wired*'s interview with TCI head John Malone, *Wired* 2.07, page 86.)

Obviously, Kaplan thinks it's not too early to count Microsoft out. "Bill Gates says he's been spending hundreds of millions of dollars a year on this business," Kaplan reasons. "Do you know what kind of return he's got to get on that investment? There isn't that much money in set-top-box software, sorry. Microsoft wants to get a piece of everything, probably per transaction. The market can't afford that. It can't afford Microsoft, and those in the industry don't want monopolists dominating their business. Not to mention that Microsoft doesn't have a clue about this business. It's a TV-set business, not a computer business.

"This happened to them once before. They missed the boat totally on networking. That's why Novell took off. Bill didn't figure it out, he didn't see it coming. He didn't approach it right, and Novell came in and ate his lunch."

According to Microware's Orduña, DAVID was not just a lucky acronym choice. While the name's been trademarked, the logo hasn't been finalized. The first version of the DAVID logo followed the biblical metaphor right down to a sling. That got a thumbs down as taking the joke a bit too far. But if Microware *really* wants to get Microsoft's goat, maybe it'll choose a logo inspired by Novell. ■ ■ ■

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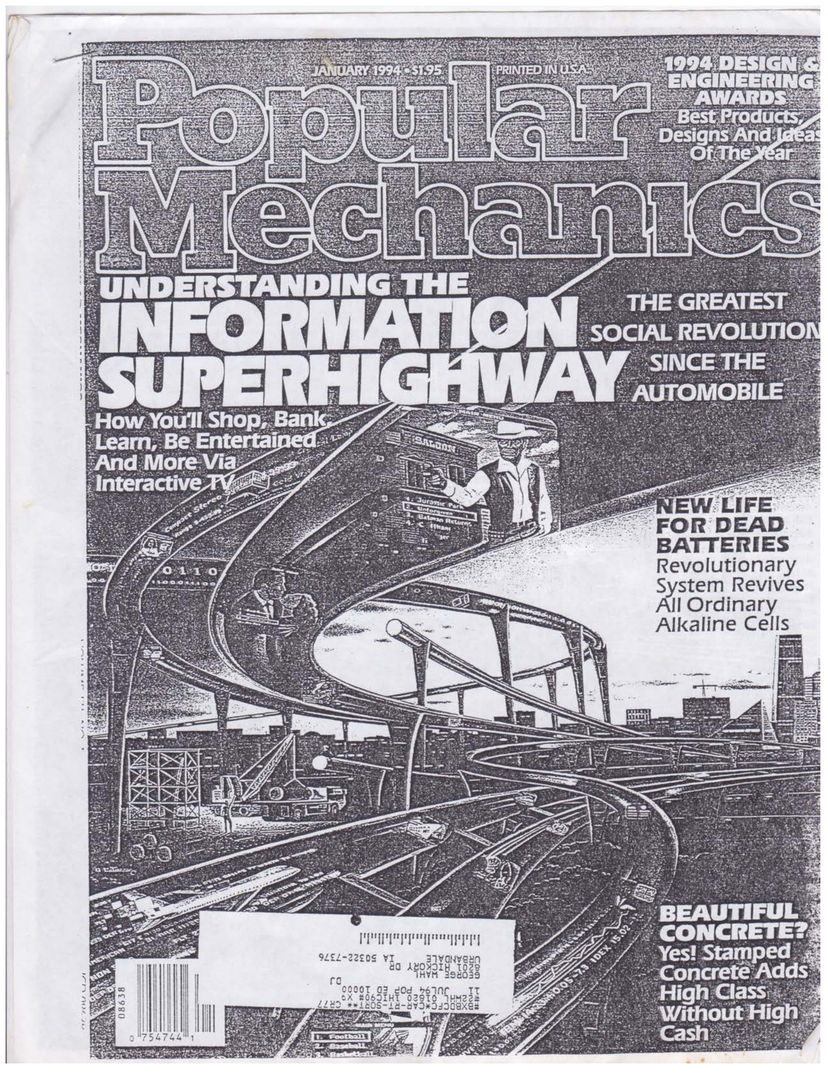
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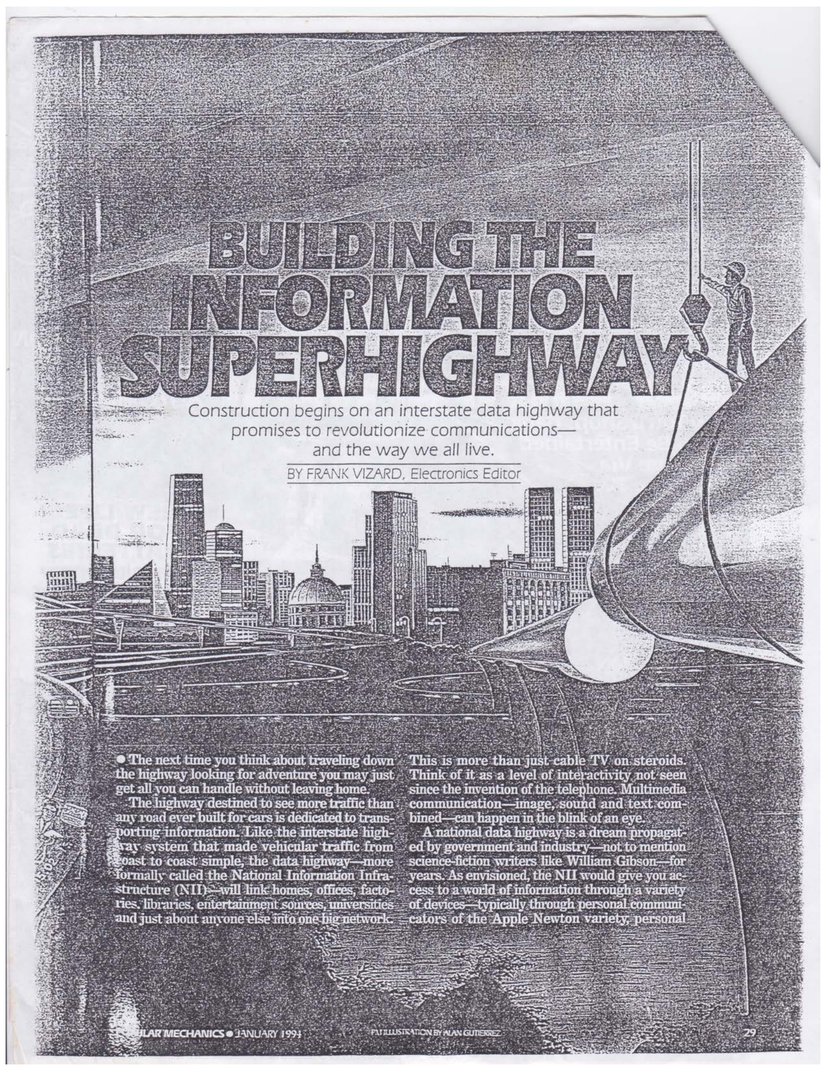


BUILDING THE INFORMATION SUPERHIGHWAY

Construction begins on an interstate data highway that promises to revolutionize communications—and the way we all live.

BY FRANK VIZARD, Electronics Editor

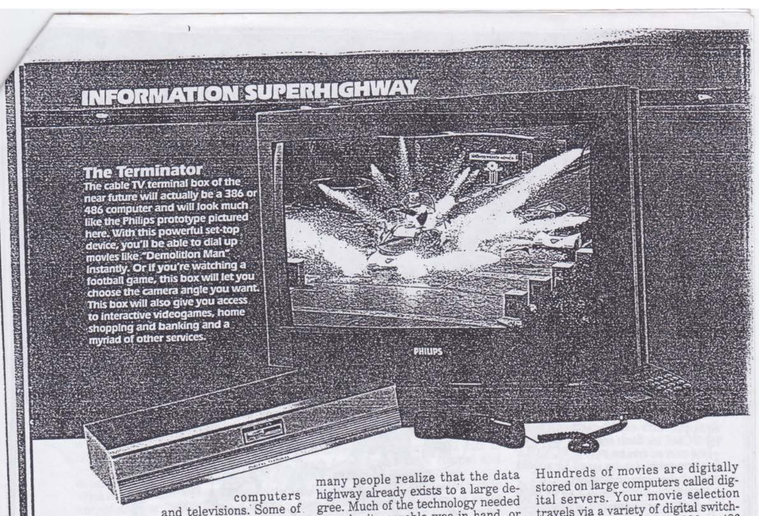
● The next time you think about traveling down the highway looking for adventure you may just get all you can handle without leaving home.

The highway destined to see more traffic than any road ever built for cars is dedicated to transporting information. Like the interstate highway system that made vehicular traffic from coast to coast simple, the data highway—more formally called the National Information Infrastructure (NII)—will link homes, offices, factories, libraries, entertainment sources, universities and just about anyone else into one big network. This is more than just cable TV on steroids. Think of it as a level of interactivity not seen since the invention of the telephone. Multimedia communication—image, sound and text combined—can happen in the blink of an eye.

A national data highway is a dream propagated by government and industry—not to mention science-fiction writers like William Gibson—for years. As envisioned, the NII would give you access to a world of information through a variety of devices—typically through personal communicators of the Apple Newton variety, personal

P.U. ILLUSTRATION BY ALAN GUTIERREZ

INFORMATION SUPERHIGHWAY



The Terminator
The cable TV terminal box of the near future will actually be a 386 or 486 computer and will look much like the Philips prototype pictured here. With this powerful set-top device, you'll be able to dial up movies like "Demolition Man" instantly. Or if you're watching a football game, this box will let you choose the camera angle you want. This box will also give you access to interactive videogames, home shopping and banking and a myriad of other services.

computers and televisions. Some of these devices may be combined in the future—think of a hybrid telecomputer, for example.

What type of information can you get? You can dial up movies on demand, play videogames with people across the nation, shop, take care of banking, make travel arrangements, tour the vaults of a museum, tap into any library or just chat.

The NII promises more than just a host of consumer conveniences. Since the data highway can handle voice, video and text simultaneously and with equal aplomb, the impact on business and health services alone stands to be substantial. Manufacturing specifications can be quickly transmitted in detail. Medical disorders can be diagnosed by specialists far away from the patient. And on the education front, students can receive lessons from the best teachers without regard to geography.

The dream is suddenly becoming a reality. The proposed merger between Bell Atlantic, one of the Baby Bell phone companies, and Tele-Communications Inc. (TCI), the nation's largest cable TV operator, woke up the world to the fact that the data highway could exist in concrete terms. The merged companies have access to 22 million customers in 59 of the top-100 markets. The Bell Atlantic/TCI merger creates a pretty big highway just by itself.

The $33 billion Bell Atlantic/TCI merger agreement suddenly made many people realize that the data highway already exists to a large degree. Much of the technology needed to make it operable was in hand, or nearly so. The road would be fiber-optic cable, hair-like glass strands that carry data as light pulses and which have a much greater capacity than copper or coaxial wire. Today, fiberoptic cable is only being used to one-tenth of 1% of its capacity (a typical 32-strand fiberoptic bundle can handle up to 5000 video channels). Basically, all that is needed is a way to connect a lot of little networks to each other to form a larger network.

The Bell Atlantic/TCI merger agreement made people realize that the data highway already exists to a large degree.

500 channels

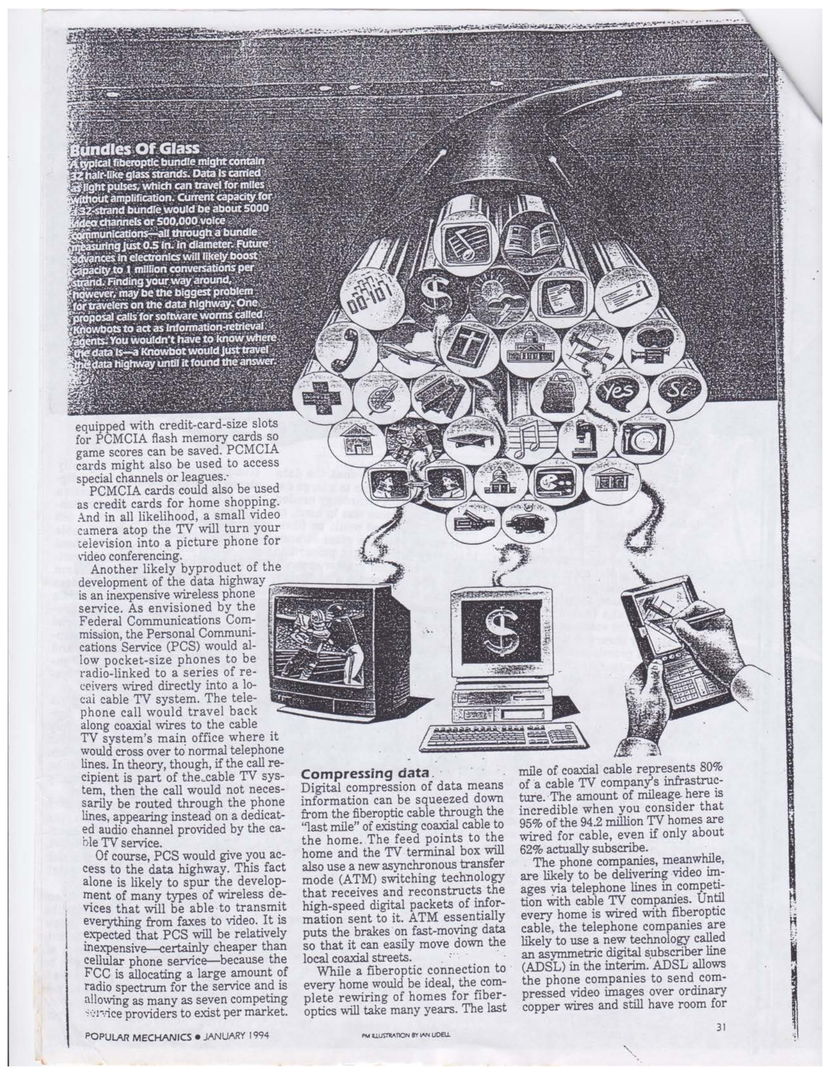
For many, the entrance ramp onto the data highway probably will look much like the new Time Warner network set to debut next April in Orlando, Florida. Accessed via a set-top box, Time Warner's Full Service Network appears, at first glance, to be a pumped-up cable TV service. Indeed, you get 500 channels, but there is more to it than just that.

