

Compuvision or Teleputer?

Historically, the computer and communication industries have been separate, although both worked with electronically encoded information and shared similar technology. The regulations that kept computing and communication apart began to crumble in 1956 when the FCC ruled that Hush-a-Phone could attach equipment to the AT&T network under special circumstances. In 1959 they opened a portion of the microwave spectrum, and the 1968 Carterphone case allowed all kinds of equipment to be tied to the network. Today, IBM is in the communication business and AT&T markets computers, but many feel that the distinction among computing, communication, news, and entertainment industries will blur or disappear.

The question is, who will lead the charge—the computer companies, entertainment companies, toy companies, or phone companies? To put it another way, will the home computer swallow up the television set or will the television set become a computer in disguise?

Not surprisingly, computer companies and entertainment companies have different answers to this question, and the debate was brought into focus by announcements at the Fifth Microsoft International CD-ROM Conference and Exposition. Let us look at the question of the home computer versus the smart TV and then come back to some of the other interesting announcements at the show and the current state of multimedia applications.

Compuvision: The Home Computer

The idea of a home computer is not

new. Figure 1 shows a Commodore PET (Personal Electronic Transactor), the first fully assembled appliance computer, designed for use by the general public at home and school. Apple, Texas Instruments, Atari, and Radio Shack also had early hopes for the home computer market, and IBM tried several years later with the PC Junior. Where are all those home computers today? The installed base is large, but I will bet that most are installed on the shelves of hall closets.

Hope springs eternal, however, and technology improves. In his address to the CD-ROM Conference, Microsoft Chairman Bill Gates stated that his company's goal was to have a computer on every desk and in every home. He feels that multimedia, with the emotional richness of image and sound, is the key to the home market. Gates, who works in close collaboration with Intel and IBM, outlined a phased approach. The phase one machine is available now; future versions may be capable of competing with a television set.

Gates' phase one machine is a fairly standard 286-based PC with a VGA display, built in CD-ROM drive, and modest audio capability. The operating system is DOS and Windows with multimedia extensions. Two companies, Headstart and Tandy, already sell similar machines, and it is widely rumored that IBM is preparing one. Gates described a base machine last year, and there has been a notable change. The CPU has been changed from an 80386 to an 80286. My guess is that

BY

Larry Press

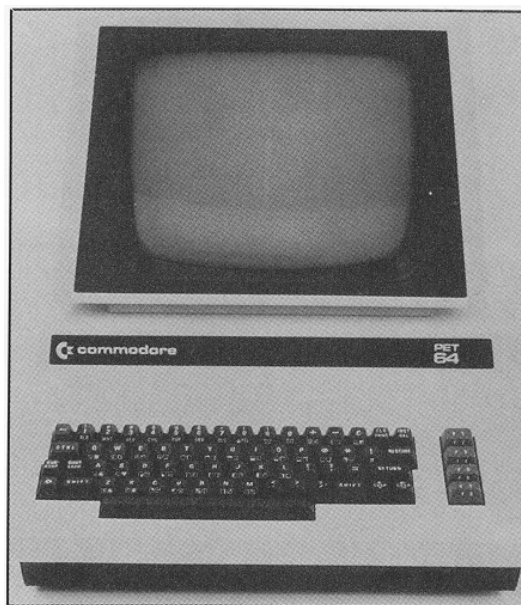


FIGURE 1. Commodore PET. The first serious attempt to market a home computer was Commodore's PET, announced in 1977. The PET was a fully assembled computer with a BASIC interpreter in ROM and audio cassette storage.

this change was made to keep the cost down for the school market, where IBM hopes to sell many multi-media computers. (They have also just announced an aggressively priced network software bundle for schools).

We will return to the phase one machine later, but a potential TV-killer was also outlined by Gates and representatives of Intel and IBM. A TV killer needs full-motion video, for which Gates is counting on Intel's DVI™ (Digital Video Interactive) technology. DVI is a proprietary scheme for compressing motion video and recording it on a CD-ROM disc (see the July 1989 *Communications* for a full description). At the conference, Intel announced a single-board DVI controller (to be marketed by IBM) and they promised the next generation would be out in 1992-93. The new board replaces two older boards, cuts cost, and improves performance. The major

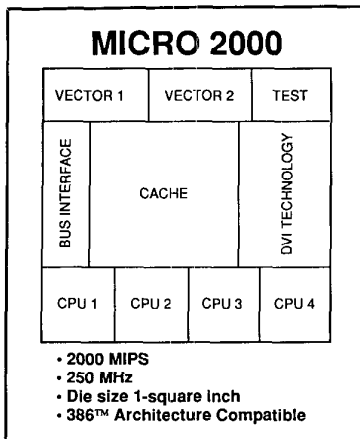


FIGURE 2. CPU 2000. Intel's Dave House predicts that by the year 2000, the Intel 786 will execute 2 billion instructions per second and have DVI motion video on the chip. This could be a TV killer.

change, however, is the availability of real-time, symmetrical recording (RTV) at 30 frames per second.