A big draw is video on demand. Hundreds of movies are digitally stored on large computers called digital servers. Your movie selection travels via a variety of digital switches to what amounts to a 386 or 486 computer masquerading as a cable box sitting on top of your TV. These set-top devices will be made by various suppliers. For example, Silicon Graphics is making set-top devices for the Time Warner system, while 3DO is doing the same for a proposed US West interactive-TV trial in Omaha, Nebraska. Other potential suppliers include Philips and GTE, a company that is also engaged in a trial interactive-TV system in Cerritos, California.

The signal, being received via fiberoptic and coaxial cable, is digitally compressed so it occupies only a small fraction of the bandwidth available. With digital compression, eight to 10 video channels can be carried in the bandwidth normally required for one channel.

Of course, you can do more than just watch movies. Just imagine watching a sporting event, for example. Since the TV is now interactive, you'll be able to choose from which camera angle you want to watch the action.

You'll also be able to play videogames or engage in hobbies like rotisserie baseball with other people on the network. And since the network is 2-way, you can expect all kinds of control accessories to be available. This would include head mounted displays (HMDs) or helmets for virtual-reality scenarios. Set-top boxes will likely com



equipped with credit-card-size slots for PCMCIA flash memory cards so game scores can be saved. PCMCIA cards might also be used to access special channels or leagues.

PCMCIA cards could also be used as credit cards for home shopping. And in all likelihood, a small video camera atop the TV will turn your television into a picture phone for video conferencing.

Another likely byproduct of the development of the data highway is an inexpensive wireless phone service. As envisioned by the Federal Communications Commission, the Personal Communications Service (PCS) would allow pocket-size phones to be radio-linked to a series of receivers wired directly into a local cable TV system. The telephone call would travel back along coaxial wires to the cable TV system's main office where it would cross over to normal telephone lines. In theory, though, if the call recipient is part of the cable TV system, then the call would not necessarily be routed through the phone lines, appearing instead on a dedicated audio channel provided by the cable TV service.

Of course, PCS would give you access to the data highway. This fact alone is likely to spur the development of many types of wireless devices that will be able to transmit everything from faxes to video. It is expected that PCS will be relatively inexpensive—certainly cheaper than cellular phone service—because the FCC is allocating a large amount of radio spectrum for the service and is allowing as many as seven competing service providers to exist per market.

Compressing data. Digital compression of data means information can be squeezed down from the fiberoptic cable through the "last mile" of existing coaxial cable to the home. The feed points to the home and the TV terminal box will also use a new asynchronous transfer mode (ATM) switching technology that receives and reconstructs the high-speed digital packets of information sent to it. ATM essentially puts the brakes on fast-moving data so that it can easily move down the local coaxial streets.

While a fiberoptic connection to every home would be ideal, the complete rewiring of homes for fiberoptics will take many years. The last mile of coaxial cable represents 80% of a cable TV company's infrastructure. The amount of mileage here is incredible when you consider that 95% of the 94.2 million TV homes are wired for cable, even if only about 62% actually subscribe.

The phone companies, meanwhile, are likely to be delivering video images via telephone lines in competition with cable TV companies. Until every home is wired with fiberoptic cable, the telephone companies are likely to use a new technology called an asymmetric digital subscriber line (ADSL) in the interim. ADSL allows the phone companies to send compressed video images over ordinary copper wires and still have room for

PM ILLUSTRATION BY IAN UDELL

Digitizing Video
At MIT, researchers created a single image of musician Yo-Yo Ma (top segment, above) from other shots of different focal lengths using digital video technology. When digitized, video flows like a stream (right) that can be easily manipulated.

voice conversations. Fiberoptic cable would bring the signal to the last mile, after which ADSL technology, which tends to degrade over distance, would bring the signal home.

The fiberoptic cable, though, is essential for 2-way communication. With coaxial cable, the signal must be amplified every 2000 ft. In a 2-way coaxial connection the amount of electronic noise added by the amplifiers makes the signal unintelligible. With fiberoptic cable, the signal can travel for miles before needing a boost, a characteristic that keeps the signal quality very clean.

The phone companies are also looking at another technology that allows digital data to be sent over existing copper wires. Called the Integrated Services Digital Network (ISDN), this technology seems most suitable for voice and text applications. If upgraded, ISDN could prove to be a shortcut to the information highway.

On the net

All of these options are fine on the local level but how do you make the connection to larger networks that allow you to telecommute to the office or tap into Washington, D.C.'s Smithsonian Museum when you're in Des Moines?

The data highway model everyone is looking at is a confederation of computer networks called the Internet. Currently, the Internet is comprised of more than 10,000 networks —from universities, libraries, science foundations, government and businesses—that are all linked together.

Estimates as to the number of people using the Internet range to as high as 30 million. This number will only get higher as this year Continental Cablevision Inc. provides special hookups that allow PCs to jack into the Internet via cable lines. This link allows users to download data at much faster rates since coaxial and fiberoptic lines are being used.

Internet users send electronic mail, chat with other Internet users on bulletin boards, play games or access about 2 million files on a variety of topics. In effect, the Internet is its own electronic community. More importantly—and this is an approach the federal government wants to take on the data highway—the Internet has an open architecture, meaning that it is available to all.

The data highway model everyone is looking at is a confederation of computer networks called the Internet.

The Internet, however, illustrates one of the practical problems facing the data highway. The Internet is a notoriously difficult piece of cyberspace to navigate, and it is often very hard to find the information you're seeking. Software developers hope to make the information-retrieval process easier in the future. One concept involves software worms called Knowbots that crawl from source to source looking for the answers to questions. You wouldn't have to know where the information is—the worm would just keep looking until it found the desired data. Traffic congestion, though, might turn out to be a major problem if too many worms are looking for information in the same place—another issue to be resolved.

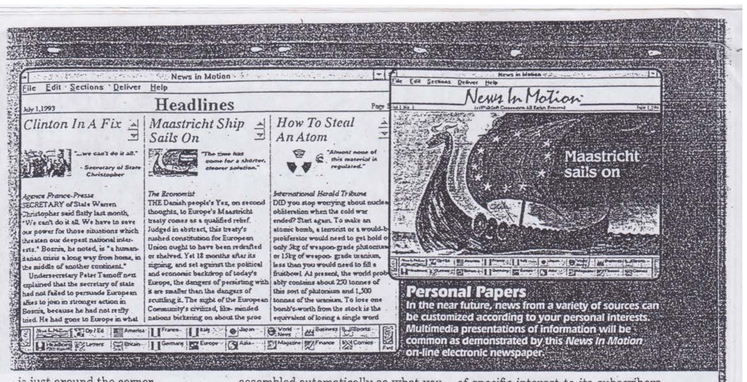
The Internet model, however, may not be the only one pursued, particularly in a short-term future devoid of standardized protocols. AT&T, for example, is investing heavily in the ImagiNation Network, formerly Sierra On-Line, in hopes of creating a nationwide network for videogame play. The network will allow players to compete against each other using Sega Genesis gear, an AT&T peripheral device called The Edge 16 and 3DO's interactive multiplayer. Once standardized protocols are developed, the ImagiNation Network would be just another lane on the information highway.

Besides information retrieval, there are other hurdles to jump as well. One is to agree to a protocol standard that allows different networks to communicate easily with one another. And while numerous companies, ranging from General Magic to IBM, are vying to develop one, the Bell Atlantic/TCI merger may just create a de facto standard.

Smart TV

Perhaps the biggest leap forward will come when video can be transmitted digitally. Translated into zeros and ones like audio on a compact disc, video becomes easily manipulated and a whole range of options begins to appear. For instance, images of the same subject but shot at different focal lengths can be combined to produce a single image. Small details can be enlarged at will. This technology

WALTER BENDER & LAURA TEODOSIO, EDDIE ELLIOT, MIT MEDIA LABORATORY PHOTOS



is just around the corner.

For example, digital video will be the cornerstone of a direct broadcast satellite (DBS) service being launched by Thomson Consumer Electronics (RCA's parent company) and Hughes Communications. Scheduled to debut this April, this DBS service will use digital video and compression technologies to offer 150 channels received in the home by an 18-in. dish for about $700.

As envisioned by researchers at MIT's Media Lab and elsewhere, digital video will have many ramifications. But perhaps most importantly, it gives your television a chance to become intelligent.

In the near future, television will have the sort of learning capabilities exhibited now by products like Apple's Newton personal communicator. As you use the television, the TV's intelligence system will note the type of programming you enjoy. So instead of channel grazing through an impossible number of channels, the TV will present you with a list of programming choices based on your viewing history. The TV may also digitally store a program it thinks you might like even when you're not at home.

Viewers will also be able to customize their viewing—of news, for example. Since the news arrives in digital form, it is relatively easy for the TV to sort through the incoming digital video stream of channels and pull out items of specific interest to you.

Or conversely, if you're interested in news footage of civil unrest in China, for example, the TV will cruise through all the news channels, pulling out any snippets relating to China. These snippets would then be assembled automatically so what you would see is one long piece of video footage on China. You no longer have to jump from news channel to news channel looking for that extra footage or different camera angle that is often critical to an understanding of events.

Customization could even extend to other types of news sources. For instance, you might subscribe to a variety of newspapers and magazines. Your television or your computer would know the type of information you are generally interested in. Articles from different sources would be blended together to create your personal newspaper that would be displayed on screen. You'd also be able to quickly print a hard copy of your newspaper—in color, of course, thanks to coming improvements in printer technology—or access your personal newspaper via a wireless computer or Newton-type personal communicator.

The arrival of digital video technology gives your television a chance to become intelligent.

Such capabilities already exist, although the technology is still too expensive for mass use. Nevertheless, the Sandpoint Corp. of Cambridge, Massachusetts, has a software program called Hoover that sucks items of specific interest to its subscribers out of 5200 publications. The system, which now costs about $28,000, prepares reports that are continuously updated.

Electronic newspapers are also likely to use multimedia in their presentations of news. A hint of things to come is the *News In Motion* on-line newspaper available on a weekly basis from Walk Soft Corp. in Rochester, New York. *News In Motion* combines audio, still pictures, animation and text to present an array of news, opinion, entertainment and sports information. With the addition of digital video, live footage could easily be integrated into the mix. You would also be able to access your personal newspaper via a wireless computer or Newton-type personal communicator.

Watching all this is the federal government, mostly with a friendly eye since Vice President Al Gore is a long-time proponent of the data highway. Indeed, someone will have to act as a data-wise state trooper to make sure commercial interests don't outweigh societal needs.

Corporate users, for instance, may be asked to pay a premium on video conferencing—money that would be allocated to install data highway terminals in the public libraries and schools of the inner city. The hope is that the federal government will take a leadership role in the creation of a common carrier channel easily accessed by all.

That role may be all the more important if, as Thomas Jefferson said, information is the currency of democracy. Thanks to the information highway, that currency is likely to get into more hands than ever. PM

8-3-94

$1.3 million, or 17.3 cents a share, compared with $635,000, or 13.5 cents a share, in the second quarter of 1993. Revenue increased 30.4 percent to $18.1 million from $13.9 million. For the first half, profit shot up 150.9 percent to $1.6 million, or 22.8 cents a share, from $650,000, or 13.8 cents a share, a year earlier. Earnings for the first six months of this year included a one-time-only gain of $509,000, or 8 cents a share, for the early retirement of long-term debt.

Preferred Risk results

Preferred Risk Mutual Insurance of West Des Moines reported lower results for the first six months of the year. The property-casualty insurer said surplus increased $1.3 million, down from $6.6 million a year earlier. Surplus increase is roughly equivalent to profits. Treasurer Phil Vanderah said expenses were higher and investment income was lower this year. The company also announced that Robert Plunk, president and chief executive, was named chairman. He replaces Bernard Mercer, who will become chairman emeritus while remaining on the board of directors.

PEOPLE

Cross to head Ames office

Ottumwa banker and former Republican aide Russell Cross has been named to head Norwest Bank's new office in Ames. Norwest acquired the office from the failed United Federal Savings Bank and will operate it as a full-service bank. The Ames office on West Lincoln Way had about $6 million in deposits at the time of the sale. Cross, a 1977 graduate of Iowa State University, was an aide to former Gov. Robert Ray and state Auditor Richard Johnson. He has been with Norwest for 12 years and headed operations at Norwest's Ottumwa office since 1990.

Broker sentenced

A former Storm Lake investment broker who pleaded guilty to federal fraud charges was sentenced to 33 months in prison and ordered to make restitution of $300,000. Daniel W. Roepke, 41, formerly of Holstein, was charged in April with defrauding clients of A.G. Edwards and Sons of

Canadian brew.

In fact, Vinton has become the standard [illegible] called Hawkeye. "It [illegible] 1970s was another

NEW TECHNOLOGY

Microware announces joint deal

By DALE KASLER
REGISTER BUSINESS WRITER

Microware Systems Corp. on Monday announced a joint venture that could enhance the Clive computer software company's journey along the information superhighway.

Microware said it would team with San Francisco-based Macromedia to create technology that will enable software developers to bring CD-ROM programs to interactive television networks.

The deal may not be much of a money-maker for Microware, said spokesman Arthur Orduna. The importance of the deal is strategic; it will further the construction of the information highway, which means it will further the interests of Microware.

Microware has been hired by IBM, Philips and other companies racing to build the highway. Microware's software, dubbed DAVID, will operate the set-top converter boxes that one day will turn TVs into interactive entertainment and information centers.

But industry leaders are beginning to realize that building the network "will be meaningless" unless there's something worthwhile to watch, Orduna said. The deal with Macromedia may help.

The San Francisco company makes a special kind of software used to create CD-ROM programs. The joint venture will create a new software package that will enable CD-ROM developers to create games and encyclopedias for interactive TV, as well as easily convert existing CD-ROM titles to the new system.

TRADE WAR AVOIDED

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With "David' Software, Microware Aims to Become a Goliath
Eds: also moved in advance and for Monday AMs.
AP Photo NY332 of Sept. 29
By STEVEN P. ROSENFELD
AP Business Writer

CLIVE, Iowa (AP) -- Eight years ago, Kenneth Kaplan got an offer to sell his software company, Microware Systems Corp., to Microsoft Corp., which was already well on its way to dominating the personal computer software industry.

""It was pretty tempting,'' said Kaplan, the firm's president and a co-founder.

But one late night a short time later, a Microware executive ""slammed his hand on the table and said, "I don't want to work for the blankety-blanks. I want to destroy the blankety-blanks,' '' Kaplan said.

""That's been our policy ever since.''

Microsoft is still trying to break into Microware's business, making programs that run computerized functions of things that are not typically thought of as a computer -- like a TV, pay phone, traffic light or a car.

Their growing rivalry, despite its David vs. Goliath nature, is a sign of how computing is changing.

In time, many products will have chips and software running inside them, and most people won't notice or think of them as computers. Microware hopes to be a standard-setter in program design for those devices.

The company gained attention last winter when one of its programs, called David, was chosen as the software for set-top devices in the interactive TV services Bell Atlantic Corp. will start this winter in northern Virginia, New Jersey and Pennsylvania.

Such set-top boxes are the key appliances that let TVs receive the advanced home shopping or video-on-demand services that phone and cable companies envision.

Microware has also formed a similar agreement with Nynex. Kaplan said he hopes to announce arrangements with at least two more regional Bell phone companies by the end of the year.

The company suffered its first loss last month when Southwestern Bell Corp. chose Microsoft and Lockheed Corp. as its partners for a two-way TV trial in suburban Dallas late next year.

""I'm not terribly concerned about the Southwestern Bell trial,'' Kaplan said. ""We have so much momentum now. Microsoft doesn't have a product and won't for at least a year.''

The two companies have different approaches to the slowly-evolving interactive TV market.

Microsoft is developing a full-network program for use in both the switching centers and the homes and businesses at the end of a network. Microware's software is more flexible, with the set-top box being one of many uses for it.

One sign of Microware's lead is that David has been licensed by 22 consumer equipment manufacturers, including IBM, Philips Consumer Electronics, GoldStar and Samsung.

The program is a version of Microware's core OS-9

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The program is a version of Microware's core OS-9 operating system, developed in the early 1980s as a speedy way for a computer chip to manage simultaneous tasks.

More than 750 companies have put OS-9 in more than 4,000 products, ranging from the CERN particle accelerator (an atom smasher) to pay phones in France to the navigation system in German-made BMWs.

Such industrial applications account for about 70 percent of Microware's approximately $20 million in revenue.

Microware has been successful because of the flexibility of its programs to fit with many systems, said Lucie Fjeldstad, a former IBM senior executive and now a multimedia consultant in New Canaan, Conn.

""The problem putting together this [illegible]

""The problem putting together this jigsaw puzzle together is that nobody has a pattern,'' Mrs. Fjeldstad said. ""Because no one knows what technology will become the standard, it is important that each of the pieces be able to plug into the other pieces.''

Microsoft was attracted to Microware after OS-9 was chosen in 1986 by Philips as the base software in the CD-Interactive player, a machine that plays movies, music and games off compact discs.

""They are the 1,300-pound gorilla of the business and anybody that's got an interest in anything to do with computers has got to look over their shoulder at those guys, no matter what it is,'' Kaplan said.

In addition to the Southwestern Bell venture, Microsoft is in a partnership with Intel Corp. and General Instrument Corp. to make a set-top box. Tests are planned in 1995, said Naren Naph, manager of interactive programs for Microsoft.

""If we sat this one out for the next two to three years we would feel we had missed,'' Naph said. ""This is a marathon we are digging in for many, many years.''

Neither company expects to see much revenue from two-way TV for some time.

But it's by far Microware's biggest opportunity since Kaplan and friend Larry Crane started the firm in 1977 when they were students at nearby Drake University. Kaplan predicts annual revenue could grow to between $100 million and $200 million in 1999.

There are no plans to go public right now, Kaplan said.

Executives believe time ""is better spent working with customers and building long-term strategic relationships than doing road shows for investment managers,'' he said.

A private sale of stock to outside investors early this year provided ""a war chest of money sitting in the bank available so we could react quickly to opportunities,'' he said.

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B RICHARD PAXSON, Iowa New

★★★

January 31, 1988

IOWA BOY

High-tech high life

From now on, when the governor and our other leaders talk about the need to encourage more "high-tech" industry in Iowa, my eyes aren't going to glaze over nearly as fast.

That's because Friday night, I saw high-tech industry at work — or rather, at play. What I learned is that it's fun and hip and hard-charging.

There is this company, Microware Systems Corp., which has its headquarters in two buildings along the Interstate highway on the west edge of Des Moines, just up the road from the pork producers' buildings.

Frankly, before last week, I'd never heard of it, which places me with the majority in the capital city's business community. We're talking low profile.

But I started paying attention when I learned that Microware is a multimillion-dollar, privately held company that has 45 employees here, 25 more in a subsidiary located in suburban Tokyo and four more in a new West Coast office.

What do they do? From a company brochure: "Microware develops and markets system software for systems based on the Motorola family of 680x0 microprocessors."

Say what? I kept asking and finally got it down to some Iowa-ese, which came out about like this: "We sell the systems that make computers compute." Uh, you make computers go? "Simply put, yeah."

This comes from Dave Davis, the firm's advertising manager, who, at the age of 34, is the third oldest chap working there.

Some other things he told me:

- "It would not be unfair to say that this company is proof that a bunch of old hippies from Drake University can stumble into an idea and discover that they've really got something."
- "We work hard and play hard, including playing basketball on our

cluding playing basketball on our company's outdoor court during the noon hours any time the weather is decent. We don't have to change clothes, because almost everybody just wears blue jeans and flannel shirts to work. Our president, Ken Kaplan, who's only 34 years old, too, took a trip to Japan and the People's Republic of China over the holidays and bought one of those Mao suits, complete with cap. The day we went back to work after New Years', he wore it all in, looked around and declared the place 'a worker's paradise.' And that's true, it is."

● "We're observing our 11th anniversary in business right now. Last year, we observed the 10th anniversary by putting out some new stickers congratulating ourselves on a decade of business and pasting them all over everything. Then we started thinking, 'Wait a minute, we're a world-wide company that is out there kicking ... the marketplace, and we can do better than stickers to celebrate'."

So what Microware did, on Friday night, was to rent the venerable Val Air Ballroom in West Des Moines. Employees, spouses, customers and friends from all over everywhere were invited for dinner, an open bar and a celebration.

The entertainment was led by the renowned B.B. King, often called "the king of the blues," who came in between performances in Minneapolis and St. Louis. In case you don't know, he is a legendary rhythm-and-blues guitarist and vocalist, and with a six-piece band behind him, he proved the legend Friday night.

In a 90-minute set, King turned Microware's shindig into a sort of grand old Drake University fraternity party, except that it was multiplied to some unbelievably higher power.

"Great time tonight, must be a good company," the 62-year-old King said later in his dressing room. "You know, we play 300 concerts a year, but for the past 15 years, that's what they've been — concerts. It was nice to get back in a club atmosphere where we had everybody up dancing in front of us. That's how I started out, playing for dances. It was fun to do that again."

It should also be noted that King was preceded on stage by "Electric Cat," a local rock band that features one of Microware's own executives, and by an outrageously funny young comedian and juggler from Newton, Toby Kid. Kid pondered some of life's great questions, like, "If a cow laughs, does milk come out her nose?" Then there were his closing words of motivation, a quote from his grandfather: "Remember, Toby, if everyone wanted the same thing in life, everybody would be after your Grandma."

Are you coming to understand this was not your average corporate bash?

Microware is not your average corporation.

I felt like I was getting a peek at Iowa's future.

— Chuck Offenburger

A MOUSE AMONG ELEPHANTS:

IOWA HIGH-TECH GOES BIG TIME

A tiny, unorthodox Iowa company, whose managers include a former reggae musician and a former Peace Corps volunteer, is teaming with technology's giants to revolutionize consumer electronics.

BOB NANDELL/The Register

Dave Lyons, Tony Hoffman, Doug Nicholson and Todd Earles, from left in back, and Eric Miller, left front, and Rick Grewell make up the team that designed the CD-I, an audio electronic product that some say will revolutionize consumer electronics. Nicholson has left Microware Sytems since this picture was taken.

A little company's big challenge

By DALE KASLER
Register Business Writer

Todd Earles had been up all night wrestling with a batch of fragile computer circuits, readying the temperamental equipment for a demonstration.

Finally the pieces were in place. Earles had rigged a mock-up of a new kind of compact disc player — a CD player that would play pictures as well as sound and some day could earn his company, chip-size Microware Systems Corp. of Clive, millions of dollars.

Now it was show time.

Microware President Ken Kaplan escorted a group visitors into the demo room. As Earles watched, Ka- turned to his guests, proudly placed his hand on computer cabinet . . . and unwittingly short-cir- d the whole system.

rles was able to restart the computer quickly and ge the demonstration. But the snafu summed up

Discover how CD-I works: 1G

the bizarre life Microware has led the past four years.

Since 1986 the obscure computer software company has worked on a technological breakthrough that could revolutionize America's living rooms. Microware was hired by electronics giants N.V. Philips of the Netherlands and Sony Corp. of Japan, co-inventors of the compact disc player, to create software for a souped-up version of the player called CD-I, for "compact disc-interactive."

Scheduled to hit the stores next fall, these players will transform a television set into a computer that

MICROWARE

Please turn to Page 4A

Small Iowa computer firm teams w

MICROWARE

Continued from Page One

biends audio, video and audience participation.

One disc will feature an entire encyclopedia combining text with sound and pictures; the "Beethoven" entry, for instance, will include excerpts from his symphonies. A photography disc will let the user focus an imaginary camera, adjust the lighting and snap the picture; the computer will reveal whether the "photo" came out blurred, too dark or just right.

At just under $1,000 each, CD-I is billed as cheaper than most home computers but more powerful than a video game system like Nintendo. It also will play ordinary, music-only compact discs.

Commercial Uses

It will have commercial uses, too. The Principal Financial Group, the Des Moines insurance giant, owns an early CD-I machine that plays an employee-training video.

Philips, known for light bulbs and Magnavox products, says tens of millions of CD-I players may be sold. That would generate millions of dollars in royalty fees for Microware, enable the Clive firm to hire several hundred more employees and could even kick-start Iowa's modest high-tech industry.

But the real story of CD-I has been the numbing test of one small company's ingenuity. Technological hurdles and the crushing demands by Philips and Sony stretched Microware's young staff to the limit.

"Nobody physically died," said engineer Eric Miller, "but several people were carted off to the rubber room."

One employee "was driven over the brink," Miller said. "Late at night, you could hear him screaming down the halls."

First in a series.

Microware's partnership with Philips and Sony sometimes was just as stormy. Sony became angry at Microware's contract demands; some at Philips accused Microware of shoddy workmanship that pushed CD-I four years behind schedule. There were fears that Philips, after spending tens of millions of dollars on the project, would cancel it.

Microware has wound up navigating a treacherous river mined with outsize egos, corporate intrigue and multinational culture clash.

"Microware is a mouse playing on the field where all the elephants are dancing," said Laura Buddine, a compact disc maker in Los Angeles.

Founded in 1977, Microware has annual revenue of $10 million and employs 130 workers, half of whom work in California, England, France and Japan. In 1986, when it was tapped for greatness by Philips and Sony, it had 35 employees, all in Iowa, and was doing only $3.5 million in annual sales. "We were pretty much nobodies at that point," Kaplan said.

Microware is ruled by offbeat tekkies. Top managers include a former reggae musician and a former Peace Corps volunteer. Blue jeans and T-shirts outnumber suits and ties. The company parking lot has a basketball hoop with the Microware logo on the Plexiglas backboard. Visitors are warned not to park underneath.

But beyond the tie-dyed T-shirts lies a company embodied by the pudgy, 37-year-old Kaplan: smart, savvy and cocky. Despite being far removed from the nation's high-tech centers, Microware has hired top-flight people from Iowa State University, Minneapolis computer companies and the West Coast.

Microware's big calling card is a powerful piece of software called OS-9. It's an "operating system," a set of computer programs etched into the circuitry that acts as a sort of traffic cop for the computer and other components. It is found in factory automation systems, bank-teller machines and elsewhere.

Multiple Tasks

Unlike some operating systems, it can perform multiple tasks simultaneously — just what Sony and Philips needed to run a machine that would mix and match a confusing jumble of audio and video data.

In spring 1986 engineers from the three companies began mapping CD-I's inner workings. Rotating between Japan, the Netherlands and Iowa, they met nearly two years, producing a thick volume known for its cover as the Green Book.

They ran into problems from the start: Philips and Sony had grossly underestimated the complexity of the task, said Rick Grewell, one of Microware's Green Book representatives.

"They thought the software would come off the shelf, there wouldn't be much new software to write," Grewell said.

They were wrong.

On an ordinary, audio compact disc player, sound is stored in thousands of microscopic bumps on the disc's surface. A laser beam inside the CD player reads the bumps as a series of zeroes and ones — the standard digital computer language — and a processor converts the code into music.

But CD-I meant video as well as sound. And keeping them in sync would require new software.

That's because it took five times as much computer data to reproduce a second of video as it did for a second of sound, Microware engineer Miller said. In effect, the disc emitted sound five times faster than pictures.

So Microware had to develop an elaborate operating system — a kind of clock, if you will — to make it seem like the video and audio flowed off the disc simultaneously.

That wasn't all. CD-I would feature "interactivity," the power for a user to talk back to the machine with a remote control button. For instance, a child could stop a cartoon and repaint the colors.

Interactivity required scads of extra software to coordinate the audience participation and to pack all that added information — extra colors, dialogue in a foreign language — into a normal-size compact disc. Trade-offs had to be made among sound quality, picture quality and number of user options.

Another challenge was to make the machine simple to use. Though endowed with the power of an early ver-

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sion of the Apple Macintosh personal computer, CD-I was conceived as a consumer product for the living room. It was to have a remote controller, not a keyboard.

"Most people can't even program their VCR," Kaplan said. "The whole trick (to CD-I) was to . . . keep the rocket science in it internally, bury it and cover it with layers and layers of software that made it so easy to use."

But too many rocket scientists nearly spoiled the formula. Although Philips was the driving force, the three companies — Philips, Sony and Microware — spent months bickering over design specifications.

Deadline

The 1987 deadline for putting CD-I on the market came and went, with the product still on the drawing boards. Eventually the product would get pushed back to fall 1991.