Earlier versions of DVI required batch processing for compression to produce production level video (PLV). With RTV it is possible for a user to digitize and store video images from a camera or other source in real time. That not only means vastly simplified production of multimedia discs; it means live video communication. One of the hits of the conference was a demonstration of RTV over a token ring network.

The following table shows Intel's DVI roadmap for full-screen, 30-frame-per-second DVI for the next few years:

TABLE 1		
Year	Method	Quality
1989	PLV 1.5	near VCR
1990	RTV 1.5	near VCR
1990-1	PLV 2.0	VCR
1990-1	RTV 2.0	VCR
1992	RTV 3.0	near TV
1992-4	PLV 3.0	TV
1994-6	PLV 4.0	TV to HDTV

Intel predicts \$50 DVI chips in 1991, and the next DVI board is expected to double performance at one third less cost. DVI is expected to be in-

cluded on the motherboard of 1995 computers.

As nice as a computer with DVI on the motherboard would be, I suspect I would still watch "The Simpsons" on a television set. The real TV killer will not be available until around the year 2000. Intel senior vice president David House has speculated about a possible Intel CPU at that time. He notes that since the original 4004 microprocessor in 1971, the number of transistors that can economically be put on one silicon chip doubles about every 18 months. Extrapolating, House foresees a 50-to-100-million transistor CPU at the end of the decade (see Figure 2).

What might Intel do with those transistors? Integration is one possibility. When IBM announced the 286-based AT in 1984, a typical motherboard had 170 chips, plus memory. By 1987, a PS/2 of similar complexity was down to 70 chips. In 1990, a 32-bit PC will be down to 10 chips, and by 1993, one. LAN support and other functions will continue to be brought onto ever faster CPU chips. By the end of the decade, House predicts a 2,000-MIP, 386-compatible CPU which includes DVI. That might be a TV killer.

Teleputer: Smart TV

That is the party line according to Intel, IBM, and Microsoft, but the entertainment world has also been busy. In the summer of 1991, Sony and Philips will roll out CD-I, an interactive CD player designed to be connected to a television set. A CD-I player contains an optical disc drive, a Motorola 680X0 CPU, and a megabyte of memory, but it will be marketed as an enhanced CD player, not a computer. It is not backed by computer companies, but entertainment companies. CD-I ads run in *Variety*, not *Communications*.

A CD-I disc may contain data in a variety of formats:

Text: 1- or 2-byte characters. When used, the second byte specifies display attributes.

Sound: Four levels ranging from 16

hours of AM radio quality monaural sound to 1 hour of audio CD quality stereo.

Image: Five levels of image, including natural still pictures, RGB with 5 bits per color, 7- and 8-bit color lookup tables, and specially encoded animation sequences.

Motion Video: Seventy-two minutes of full-frame motion video, which may be accompanied by FM quality monaural sound.

The hardware also supports special effects such as fades, pans over large virtual images, and independent video planes that are automatically layered or superimposed upon each other (two planes for images, and one each for the cursor and motion video).

CD-I was announced at the 1986 CD-ROM Conference, and in looking back to an article I wrote at the time, I note the prediction that players would be on the market by Christmas, 1988. When that date came and went, and DVI was announced, there was a tendency to write off CD-I.

Bringing CD-I to market has been delayed, but Philips and Sony have been busy in the meantime. An interim format, CD-ROM XA, was designed and is now being shipped. CD-ROM XA provides CD-I audio and some of the CD-I image formats. An industrial training version of CD-I has also been developed. The player is being marketed in Europe and the United States, and Philips has formed joint ventures to develop CD-I training material. Philips has also been lining up drive suppliers. Panasonic, Yamaha, Pioneer, Sharp, Ricoh, Sanyo, and Fujitsu have all developed prototype players or disclosed plans for doing so. But more important than all of this, Philips and Sony have been working on software.