Part of the problem was that Philips' timetable was unrealistic, Kaplan said. The Dutch, trying to beat rival multimedia products to the market, had publicly announced CD-I too soon, Kaplan said.

Another problem was a disagreement on the machine's function.

Sony, whose forte is audio electronics, just wanted to build "an upgraded music machine," said Mark Dillon, a former Philips executive. But Philips wanted a more sophisticated and more expensive audio-video player with computer powers, he said. It took eight months, but Philips won.

Microware was often caught in a tug of war. "We would get dragged one way or another," Miller said. "We were very careful never to align ourselves completely with one company or another."

Kaplan "has been kind of the Henry Kissinger of this," Dillon added.

Language Barriers

Language barriers cropped up.

"There was a large amount of miscommunication," said Cindy Murphy, a former Sony Corp. of America executive. "We spent one entire meeting talking about what we hadn't understood in the last meeting."

Often a fourth voice was heard, too: Japan's giant Matsushita Electric Industrial Co. was welcomed to the table as a "political" gesture, Kaplan said. Matsushita, which makes the Panasonic and Technics brands, was needed more for its marketing clout than its technological know-how.

Kaplan and other Microware people said Philips slowed the project by changing design requirements.

"Every day," Kaplan said, "they're coming up with a brilliant, 'Oh, we can do this! We've just got to add this

Continued on next page

Microware bridged confidence gap

Continued from preceding page

bit and this piece and we can do this kind of video! Look at this neat thing we can do with the audio!'"

Played Ball

Kaplan said Microware played ball within reason.

"There comes a point where you've got to say, 'Stop, it's good enough, let's not do any more features. Let's make the damned product. You may be Philips, you may be Sony, but we've got to eat.'"

The negotiations were a little scary for Microware's young brains.

"You're dealing with companies that have $60 billion in revenue and 6,000 employees in a single country," said Miller, 30, the former reggae musician. "I feel like a little mouse, saying the elephant is wrong."

In time, though, the elephants listened. "They came to respect us," said Grewell, 32, who was fresh out of the Peace Corps in Ecuador when he joined Microware. "We basically designed all the software, and they accepted that."

But the ex-leader of the Philips team, Richard Bruno, said Microware didn't enjoy much respect.

"There was a severe confidence gap . . . both within Philips and Sony about (Microware's) ability to deliver," said Bruno, now a consultant.

Bruno contended that late and sloppy work by Microware was a major reason CD-I fell behind schedule. He disputed Microware's contention that Philips kept adding design requirements; instead, the product was simplified so Microware could keep up.

Kaplan, in response, portrayed Bruno as brilliant but egotistical and difficult to work with. Kaplan and others at Microware hold Bruno largely responsible for Philips' penchant for changing specifications.

Different Project

Tim Harris, a former Microware engineer, blames both sides. Philips did keep messing up specifications, he said, but Microware slowed things down by shifting some of its top CD-I people to a completely different project in early 1988.

"When you've got 13 or 14 engineers, you can only spread them so thin," Harris said. "It's hard to take on a lot of big projects."

Kaplan defended the move, saying Microware had put more than half its engineering staff on CD-I but couldn't afford to "bet all our chips" on a project that was far from a sure thing: "We had to protect our core business."

And Microware executive Robert Sorensen said much of the grunt work was finished when the engineers were transferred to the new project.

Numbness Set In

Microware people spent long hours hunkered over computer screens, designing codes. Numbness set in; simple details would take forever, Earles said.

Microware began receiving from Europe and Japan shipments of prototype equipment — bulky sheets of computer circuits with spaghetti wires sticking out the back.

"You could knock a little jumper loose," Harris said, "and you could spend a week trying to get the machine back running again."

Frequently engineers wore wristbands linked to the computer by a telephone cord to prevent static electricity from short-circuiting everything, Harris said.

"You looked like you were chained to the computer," he said.

Kaplan often messed up demonstrations by short-circuiting a machine.

"It's the opposite of the Midas touch," he said. "I have a jinx with prototypes."

One time a top Philips engineer was flown in from the Netherlands to examine a faulty circuit board. The engineer picked it up, bent it between his hands, and it worked.

The hardware from Sony usually arrived with instructions in Japanese.

"They would provide some crude translations, but they were mostly insufficient," Miller recalled. "We would have to poke it and see what happened, hunt and peck."

The time difference made it tough to ask for help. The best time to call the Netherlands was 3 a.m. in Iowa.

"We like to say, 'The sun never sets on CD-I,'" Miller said.

Grewell and engineer Dave Lyons said they nearly quit several times over one task. Miller said Harris became a "CD-I casualty" whose voice could be heard shrieking through the corridors at night; Harris merely says the project burned him out.

Computer Boards

In time, Philips and Sony shipped advanced hardware. Unwieldy stacks of computer boards gave way to reli-

What's ahead in this series

MONDAY: How Microware, rather than an industry giant, won a potentially lucrative software project.

TUESDAY: Problems with its big corporate partners added to tiny Microware's anxieties.

able microchips. Refrigerator-size computer cabinets shrank to the size of regular CD players.

Microware built a studio to make test discs. But often the discs played nothing more than electronic gobbledygook. The Microware staff used them as coasters and Frisbees.

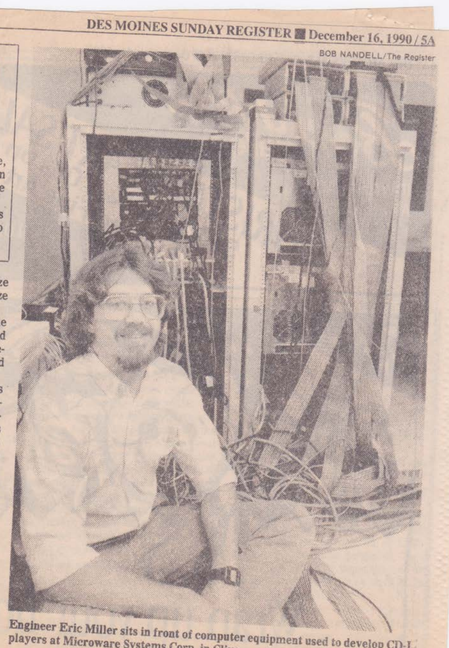
The first disc that worked was made in late 1987. The video consisted of snapshots of balloons, an airplane flying over Microware's offices and some slides of Ecuador that Grewell took in the Peace Corps. The audio consisted of some music taken from Grewell's CD collection at home. The disc was so primitive, it didn't include "interactivity," the capability for audience participation.

The disc is framed and mounted in Kaplan's office. But in 1987 it didn't seem historic.

"You had been so close to it for so long that when it finally did work, it wasn't like a big milestone," Lyons remembered.

"It was like, we can go home now," Grewell said.

BOB NANDELL/The Register



Engineer Eric Miller sits in front of computer equipment used to develop CD-I players at Microware Systems Corp. in Clive.

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Small artificial Christmas trees

A MOUSE AMONG ELEPHANTS:
IOWA HIGH-TECH GOES BIG TIME

Microware Systems of Iowa finds its high expectations buffeted by big-money global forces beyond its control.

When giants sneezed, Iowans shook

By DALE KASLER
Register Business Writer

Last in a series.

The corporate shake-up took place in the Netherlands, but the tremors were felt in Iowa.

In the summer and fall of 1988, Dutch manufacturing giant N.V. Philips reorganized its faltering consumer electronics division. Hundreds of jobs were cut, managers were shipped elsewhere. And Philips launched an internal review of its sagging efforts to build a new compact disc player called "compact disc-interactive," or CD-I.

The review frightened Microware Systems Corp., the small Clive company that Philips hired to create the software for CD-I players.

"It wasn't clear if CD-I would survive," said Ken Kaplan, Microware's president. "It was costing them a fortune, it was late, over budget, it seemed stalled."

Next Fall

Philips decided to proceed with the project; CD-I players, which will blend audio, video and audience participation, will go on sale next fall.

But the episode illustrated Microware's vulnerability to outside forces. On the largest and most demanding contract of its young life, the small Iowa company was often at the mercy of others.

Philips wavered on CD-I. So did Sony Corp. of Japan, the third partner in the project. People in the industry started pointing fingers. For a while everywhere Microware turned, the project was getting battered.

Like at the big national computer conference three years ago in Seattle, where microchip maker Intel Corp. showed off a multimedia computer called Digital Video Interactive. The system seemed jazzier than CD-I. It was endorsed with great fanfare by IBM Corp. and Microsoft Corp., the software maker that once tried to buy Microware after being snubbed by CD-I but now was turning into an arch-enemy of Microware's.

Digital Video took the conference by storm. "All

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Microware vulnerable to global forces

MICROWARE

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these computer wonks were going around saying, 'CD-I is dead,'" said Mark Dillon, a former Philips CD-I executive.

Kaplan was there, too. "It was disheartening," he said. "The morale of the people who were there probably was at its lowest point. The people in the CD-I community had to endure a lot of jeering."

In time, CD-I people learned not to worry about Digital Video, Kaplan said. But there continued to be hand-wringing over the four-year delay in bringing CD-I to market.

"It's basically been the little boy that cried wolf," said Laura Buddine of Tiger Media, a Los Angeles disc creator. "Every year, they told us, it'll be ready.

"Because of these delays, we know of 11 other systems that are coming onto the market in the next 15 months," Buddine added. "The window of opportunity (for CD-I) is possibly closed."

Four Years Late

Not true, Philips officials say. Yes, CD-I is four years late. Yes, there will be competition from other audio-video disc systems.

Yes, it's unclear whether CD-I will become the standard format for multimedia systems, the way VHS became the standard for videocassette recorders — or if CD-I will wither like Sony's woebegone Betamax. Makers of other systems are taking potshots at CD-I to prevent its worldwide acceptance.

But Philips notes that CD-I already has lined up the support of nine major electronics manufacturers who will build the product. That translates into mass-market clout other systems lack.

"I don't feel the window of opportunity has passed at all," said Jerry Calabrese, a vice president at Philips' U.S. subsidiary.

But in 1988 the window was nearly slammed shut by Philips itself.

Project Review

CD-I already had cost Philips tens of millions of dollars and was falling far behind schedule when top management removed David Geest, the man who hired Microware, as head of CD-I. In came Gaston Bastiaens, a cost-conscious executive who was ordered to review the whole project.

"We were definitely biting nails," Kaplan said.

In late fall 1988, Kaplan's sources at Philips told him the project would be saved. He breathed more easily.

"If they had pulled the plug on CD-I at a critical moment, they wouldn't have killed us, but it really would have hurt," Kaplan said. "We could have been working on something useful all that time. We had some of our best minds working on that.

"With a big corporation, you always have the risk at some very high level that somebody's going to cancel the whole thing," he said. "Big companies are good at throwing curve balls."

Chances of Success

Like this one: Just after giving CD-I the go-ahead, Philips dragged Microware into a venture to improve its chances of success.

Philips needed help creating software to design games and other programs for CD-I discs. This was crucial: Without discs, a CD-I player would be an empty box no one would buy. And for a long time, disc creators complained that Philips' software was inadequate.

"The most serious underestimation of the whole CD-I project was how complicated it was going to be to make the discs," said Kim Kempf, a Microware vice president.

But Microware turned down Philips' request to help make software for disc designers. There wasn't much money in it and it would divert talent from the main task of designing the players themselves, said Microware executive Robert Sorensen.

Couldn't Refuse

Philips persisted, making an offer Microware couldn't refuse: Without better software for disc creation, CD-I might be a flop, he said.

"Kaplan kind of found himself in a position of, 'Hey, I didn't sign up for this, but if I don't, everything else I signed up for is wasted,'" Dillon said.

Microware relented. It joined Philips as a partner in a company called OptImage to produce software for disc makers. OptImage is based in Clive and run by Sorensen.

But while Microware was getting itself in more deeply, the third partner in CD-I was playing hard to get.

Until early this year, four years into the project, Sony wouldn't commit to manufacturing CD-I players.

Preoccupied

Geest, former managing director at Philips, said Sony was preoccupied with developing an office computer system.

Kaplan said Sony's foot-dragging reflected a Japanese firm's traditional wait-and-see mentality. "Let the Western company develop the technology and kill themselves doing it, and then you jump in and you steal the market," Kaplan explained.

Sony spokesman Steve Burke denied Sony dragged its feet: "We were making significant contributions."

But he acknowledged Sony has a go-slow culture. "We began developing videotape recorders in 1958. We didn't launch a product to the market until Betamax in 1975," Burke said.

Abandoned Ship

Either way, Sony's reluctance threatened the project, Sorensen said. Disc designers and other manufacturers might have abandoned ship if Sony didn't get on board, he said.

"It takes Sony to bring credibility to this thing. If they don't believe in it, if they aren't going to release a product, it's got big problems."

Two events appeared to move Sony. Matsushita Industrial Electric Co., a Japanese firm that makes the Panasonic and Technics brands, was brought in to help with CD-I development, Sorensen said. That helped "nudge Sony along a bit, to see that their big competitor is beginning to get excited about this technology," he said.

A Sony management change in the past year helped, too. Control of CD-I passed from Toshio Doy, who wasn't interested in the project, to Nobuyki Idei, who was.

"In big companies, products need advocates," Kaplan said. "They finally got the right guy to run with it."

Millions in Royalties

Today Microware is fine-tuning the software and waiting for next fall's

y got the right guy to run with it."

Millions in Royalties

Today Microware is fine-tuning the software and waiting for next fall's product launch — and potentially millions of dollars in royalties. The company plans to plow money into disc design and production, along with new projects like a "smart telephone" using similar technology. Employment may grow into the hundreds from the current staff of 130, of whom 65 work in Clive.

That is, if CD-I sells.

"The real test is, will people be buying?" said Rockley Miller, editor of Videodisc Monitor magazine.

But even getting this far has been an achievement.

"There were dark days," Kaplan said. "It was not a sure thing that there would ever be a product."

A month ago, Kaplan was in Tokyo visiting a friend who works for Fujitsu, the Japanese computer giant.

The friend had told Kaplan for years that CD-I would never work. But last month, as they sat on mats in his living room, the friend raised a cup of sake to Kaplan and said, "I never would have believed it, but you guys did it."

Kaplan sipped his sake and thought to himself: "We must really be on the right track."

A MOUSE AMONG ELEPHANTS:
IOWA HIGH-TECH GOES BIG TIME

Plucked from obscurity to help develop a technological breakthrough, Microware Systems of Iowa finds itself in a world where science often takes a back seat to politics and intrigue.

Tiny firm overcame corporate politics

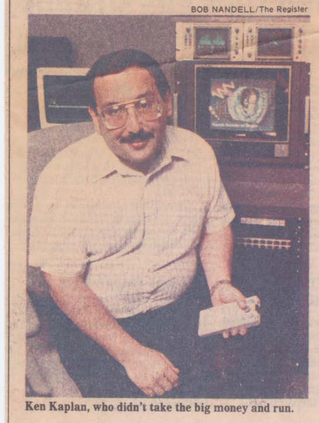
By DALE KASLER
Register Business Writer

Second in a series.

On March 13, 1986, the day he made $350 million, Bill Gates offered Ken Kaplan a piece of the action.

Gates was king of the computer software world, the 30-year-old boy-wonder chairman of Microsoft Corp. of Seattle. That morning Microsoft sold stock to the public for the first time in what Fortune magazine called "the deal that made Bill Gates $350 million."

BOB NANDELL/The Register



Ken Kaplan, who didn't take the big money and run.

Kaplan by comparison was a nobody, the schleppy-looking president of a tiny Clive, Ia., software company called Microware Systems Corp.

Yet Kaplan had something Gates dearly wanted: a lucrative contract to help create an audio-video compact disc player called compact disc-interactive, or CD-I.

So Gates tried to buy Kaplan's company. As the two men sat in Gates' office, Gates offered enough Microsoft stock to enrich Kaplan and his colleagues beyond their dreams.

"On the Beach"

"We would have done really, really well," Kaplan mused later. "I'd be sitting on the beach in San Diego somewhere."

Gates' offer was just another twist in the remarkable journey of a small Iowa company — a tumultuous ride from an obscure corner of the computer software industry to the world stage of big-time electronics.

Microware was hired by N.V. Philips of the Netherlands and Sony Corp. of Japan to create software for CD-I. Designed to hook up to a TV set, a CD-I player would play pictures as well as sound. It would give the viewer the ability to talk back to the set.

This probably was the most complicated assignment ever attempted by Microware's engineers. But science was only part of the story.

Corporate politics helped Microware get hired. Politics influenced the contract negotiations — in which

MICROWARE
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Tiny high-tech firm overcame corporate politics

MICROWARE

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Microware demanded so much money it nearly got fired — and the flirtation with Gates' company.

Microware had dealt with large corporations before, but this was ridiculous.

"We were virgins to a large extent," Kaplan said. "We had no idea it would end up being nearly as political as it became."

Kaplan wasn't a complete amateur. The Chicago native studied political science at Drake University in the early '70s. The would-be law student took a computer class and got hooked. After graduation he and two friends went into the software business.

Rundown Neighborhood

They operated out of a spare bedroom in a rundown Drake neighborhood, "living hand to mouth," Kaplan said.

In 1979 Microware got its first big contract. Motorola Inc. handed the boys $100,000 to develop software for a new microchip.

The job was a nightmare. Motorola kept changing its mind about design requirements, Kaplan said.

"We were so grateful to have gotten the business from them ... it didn't enter our consciousness to tell them 'No.' We were so in awe."

Cumbersome

But two positives emerged. First, Microware learned that big companies are slow and cumbersome. Second, as a sidelight to the job, Microware developed an "operating system," a series of programs that directs traffic for the computer.

"It was real lucky that it didn't get put into the contract. Motorola would have ended up owning it," Kaplan said.

Microware dubbed this system "OS-9" and began selling it.

Microware was still small — 36 employees, $3.5 million in annual sales — in July 1985, when Kaplan went to Chicago to meet a Philips executive named David Geest. Microware had worked with Philips on a small project before, but Geest (pronounced "haste") had something big in mind.

Kaplan sat at a conference table in the middle of a cavernous ballroom. On the other side sat Geest, a 300-pound bear of a man, flanked by two lieutenants.

"It Was Surreal"

"This was surreal," Kaplan said later. "Like a tribunal."

Geest began speaking in heavily accented English:

"We have a proposal for you. After you hear our proposal, you will have three choices.

"You can walk out of this room, and we will never talk again. Or you can tell us you want to study this matter further, then get back to us. Or you can agree to cooperate."

Then he outlined CD-I:

"We are going to create a new consumer electronics industry," he thundered. "This will open new worlds in entertainment, in education. We expect it to be a bigger seller than the compact disc, even the videocassette machine."

No Hesitation

Kaplan didn't hesitate. Yes, he said, Microware wanted in.

Microware's OS-9 system was chosen over 60 competitors — but not on technical merit alone.

Richard Bruno, an engineer who led Philips' CD-I team, said Philips leaned toward Seattle's Microsoft.

But politics intervened.

Gates' company made operating systems for IBM personal computers. Philips feared IBM dominated Microsoft and would dominate CD-I.

"Very Dangerous"

"Can you imagine a computer giant controlling the consumer electronics industry? Dangerous, very dangerous strategically," said Bruno, now a private consultant in Chicago.

Microware heard about — and exploited — Philips' fears.

"Had they gone with Microsoft ... they would have surrendered control," Kaplan said. "We're not shy about saying that."

Microware wasn't shy about playing hardball, either. After getting hired, the firm showed up at the bargaining table and demanded a whopping 50 percent of the royalties from sales of CD-I players.

A royalty is the fee paid to the co-inventors — Philips, Sony and Microware — by any manufacturer building a CD-I player. Nine manufacturers have said they'll make players. Scheduled to hit the stores next fall at just under $1,000, the product could generate millions of dollars in royalties.

And Microware wanted half.

Split the Royalty

"The technology ... was half hardware and half software," Kaplan reasoned. "We were contributing all the software, Philips and Sony were contributing the hardware. They should split the hardware royalty and we should get the software royalty. Very simple."

The Dutch and Japanese didn't see it that way, particularly Sony.

"These Sony guys were really something else," Kaplan said. "I'd never seen a Japanese get up and scream and holler at a meeting, before or since. Some of these Sony guys did that."

Sony wanted to dump Microware and hire Microsoft, said Bruno. But Philips, still wary of the IBM link, wouldn't change horses.

"If it weren't for the insistence of Philips at that point, Sony probably would have switched over to Microsoft," Bruno said.

Sony declined to comment.

Kaplan worried about pushing too hard. But the Motorola job taught him to be patient with big companies. And Microware, through a joint venture with a Tokyo distributor, had learned the ways of Japan.

"Our Japanese colleagues helped us with the negotiations," Kaplan said. "They were good teachers for us in understanding the Japanese point of view."

The deal was finally done at a meeting in Tokyo in either February or March 1986; Microware officials aren't sure when. Microware got what it wanted: 50 percent of the royalties, plus millions of dollars up front to meet development costs. Everyone shook hands and made up.

"We all went out and had a big party, ate a bunch of sushi and drank a bunch of Kirin beer," Kaplan said.

Buyout Offer

Microware had one more distraction: the buyout offer from Microsoft.

Microsoft was angry at Philips for choosing a different software company — and unveiling the CD-I project at a high-profile conference sponsored by Microsoft. More important, Microsoft's Gates feared that CD-I would be the "Trojan Horse" that would finally bring computers into the home in huge numbers — something he was trying to do.

By purchasing Microware, Gates could force CD-I to use his company's technology, Kaplan said.

Microsoft had no comment.

In time, Microware's relationship with Microsoft would turn into a feud. Kaplan pasted a picture of Gates to the bull's-eye of his office dart board.

But in early 1986, Kaplan's company was thinking seriously of selling.

Half the Stock

Kaplan owned half the stock in Microware; a handful of top lieutenants owned the rest. Although he could have forced the issue himself, internal politics came into play. Kaplan wanted a consensus. One night in early April they met until 2 a.m. to decide on how to respond.

"There were basically two camps," Kaplan recalled. "One camp wanted to take the money and run. I for one didn't really want to sell out. We were kind of deadlocked."

A vice president named Kim Kempf broke the stalemate. Selling the company would mean working for a large corporation with less freedom and creativity, he said.

"I don't want to work for the sons of bitches," Kempf yelled, banging his hand on the conference table. "I want to destroy the sons of bitches!"

Microware turned down the offer.

TUESDAY: Problems with its big corporate partners added to tiny Microware's anxieties.

them 'No.' We were so in awe."

Cumbersome

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Microware dubbed this system "OS-9" and began selling it.

Microware was still small — 36 employees, $3.5 million in annual sales — in July 1985, when Kaplan went to Chicago to meet a Philips executive named David Geest. Microware had worked with Philips on a small project before, but Geest (pronounced "haste") had something big in mind.

Kaplan sat at a conference table in the middle of a cavernous ballroom. On the other side sat Geest, a 300-pound bear of a man, flanked by two lieutenants.

"It Was Surreal"

"This was surreal," Kaplan said later. "Like a tribunal."

Geest began speaking in heavily accented English:

"We have a proposal for you. After you hear our proposal, you will have three choices.

"You can walk out of this room, and we will never talk again. Or you about saying that."

Microware wasn't shy about playing hardball, either. After getting hired, the firm showed up at the bargaining table and demanded a whopping 50 percent of the royalties from sales of CD-I players.

A royalty is the fee paid to the co-inventors — Philips, Sony and Microware — by any manufacturer building a CD-I player. Nine manufacturers have said they'll make players. Scheduled to hit the stores next fall at just under $1,000, the product could generate millions of dollars in royalties.

And Microware wanted half.

Split the Royalty

"The technology ... was half hardware and half software," Kaplan reasoned. "We were contributing all the software, Philips and Sony were contributing the hardware. They should split the hardware royalty and we should get the software royalty. Very simple."

The Dutch and Japanese didn't see it that way, particularly Sony.

"These Sony guys were really something else," Kaplan said. "I'd never seen a Japanese get up and scream and holler at a meeting, before or since. Some of these Sony guys did that."

Sony wanted to dump Microware and hire Microsoft, said Bruno. But Philips, still wary of the IBM link, wouldn't change horses.

"If it weren't for the insistence of the home in huge numbers — something he was trying to do.

By purchasing Microware, Gates could force CD-I to use his company's technology, Kaplan said.

Microsoft had no comment.

In time, Microware's relationship with Microsoft would turn into a feud. Kaplan pasted a picture of Gates to the bull's-eye of his office dart board.

But in early 1986, Kaplan's company was thinking seriously of selling.

Half the Stock

Kaplan owned half the stock in Microware; a handful of top lieutenants owned the rest. Although he could have forced the issue himself, internal politics came into play. Kaplan wanted a consensus. One night in early April they met until 2 a.m. to decide on how to respond.

"There were basically two camps," Kaplan recalled. "One camp wanted to take the money and run. I for one didn't really want to sell out. We were kind of deadlocked."

A vice president named Kim Kempf broke the stalemate. Selling the company would mean working for a large corporation with less freedom and creativity, he said.

"I don't want to work for the sons of bitches," Kempf yelled, banging his hand on the conference table. "I want to destroy the sons of bitches!"

Microware turned down the offer.

TUESDAY: Problems with its big corporate partners added to tiny Microware's anxieties.

on the television set, pop a disc into the player and enter the world of ct disc-interactive," or CD-I. Shown here is "Cartoon Jukebox," a chil- isc featuring short cartoons. By pointing at the TV screen with a re- ntroller, the child selects . . .

2. . . . "Home on the Range," featuring a cowboy strumming his guitar and warbling the familiar ditty. But CD-I discs aren't merely watched and listened to. Here, by pointing the remote controller at the "color pallet" at the bottom of the screen, the child stops the cartoon and . . .

gins repainting. The remote controller picks a color from the choices at of the screen and "brushes" the cowboy, horse and guitar. When the s satisfied with the new color scheme, he or she points the remote at TV at the bottom of the screen. CD-I puts away the paint brush . . .

4. . . . and returns to "Home on the Range." The cartoon begins again. The cow- boy is strumming and singing the same tune, but something is different. His trusty horse has turned blue and his guitar has become green — just the way the viewer repainted them.

1. Turn on the television set, pop a disc into the player and enter the world of "compact disc-interactive," or CD-I. Shown here is "Cartoon Jukebox," a children's disc featuring short cartoons. By pointing at the TV screen with a remote controller, the child selects . . .

2. . . . "Home on the Range," featuring a cowboy strumming his gui warbling the familiar ditty. But CD-I discs aren't merely watched and l to. Here, by pointing the remote controller at the "color pallet" at the of the screen, the child stops the cartoon and . . .

3. . . . begins repainting. The remote controller picks a color from the choices at the top of the screen and "brushes" the cowboy, horse and guitar. When the viewer is satisfied with the new color scheme, he or she points the remote at ' the little TV at the bottom of the screen. CD-I puts away the paint brush . . .

4. . . . and returns to "Home on the Range." The cartoon begins again. Th boy is strumming and singing the same tune, but something is differe trusty horse has turned blue and his guitar has become green — just t the viewer repainted them.

Viewer participation in CDs' future

By DALE KASLER
Register Business Writer

A cartoon cowboy is strumming a guitar and singing "Home on the Range" when, quicker than he can warble "where the deer and the antelope play," the scenery starts changing color.

His horse turns blue. His guitar goes green. The deer and the antelope roam in red.

Welcome to the future, pardner. Welcome to CD-I.

CD-I, or compact disc-interactive, is a compact disc player that mixes audio and video with audience participation. Hooked up to a television set, CD-I enables viewers to repaint a cartoon, skim through an encyclopedia, play a video game, tour a museum and so on.

A MOUSE AMONG ELEPHANTS:
IOWA HIGH-TECH GOES BIG TIME

Not Kid Stuff

CD-I is aimed at the consumer electronics market, designed to be used with a simple remote control device.

This isn't kid stuff. This is also a powerful computer, "the Trojan horse that will bring computers into the home," said Dave Davis, advertising manager of Microware Systems Corp. of Clive, which helped create CD-I.

Sony Corp. of Japan and N.V. Philips of the Netherlands invented CD-I, and Microware developed the software that makes it tick. The players are scheduled to go on sale next fall for less than $1,000; the discs will cost $20 to $50, said Emil Petrone, a Philips executive in Los Angeles.

For instance, "Home on the Range" is part of "Cartoon Jukebox," a Philips-created disc that features a series of animated shorts. "The Saints Go Marching In" stars a band of cartoon instruments under the viewer's direction. On command, one of the instruments can leap in front of the band and play a solo. The "Old MacDonald" cartoon can switch from English to Spanish to French.

For grown-ups, "Treasures of the Smithsonian" provides a self-guided tour of the Washington, D.C., museums. At the Air and Space Museum,

MICROWARE
Please turn to Page 2G

Audience participation a big part of CDs' future

MICROWARE

Continued from Page One

for instance, viewers can see a cutaway view of the X-1, hear an explanation about the supersonic jet and listen to the roar as it "breaks" the sound barrier.

There are video games, too, such as "Palm Springs Golf," which features cheering and groaning from the gallery as well as play-by-play from ABC Sports' Jim McKay.

Sports Disc Possible

CD-I won't be just for the living room. Tower Records, a national record store chain, is considering purchasing CD-I players for their stores, said Microware engineer Eric Miller. Microware would furnish custom-made discs enabling shoppers to watch videos of different songs they choose by touching the screen.

Miller said the possibilities are endless. Among the programs under discussion are a sports disc that would enable the user to choose different views of a football game — from the sidelines, from the wide receiver, from the quarterback. A medical program would take the viewer inside an operating room, and allow the user to choose which doctor to explain the procedure — the surgeon, the anesthesiologist and so on.

A disc firm in Tallahassee, Fla., has helped set up a course in CD-I design at Florida State University.

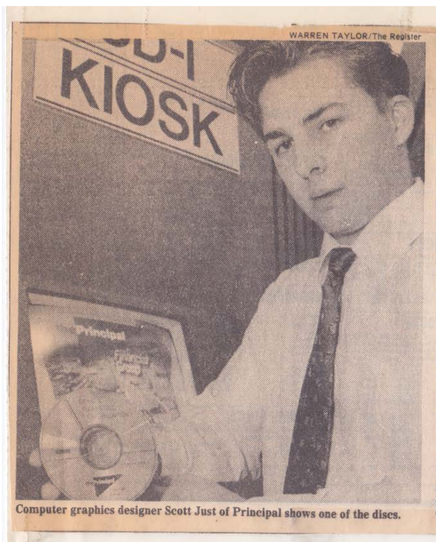
"Not Video"

"CD-I is not video, it's not a computer, it's not a music box," said Mick Everall, executive vice president of Interlight Productions Inc. of Tallahassee. "It's a little bit of everything."

Yet technological constraints still force disc designers to make trade-offs between video quality, sound quality and the amount of interactivity, or viewer choices. Many early programs will use still pictures, not full-motion video.

"We're in the Pong stage of CD-I design," said Mark Dillon, a former Philips executive. "The first video game, remember? The little black and white ball bouncing back and forth.

"We'll get better and better at it."



Computer graphics designer Scott Just of Principal shows one of the discs.

Principal first to use Microware's disc system

By DALE KASLER
Register Business Writer

A Des Moines insurance company Monday became the first U.S. corporation to install a powerful new compact disc player, developed by an Iowa high-tech firm, that plays videos.

Principal Financial Group unveiled an employee-training video, complete with sound and pictures, on what looks like an ordinary compact disc. The disc was played on a souped-up CD player called Compact Disc-Interactive.

CD-I was developed by Microware Systems Corp. of Clive in a joint venture with electronics giants N.V. Philips of the Netherlands and Sony Corp. of Japan. The electronics firms developed the computerized CD player, while Microware created the disc.

Principal's video "is the first commercial application in the United States" of the new technology, said Eric Miller, manager of new media systems at Microware. "They are the only corporation that has installed a CD-I system."

A handful of CD-I players have been introduced in France and Japan, he said.

The "interactive" technology gives CD-I much of the capabilities of a computer, Miller said. By pressing the television screen, users can pick which portion of the program they want to watch, have a portion repeated, answer questions posed by the videos and even request closed-caption narration, he said.

The advantage over existing computer interactive video is cost. Principal bought the CD-I player for about $3,000, said Michael Walsh, director of the mature market center at Principal. The same technology on a computer would have cost $20,000, he said.

Within a year, Microware hopes the cost will be reduced to $700 per unit, Miller said. And Microware and its partners hope to introduce a model

VIDEO

Please turn to Page 8S

Principal first to use new disc

VIDEO

Continued from Page 5S

for the home market in a few years at $400 or less, he said.

To create a disc, it costs Microware about $1,000 per minute of programming, Miller said. But duplicates of a disc cost only $5 each.

The CD-I player also will play standard music discs, Miller added.

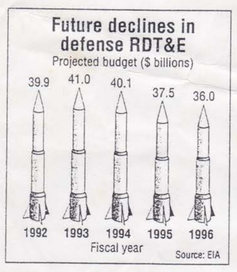
Principal plans to buy at least 85 machines over the next two years, Walsh said. They would be installed in field offices and other remote sites for employee and agent training as well as consumer promotion, Walsh said.

The first Principal machine was put on display for employees at the insurer's Principal Tower on Pleasant Street.

Walsh said a Principal "technology team" began studying CD-I two years ago. The insurance giant invested about $40,000 in the development of the technology.

"There's always a concern about being a pioneer, with all the arrows in your back," he said. "But for 40 grand, why not?"

ELECTRONIC BUSINESS 5/6/91



new electronics and weapons systems for the military, ranging from the smallest radiation-proof semiconductor to the B-2 Stealth bomber.

For fiscal 1992 the DOD is seeking from Congress $39.9 billion for RDT&E, an increase of 11.3% when adjusted for inflation. Increased spending for the Strategic Defense Initiative ("Star Wars") and the Advanced Tactical Fighter program account for much of the increase.

But RDT&E is expected to be only $41 billion in fiscal 1993—a real increase of only 0.9%—and is expected to shrink each year after that. Coming so soon after the Persian Gulf war, where high-tech weaponry proved so successful, the EIA predictions are setting off alarms.

At a recent Washington seminar, Geoffrey K. Bentley, business research manager for Textron Defense Systems, warned that the number of companies participating in military R&D is shrinking and threatens to erode the nation's technological edge.

Among the proposed remedies: Allow defense contractors to make a profit on R&D efforts. Now when defense companies sink huge sums of money into R&D, they are gambling that they will win big procurement orders from the Pentagon. Making money on the research itself—and thus reducing the gamble—will encourage more research, said C. M. Herzfeld, director of research and engineering at the DOD. "Industry can no longer subsidize R&D on projects that may never get built," he said.

But Herzfeld, who in essence is the Pentagon's chief technology officer, also issued a challenge to defense contractors. "I think RDT&E is here to stay," he said. "That's the good news. But it will change. What you want to do is look for the opportunities instead of crying about shrinking budgets."

RICK WHITING

SOFTWARE

A real market emerges for real-time systems

A MARKET for hardware-independent real-time operating systems (which permit computers to respond instantaneously to user commands) is blossoming for a handful of companies whose sales could skyrocket if their expectations materialize.

Makers of single-board computers and products with embedded microprocessors appear to be turning away from hardware-dependent and in-house real-time code to buy from companies such as Wind River Systems Inc., Ready Systems Corp., and Microware Systems Corp., which develop commercial real-time software.

"It's a $750 million market that could go to $1 billion next year," says Mitch Bishop, Wind River's director of marketing. "The reality is that real-time is arriving in the real world as an emerging marketplace."

Bishop says his Alameda, Calif.-based company's growth will double from $8 million in annual revenue for fiscal 1991 (ended Feb. 1) to $16 million next year. "There are a number of factors affecting that growth," he says. Traditionally, companies have built their own hardware and real-time operating systems but now want to get away from the hassles of redoing code every time new hardware is added. "They want shrink-wrapped software that will work on Intel, Motorola, or Sparc chips, not just a single architecture," he explains.


Wind River's Bishop: The real-time software systems market could reach $1 billion

Privately held Ready Systems in Sunnyvale, Calif., is the largest independent company in the market, with Microware of Des Moines a close second, and Wind River third. Dataquest analyst Doug Crook says that while it's difficult to determine the actual size of the real-time market, it's at least a $500 million market on the software side. "Last year we determined $1.3 billion went into real-time hardware, and operating systems are a component of that," he says. "It's a good strong niche market that an $8 million company can make money in."

DAVE WEBB

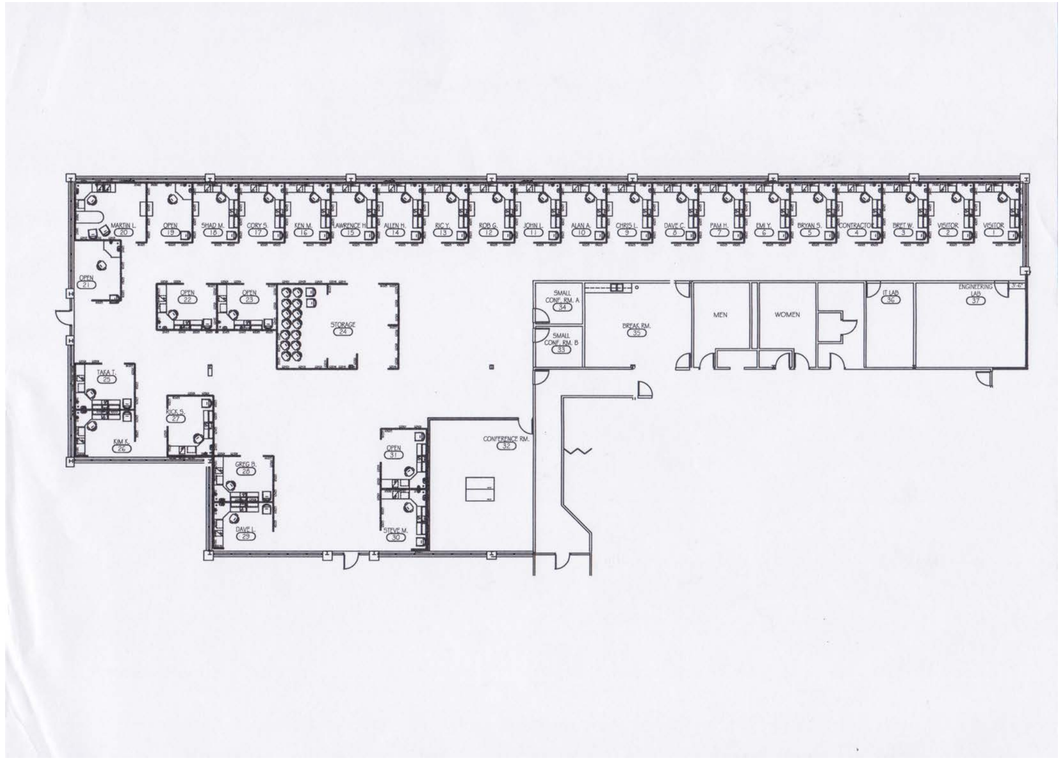
MULTIMEDIA

Multimedia: standards, but few products

MULTIMEDIA computers, whose bags of tricks include sound, animation, still images, and, in some cases, full-motion video, have yet to make much of a dent in the marketplace. But their potential impact could be huge, and vendors have been jockeying for years to ensure that they are positioned to exploit the market.

That activity has heated up in recent months. In March Microsoft Corp. of Redmond, Wash., announced that 11 hardware manufacturers had signed on in support of the software company's Multimedia PC (MPC) specification. Computers bearing the MPC mark would contain a 286 or a 386/486 microprocessor, 2 megabytes or more of random access memory, a 30-MB or larger hard disk, a 4-bit or 8-bit VGA video display, a digital audio subsystem, and a CD-ROM drive. They also would be compatible with Microsoft's Windows 3.0.

The MPC standard was seen in some quarters as a power grab by Microsoft, and one that was being coun-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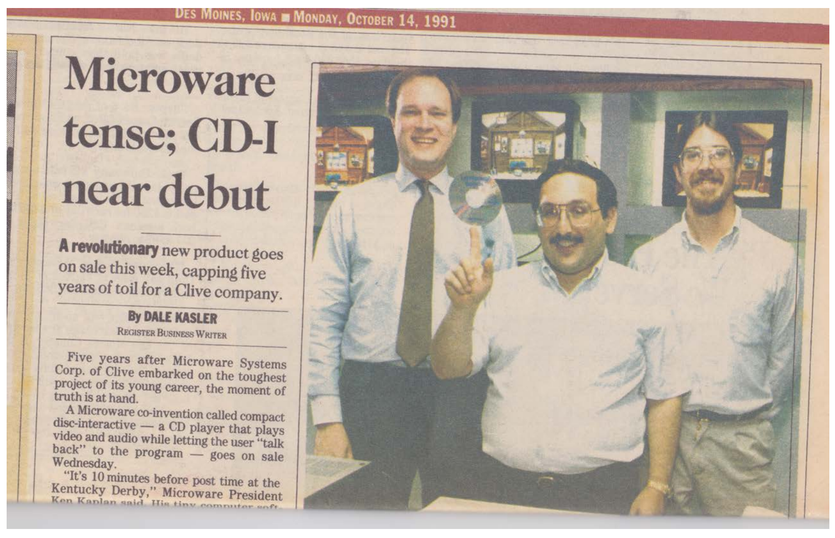
Anderson, Alan	2454	Engineer	
Barton, Greg	2430	Engineer	
Crowe, David	2433	Engineer	
Erickson, Brian	2317	Facilities	Cell: 202-5035
Engineering Lab	2399	2nd floor	
Green, Randy	2437	Engineer	
Heckmann, Pam	2473	Contractor	
Hemphill, Lawrence	2468	Products line manager (os-9)	Cell: 707-6993
Hewitt, Lori	2265	Facilities	
Huffman, Allen	2438	Engineer	
Kempf, Kim	2417	Engineer	Cell: 988-6946
Lengeling, John	2476	Engineer	Cell: 229-6100
Long, Martin	2350	Dept Head, Engineering	
Lyons, Dave	2380	Engineer	
MacCleod, Ken	2368	Engineer	
McClellan, Steve	2374	Engineer	
Nevinski, Mike	2381	Engineer	
Schmitz, Cory	2428	Engineer	
Stoen, Rick	2448	Engineer	
Takaya, Taka	2440	Engineer	
Wilkening, Bret	2496	IT	Cell: 707-7130
Yanagi, Emi	2415	Engineer	
Yeates, Ric	2366	Engineer	
Babbage Room		Conf room 2nd floor	
Cray	2280	Conf room 2nd floor	
Iminsky Training		East side 1st floor Conf room	
Von Neumann	2270	East side 2nd floor Conf room	
Voice mail local		327-2499	
Voice mail 800		800-475-9000	
Board Room		2nd floor main Conf room	
Fax Main line		224-1352	
Brad Hickok **Iowa Reality**		**453-5446: Main Line** **681-2269: Mobile**	Maintenance
Fax 2nd floor		327-5526	



DES MOINES, IOWA ■ MONDAY, OCTOBER 14, 1991

Microware tense; CD-I near debut

A revolutionary new product goes on sale this week, capping five years of toil for a Clive company.

By DALE KASLER
REGISTER BUSINESS WRITER

Five years after Microware Systems Corp. of Clive embarked on the toughest project of its young career, the moment of truth is at hand.

A Microware co-invention called compact disc-interactive — a CD player that plays video and audio while letting the user "talk back" to the program — goes on sale Wednesday.

"It's 10 minutes before post time at the Kentucky Derby," Microware President Ken Kaplan said. His tiny computer soft-

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A Microware co-invention called compact disc-interactive — a CD player that plays video and audio while letting the user "talk back" to the program — goes on sale Wednesday.

"It's 10 minutes before post time at the Kentucky Derby," Microware President Ken Kaplan said. His tiny computer software firm could earn millions of dollars in royalties if CD-I is a big seller.

That's a big if. Expected to retail for about $800 each, CD-I will have to prove itself against home computers, Nintendo game systems and other products with similar characteristics.

Fickle Market

"The consumer market can be pretty fickle and unpredictable," warned Rockley Miller, editor of a technology newsletter called Multimedia & Videodisc Monitor. "At the same time, (CD-I) has the right ingredients for success."

The product will be launched by Microware's partner, N.V. Phillips, the giant Dutch electronics manufacturer, with a press conference in New York. CD-I will be immediately available in 10 major U.S. markets but may not reach smaller cities such as Des Moines until next spring.

Manufactured at a Phillips plant in Belgium, the product will bear Phillips' name alone; Microware is essentially a silent partner whose work is buried deep inside the machinery. Most Microware employees who worked on CD-I completed their tasks two years ago and have moved on to other projects.

Looms Large

Still, CD-I looms large at Microware.

One of its engineers is helping a Korean electronics manufacturer develop a line of CD-I players. A production studio is creating CD-I discs for outside clients, such as magazine publishers. A Microware subsidiary makes special software others can use to make discs. Another subsidiary, whose formation was announced last week, will use CD-I players in shopping-mall kiosks where consumers can order products from catalog merchants.

Even workers who are not involved are buzzing about CD-I.

"Everybody at Microware follows the CD-I world very closely, both as a personal and professional matter," Kaplan said.

Breakthrough

CD-I is touted as a breakthrough in home entertainment. The machine looks like a traditional audio CD player and the discs look like typical CDs. But CD-I is hooked up to a television set. The discs, which will cost $20 to $60 each, will play pictures and sound. The machine incorporates computer power to let the viewer "interact" with the program via a remote control clicker.

For example, a disc of children's cartoons is programmed so the child can stop the show in midstream, re-color the cartoon figures, listen to the songs in French and tinker with the musical instrumentation.

Microware's job was to develop an operating system — a sophisticated package of computer software burned into the circuitry — that would enable CD-I players to mix sound, video and the interactive qualities.

BOB NANDELL/THE REGISTER

Microware officials show off the long-awaited production model of the CD-I machine they helped create. From left are Bob Sorenson, Ken Kaplan and Eric Miller. Microware designed complex software for the compact disc machines.

Hired in 1986

The Clive company was hired in 1986 by Phillips and Japan's Sony Corp., the co-inventors of the CD-I concept (Sony will introduce its line of CD-I players next year).

Back then, Microware was a 9-year-old company with about three dozen employees, $3.5 million in annual sales and a small cult following in the software business.

Even today, Microware, with more than 100 employees and more than $10 million in annual sales, isn't a household name, but its visibility was raised somewhat by CD-I. Sometimes that was a mixed blessing.

The Iowa company — an informal outfit populated by techies in T-shirts — was thrust into international corporate politics, often acting as middleman between Phillips and Sony. Microware was nearly fired before work began when Sony became an-

MICROWARE *Please turn to Page* **4B**

TECHNOLOGY

Clive company watching closely as CD-I nears debut

MICROWARE

Continued from Page 1B

gered at the small company's tough contract demands. Microware was blamed by some at Phillips for delays in engineering that postponed the consumer launch of CD-I by about four years. At one point Phillips nearly scrubbed the product.

Tough Hurdles

The technological hurdles seemed almost insurmountable. Phillips and Sony figured Microware could just take existing software off the shelf and plug it into the players. Microware's software was exceptional at performing multiple tasks simultaneously — just what was needed for a machine that would have to juggle audio and video data.

Yet it took Microware's engineers about two years just to lay the blueprints. Then months were spent wrestling with prototype players shipped from Phillips and Sony. The primitive machinery, infested with spaghetti wires and fragile circuitry, often failed for no apparent reason.

Today, much of that work seems like ancient history, Kaplan said. In some ways, Wednesday's launch "is almost anticlimactic," he said. "Our core work has been in the can for a couple of years, and we've been waiting ever since."

> **"The reaction of the consumer is likely to be, 'Gee, that's interesting, but what can I do with it?'"**
>
> — Robert Gerson
> *newsletter editor*

For that matter, it could be a couple of more years before it's known if CD-I will catch on with the public.

Marketing Important

Electronics experts said CD-I's success will depend less on Microware's technological know-how than on Phillips' marketing prowess. It's a given that the machines will work well; it's less sure if Phillips can convince people that CD-I offers something they want, said Robert Gerson, editor of an electronics newsletter called Twice.

"The reaction of the consumer is likely to be, 'Gee, that's interesting, but what can I do with it?' That's where the marketing job comes in," Gerson said.

CD-I initially will be sold at mass-market retailers such as Sears, Montgomery Ward, Dillard's and Radio Shack. The launch will be supported by live demonstrations at some shopping malls, "kind of like the old microwave oven days," said Gerald Calabrese, a vice president at Phillips' U.S. subsidiary.

Discs will be sold in racks next to the players for the first year or two, Calabrese said. Only after customers are familiarized with the concept will discs go on sale at record stores.

Exciting Discs

A crop of exciting discs is the ultimate guarantor of success, experts said, and CD-I is getting off on the right foot. A Phillips subsidiary has created discs with high-visibility elements, including a Sesame Street program for kids, a "tour" of the Smithsonian for adults and so on.

Still, CD-I must distinguish itself from game systems like Nintendo and new generations of home computers that feature audio and video, Gerson said. Computer-maker Commodore International already is on the market with a product similar to CD-I called CDTV, although it has yet to make much of a dent.

"We've got a lot of stuff coming out in this genre, this whole concept of putting something on the screen, video-interactive," Gerson said. "There's word of Apple (Computer Inc.) working on a product."

Back in Iowa, Microware continues to bet on CD-I.

Profit Center

The firm built a production studio five years ago to create prototype discs used to test the players. Now the studio is becoming a profit center to create programs for outside clients. Microware soon will announce contracts with several firms, including magazine and book publishers, Kaplan said.

Meanwhile, Microware engineer Eric Miller is helping South Korean electronics manufacturer Gold Star develop a line of CD-I players. "They're real good with hardware; they're not so good with software," said Miller, who has traveled to Korea several times to work on the project.

Separately, Microware announced last week that it is forming a subsidiary called MicroMall Inc. to bring catalog shopping to new markets through CD-I. MicroMall President Charles Spong, a former Younkers Inc. official, said kiosks composed of CD-I players and TV screens will be placed in shopping malls, hotel lobbies and office buildings. The screens will beam images and descriptions of merchandise from catalogs such as Spiegel. Consumers can put their credit cards into a slot and have their orders transmitted electronically to the catalog house.

Another Spinoff

In a wing of Microware's offices, another CD-I spinoff called OptImage is bursting at the seams.

OptImage, a joint venture with Phillips, doesn't create discs; it creates a line of software that outside customers can purchase to create discs. Out of that specialized niche has sprouted a 3-year-old business that employs 30 workers and had to lease space in a West Des Moines office park to handle overflow work. Customers include Berlitz International Inc., which needs the software tools to make language-instruction CD-I discs, OptImage President Robert Sorenson said.

Sorenson was at Phillips headquarters in the Netherlands two weeks ago when he heard the good news: The first batch of CD-I players had just left the airport, bound for the United States.

A few days later, Sorenson thought back to the five years of heartache and hard work, the days and nights when it seemed like CD-I would never work. He thought about the planeload of players arriving in the United States. He made a joke: "They're probably stuck in Customs right now."

The Des Moines Register

BUSINESS

WEDNESDAY, JANUARY 19, 1994 ■ 10S

◆ GRAIN PRICES FALL

News of a bigger Australian wheat crop sent wheat futures lower, pulling corn and soybeans along.

Inside on Page 9S

Microware secures major accounts

Iowa software firm gains a key role in future of interactive TV

By DALE KASLER
REGISTER BUSINESS WRITER

Microware Systems Corp., a small computer-software company in Iowa, announced Tuesday it has obtained major contracts to supply technology to IBM Corp., Philips Consumer Electronics and other architects of the "information superhighway."

Microware's OS-9 operating system will be used in set-top converter boxes that will turn TV sets into interactive, multimedia entertainment centers. It will supply software to manufacturers around the world, from Silicon Valley to South Korea.

The contracts will be worth millions of dollars — and about 200 jobs — to Microware, whose annual revenue is about $15 million. The company's worldwide employment could double, to about 400 workers, in three or four years. Company President Kenneth Kaplan said employment at Microware's Clive headquarters is likely to jump to 150 to 200 workers, from the current 100 workers, in three or four years.

Development is complete and the software is being shipped already, Kaplan said.

Microware has been working informally with many of these companies for more than a year, and its emergence in the multimedia industry is starting to get noticed nationwide. Recently it was chosen for a high-profile research and development project on the information superhighway, and on Tuesday the little company was the subject of a flattering and prominent story in The Wall Street Journal.

The announcement of these contracts secured Microware's status as a force to be reckoned with.

"It really gives us a tremendous push," Kaplan said.

Microware will supply software to 10 different manufacturers of set-top converters. Some of those manufacturers, such as IBM and Philips, have been selected to supply converters for Bell Atlantic Corp., the acknowledged leader in the race to provide interactive video services.

Bell Atlantic has said it hopes to wire some 10 million homes by the end of the decade. Each home would have a converter box on top of the TV set. The boxes are needed to transmit and decode streams of video and computer data between the phone company and the TV sets. The interactive services would include unlimited pay-per-view movies, video games, home-shopping channels and other programming.

Besides IBM and Philips, the companies that have contracted with Microware are Compression Labs Inc. of San Jose, Calif.; Gold-Star Co. Ltd. of Seoul, South Korea; Kyocera Corp. of Tokyo; ICTV of Santa Clara, Calif.; Adaptive Micro-Ware of Fort Wayne, Ind.; Divicom of Milpitas, Calif.; Eurodec of Paris; and Samsung Electronics Co. Ltd. of Suwon, South Korea.

"It became clear to us that the best choice . . . was the Microware OS-9," said Brian Smith, a vice president at Philips.

OS-9 is an operating system — a set of programs, like DOS, that control the basic functions of a computer. It has been used for some

TV *Please turn to Page* 9S

CHRYSLER PROFITS

CHALLENGES FROM OTHER STATES

BUSINESS/FINANCE

New contracts will mean millions for Microware

TV

Continued from Page 10S

time in robotics and other industrial settings. But recently it has found a home in interactive media systems; Philips hired Microware to develop the inner workings of its interactive, audio-video compact disc player, called CD-I.

OS-9's strong suit is its ability to perform multiple tasks at the same time — which is exactly what is needed to transmit and decode huge volumes of data from a phone company to millions of TV sets, and vice versa.

Kaplan said the technical requirements of the set-top converter boxes essentially left the vendors one choice for an operating system: Microware's. The company for more than a year has been working on a spinoff of OS-9 called DAVID, for Digital Audio Video Interactive Decoder.

Microware's system "is very robust, it is reliable, it is not buggy," said David Serlin of ICTV, one of the 10 companies that are buying software from Microware. ICTV is going to supply converter boxes for Cox Cable Communications, which plans to test-market an interactive video system in Omaha.

Serlin cited another reason for working with Microware: It isn't Microsoft Corp., the software behemoth run by Bill Gates. While Gates' company often tries to throw its weight around, the Iowa firm is more user-friendly, Serlin said.

"They're cooperative, they're friendly, they're flexible," he said of the Iowa company.

Microsoft, which once tried to buy Microware in an effort to horn in on the Philips CD-I project, has been trying to enter the interactive video market as well.

1,300-pound, fiberglass *Please turn to Page 4*

Please turn to Page 11

New machine plays CDs, acts like a computer

By MARY CHALLENDER
Register Staff Writer

Imagine a compact disc player that not only plays music but also looks up reference material, shows travelogues in three languages and tells you why your car has a weird ping.

You can find the device in Clive.

Two Clive companies, Microware and OptImage, both located at 1900 N.W. 114th St., have been working with Phillips International, Netherlands, to develop the equipment, called a CD-I (compact disc — interactive).

The CD-I looks like a compact disc player and plays audio-visual compact discs as well as the standard audio discs now available. But it has the processing and memory capabilities of a Macintosh home computer, said Robert Sorensen, president and chief executive officer of OptImage.

"This is truly a new media," said Sorensen, 35, 1800 E. 31st St. "There's nothing else like this today."

The CD-I hooks up to a television set for videos and can be hooked up to a stereo for sound. Instead of a keyboard, it is controlled by a wireless remote control unit.

"It's kind of a way to sneak computers into the home," Sorensen said.

MICROWARE
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CHARLES SCHLOSSER/The Register

OptImage President Robert Sorensen demonstrates the capabilities of the new CD-I player, which reproduces video images stored on compact discs. The player is available through Microware, located at 1900 N.W. 114th St., Clive.

New machine plays CDs, acts like a computer

MICROWARE

Continued from Page 1

"Consumers won't be uneasy using the remote control. They're used to running their VCRs and TVs with one."

Sorensen, a former vice president of research and development for Microware, said that the company worked with Phillips and Sony Corp. last year designing the player.

Once a workable model was developed, OptImage was formed to design discs to run on the player.

Sorensen said the four employees at OptImage's Clive office write programs for the discs.

"There are only about 100 people in the world who have the training to write CD-I discs," Sorensen said.

The Clive workers are trying to make it easier to write the discs, he said. "If we make it easier, thousands of people will be able to write the discs."

On Market in '89

Sorensen said the company hopes to have a library of about 30 discs available when the CD-I goes on the market early next year.

The players already are available for industrial use, Sorensen said.

The industrial players, which have a floppy disc drive and jacks for a keyboard and printer, sell for between $2,000 and $3,000. But Sorensen said CD-I players for the home probably will sell for a retail price of less than $1,000.

Discs have been commissioned by the Smithsonian Institution in Washington, D.C., "Tell Me Why" children's books and Time-Life Inc. A music video featuring Frank Sinatra also has been commissioned, Sorensen said.

Although the CD-I might someday replace the VCR, that's not how it is being sold, Sorensen said. There are no plans to develop discs of hit movies.

Phillips and Sony sell VCRs too, Sorensen said, "so they don't really care."

"This is an entire new area of use," Sorensen said. "We call it 'edutainment.' It's education and entertainment. One disc could hold the information in an entire volume of encyclopedias, complete with beautiful color pictures and sound."

The CD-I would be a perfect guide for do-it-yourself projects, Sorensen

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Car Repair by CD

"Say you start up the car and it's not running well," Sorensen said. "The disc will give a list of symptoms to choose from. Is it a little jumpy? If you say 'yes,' it might suggest you check the plugs.

"The video will show you how to remove a spark plug, then show you a picture of four spark plugs. 'Which does yours resemble?' the audio might ask. If your spark plug looks like the clean one, the computer may say, 'Well, maybe it's not a spark plug problem. Let's check the fuel filter.'"

Sorensen said he plans to hire about 25 more employees with technical writing and computer science backgrounds to work in the Clive office.

THE WALL STREET JOURNAL.

MARKETPLACE

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Law: *The information highway helps non-lawyers with legal problems* ***Page B10.***

Little Microware Aims to Be a Multimedia Giant

By John J. Keller
Staff Reporter of The Wall Street Journal

A tiny Des Moines software company hopes to do for multimedia systems what **Microsoft** Corp. has done for PCs.

Microsoft came to dominate the personal-computer industry by designing the internal software, known as the operating system, that made millions of PCs run. Now little-known **Microware Systems** Corp. is trying to get the same hold in interactive software by designing the operating system for the TV set-top boxes expected to be in millions of homes.

Kenneth Kaplan

Little-known Microware has just landed a coveted piece of business. **Bell Atlantic** Corp., the regional Bell company, expects to distribute an interactive service to 10 million households by the turn of the century. It has placed orders for set-top boxes from three suppliers. All the boxes, in turn, rely on Microware's OS/9 software.

The company's software is already used in hundreds of critical systems worldwide. The California Department of Transportation has begun relying on OS/9 to run traffic lights, toll booths and even to help weigh trucks. Chrysler Corp. uses OS/9 in the computer systems that design and build braking systems. At the University of Cern in Switzerland, the particle accelerator couldn't smash atoms without thousands of Microware systems controlling its magnets.

The key feature at the heart of these myriad applications is OS/9's ability to handle multiple "real-time" tasks simultaneously, which can be traced to the software's robotic origins. Such "multitasking" powers are seen as a critical feature for interactive networks, letting "interactivists" shop on a network or respond instantly to the button-pressing of fellow game-players.

"Their software has a lot of the functions that everybody believes will be necessary for the future interactive services," says Lucy Fjeldstadt, former vice president of multimedia at International Business Machines Corp., who now runs a consulting firm in New Canaan, Conn.

Microware would seem to be a surprise contender in the highly competitive multimedia sweepstakes, in which Microsoft has invested $100 million a year. It was founded 17 years ago by Kenneth Kaplan, a computer buff at Drake University in Des Moines, and two friends. They started out trying to build an educational robot for teaching handicapped children, a project that went nowhere.

Microware got its first big break in 1980, when Motorola Inc. approached Mr. Kaplan and his partners and asked them to design an operating system for a new microprocessor. "Today about 80% of our business is Motorola-based," Mr. Kaplan says. "We owe our existence to them."

By 1982, Tandy Corp. chose OS/9 for its TRS-80 color computer, an early entry in home computers. Soon after, Fujitsu Ltd. in Japan fitted its machines with OS/9. By 1986, when Philips and Sony Corp. began looking for a real-time operating system for their CD-Interactive player, they turned to Microware because OS/9 was proven in large commercial and scientific projects.

Microsoft last year allied with chip maker Intel Corp. and cable-box maker General Instrument Corp. in a bid to dominate the set-top market. But the trio hasn't announced a final product and seems to be running behind schedule. The effort also ran into resistance when cable companies balked at Microsoft's plan to charge a fee each time a consumer conducted a transaction using its set-top software.

Microware's founder, Mr. Kaplan, says Microsoft's efforts to control the market simply won't work this time. "Anybody in computers always talks about how they support open standards," he says. "But in the dark recesses of their greedy little hearts, they want things to be proprietary" and use that edge to their own advantage.

OS/9, by contrast, will work with myriad rival systems, Mr. Kaplan says, including gear from IBM, Philips N.V. and several other set-top vendors selected last week by Bell Atlantic. Nor does Microware intend to impose additional per-transaction user fees beyond what it charges for licensing OS/9, the company says.

Microware's OS/9 went head-to-head with a prototype from Microsoft called Modular Windows in a test by Bell Atlantic, says Arthur Orduna, a Microware marketing manager. He brags that OS/9 beat its rival.

A Microsoft spokeswoman doesn't dispute this account. However, she said Microsoft is interested in not only supplying real-time software for set-top boxes, but also graphical software that presents a

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MARKETSCAN

from phone companies.

Tiny Microware Aims To Become A Giant In Multimedia Arena

Continued From Page B1

picture on the television screen that could entice consumers to use the service. "[Chairman] Bill Gates has said that the early [interactive services] trials will be disappointing because we haven't made enough progress in user interfaces and the richness of services delivered." She added that Microsoft may be behind schedule because it is trying to deliver software for several segments of the market, including cable head-end systems, set-top boxes and the programs delivered over the networks.

Mr. Kaplan says Microsoft in March 1986 tried to buy Microware. Microsoft had begun trading publicly on the over-the-counter market. According to Mr. Kaplan, Mr. Gates saw that Microware was chosen as the operating system for the Philips-Sony CD-i machine and "he wanted into that market badly." Rather than design a new operating system, Mr. Gates figured it made more sense to buy Microware, Mr. Kaplan says. "I refused and wanted a joint venture instead and the talks fell apart." Mr. Gates, through a spokeswoman, confirmed the account.

Compared with Microsoft, Microware is truly micro. The closely held company doesn't give out numbers. Mr. Kaplan, its president, will say only that "we're one one-hundredth the size of Microsoft," which would indicate revenue of about $25 million or more. Tonight, Bell Atlantic's key partner in multimedia software, Oracle Corp., is staging events in four cities to outline its interactive ambitions.

The Bell Atlantic effort is a much-watched affair because, while the phone company could change its suppliers, it intends to deliver new services to 250,000 homes by year's end, adding another million homes in 1995. Bell Atlantic's plan to acquire cable giant Tele-Communications Inc. could give it access to more than 20 million homes.

Today half of Microware's sales are overseas, as are half of Microware's 200 employees. "They have a nice, tight system that operates well," says Brian Smith, vice president of market development at Philips's Digital Video Communications Systems Division. "It's powerful enough to do real-time video functions, and you can still load applications software on top."

Microware Systems Corporation: A Family of Many Faces

By Steve Simpson

MICROWARE EMPLOYEES - A DIVERSIFIED GROUP

There are people in the room who are Russian, Chinese, Ukrainian, Indian, African-American, Taiwanese, Australian, Korean, Singaporean and Japanese. This is not a gathering of the United Nations. This is an everyday occurrence at Microware Systems Corporation, a Des Moines-based software developer. Microware has become a mini "melting pot" in the heart of central Iowa.

Microware is an international organization with its headquarters in Des Moines and offices in England, France and Japan. The company develops and markets advanced real-time system software that is used for factory automation, consumer electronics, aviation, military and intelligent products.

This company was founded by Chicago-native Ken Kaplan while he was a student at Drake University. It has been Ken's commitment to finding the best and brightest people that has created such a cultural blend in a small company. Microware employees often refer to Microware as a family. It's a family where cultural and racial differences are recognized and understood. These differences are not barriers to communication or working together. In fact, people, often take time to learn more from people of other cultures.

Their lives are as diverse as their cultural heritage. From Michael Martin, an African-American who was born and raised in Des Moines, to Michael Soolkin, a Russian Jew who spoke almost no English when he came to the United States two years ago. From Anil Purohit, an Indian whose ancestors were Hindu priests, to Xiao-Lin Lu, a Chinese woman who came to the U.S. for her second Master's degree.

They have each faced different journeys on their ways to Microware. Several came to the U.S. originally to continue their education, mostly for postgraduate degrees. They have left family and friends seeking opportunities. Michael Sooklin and his wife came to the U.S. from Moscow to visit friends. The friends convinced the couple to stay. They literally had only the clothes on their backs. As Jews, they were not treated very well in the Soviet Union, Soolkin tells. "We were denied opportunities such as choosing the university we wanted to attend. We were never told, 'You cannot attend this university because you are a Jew.' But, we

guage itself does not impose a barrier for these people, other people's lack of patience and understanding does. Xiao-Lin Lu illustrated this with a personal incident. "I was looking at an apartment here in Des Moines one Sunday afternoon. The manager told me to wait until Monday and come back to look. Knowing that I had to be at work all day Monday, I asked him if I could possibly look at it that day. He asked me, 'Do you understand English?' This gave me a very bad feeling because he immediately implied that I was less intelligent. But, this is fortunately an isolated case."

PUTTING DIFFERENCES ASIDE AT MICROWARE

So, how do all these people and cultures come together under one roof in Des Moines? It is through a sense of community and a commitment to understanding. It is by creating an atmosphere where the focus is on the individual, not corporate structure and dress codes.

employees at Microware are given freedoms not afforded people at most other companies. People listen to music while they work. Liberal dress codes allow people to work in shorts in the summer and jeans or sweat pants in the winter. There is a daily basketball game over the lunch hour when the weather cooperates. Lunch is served daily in Microware's cafeteria. Each of these contributes to Microware's acceptance of people from other cultures.

Daily examples support that this openness has made employees more comfortable than in other environments. Anil listens to traditional Indian music. Pookie dresses in

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Nehames "Pookie" Bernstine faces a different struggle. Bernstine spent nine years in professional baseball, including the Iowa Cubs, before leaving the sport. "It's a different life as a ball player. People know who you are, and some even look up to you," says Bernstine. "Until Microware, I struggled with being treated as just another black man."

FACING CHALLENGES IN THE COMMUNITY

People from minority cultures often face barriers in their daily lives. While lan-

MICROWARE EMPLOYEES - A DIVERSIFIED GROUP

guage itself does not impose a barrier for these people, other people's lack of patience and understanding does. Xiao-Lin Lu illustrated this with a personal incident. "I was looking at an apartment here in Des Moines one Sunday afternoon. The manager told me to wait until Monday and come back to look. Knowing that I had to be at work all day Monday, I asked him if I could possibly look at it that day. He asked me, `Do you understand English?' This gave me a very bad feeling because he immediately implied that I was less intelligent. But, this is fortunately an isolated case."

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Daily examples support that this openness has made employees more comfortable than in other environments. Anil listens to traditional Indian music. Pookie dresses in urban wear. As he says, "I couldn't wear what I wear in many other companies. Microware lets me be myself." Lunch tables are not segregated, but rather filled with cultural variety. Employees carry on conversations in their native tongues. Other Microware employees who have learned foreign languages often get an opportunity to practice those languages.

But Microware is more than just a fun place to work. The relaxed atmosphere allows Microware's employees to concentrate on developing technologically advanced software. People focus on creative solutions

MICROWARE: continued on page 18

MICROWARE: CONTINUED FROM PAGE 5

to software development, not on dress codes.

SETTING AN EXAMPLE AT MICROWARE

When asked about what Des Moines and the rest of the country can do about improving cultural acceptance, Microware's employees look to their very employer to set an example. They have a keen awareness of the problems facing ethnic groups in society. They have run head on into racism, discrimination and misunderstanding. However, they feel comfortable coming to work every day at Microware. At work, they find understanding and interest in their ethnic heritage. They know they can sit down to work, or even eat lunch, with anyone from Microware and feel a sense of belonging and cooperation.

They look to understanding and education as the keys to calming racial tension. By taking an educated look at people from other cultures, society can understand the needs and concerns of others. "If you value your freedom, if you value your self," asks Kris Hoffmeyer, a Korean-American, "why can't you turn it around to others?" Through this understanding, people from all cultures can work together in a society freer from discrimination and racial tension.

Pookie Bernstine summed it up well: "For my wife and for my young children, I'd like to see the whole country become like Microware."

NOTE: Due to Microware's continued success and growth, new job opportunities are available on a relatively regular basis. We invite people in the Des Moines community to watch for future listings in The Communicator or the Des Moines Register and apply for positions for which they are qualified. Microware is an Equal Opportunity/ Affirmative Action Employer.

RISC 88000

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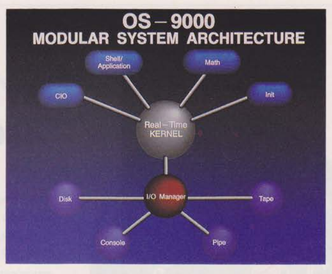
Memory modules are the foundation of the OS-9000 Operating System. OS-9000 has been designed so that each module provides specific functions. This modularity allows you to customize OS-9000 for your particular application. As an example, a small, ROM-based control computer does not need the disk-related modules.



Evaluation systems are now available for selected VMEbus and popular PC-AT/386 systems. Call Microware today to find out more about how you can put the real-time power of OS-9000 to work for you.

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