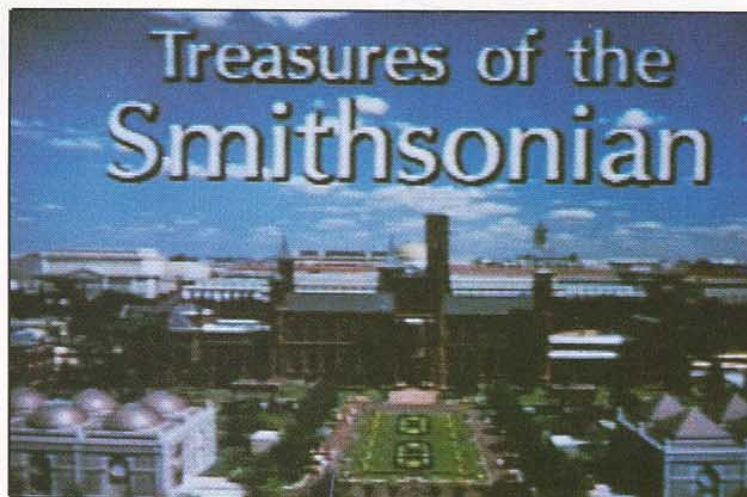
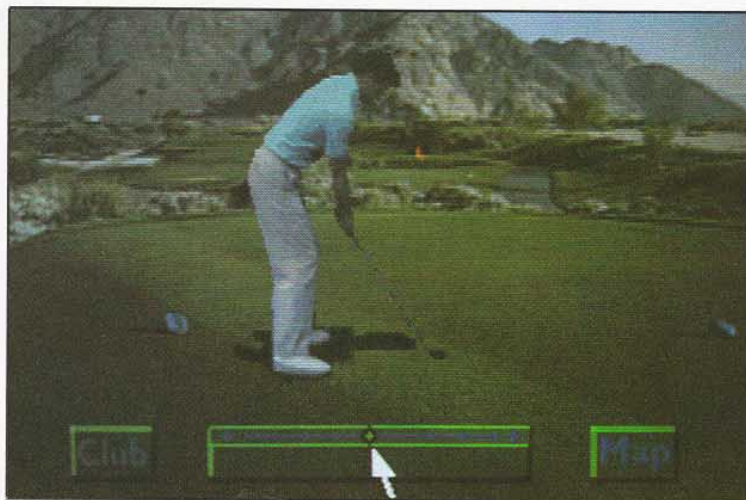
For its part, Sony has been buying American record and film companies. Philips, in partnership with PolyGram, a record company and audio CD marketer and distributor, has formed American Interactive Media (AIM) and sister companies

in Japan and Europe. AIM is a CD-I publisher, but in the early stages they were acting as a CD-I midwife, developing some titles of their own and supporting third party developers with expertise and money. (The success of Audio CDs has left Philips and PolyGram with lots of the latter.) Rand-McNally, Time-Life, Grolliers, Children's Television Workshop, ABC Sports, Hanna-Barbera, Caesar's World, Britanica Software, Parker Brothers, and The Sporting News are among the companies working on CD-I titles for publication by AIM.

AIM promises to have 26 titles at the time of the CD-I introduction. They include entertainment (board, video, and adventure games, as well as an interactive biography of Frank Sinatra), special interest (how-to, sports, and museum tours), and children's titles ("Sesame Street," coloring books, the Bible, and others). Many of these are in prototype today (see Figure 3). For example, the *Palm Springs Golf Open* (3a) uses two graphic layers. The background layer is 360-degree photos of a golf course in Palm Springs, California. The foreground is used for surprisingly good animation of a golfer swinging, the ball travelling and then coming to rest. The user selects a club, aims the player, and controls the speed and angle of the swing. An ABC golf commentator and a caddy offer commentary. The disc is technically the most impressive one I have seen.

Treasures of The Smithsonian (3b) is a disc of surrogate travel to the Smithsonian Institute. You steer through over 200 exhibits of art, natural wonders, and science. You can also interact with the exhibits. In one you play a harpsichord; in another you

FIGURE 3a-c. CD-I Applications. Philips/PolyGram subsidiary American Interactive Media has developed and supported CD-I demonstration and development. The golf simulation (a) is done in two planes, one for the golfer and moving ball, the other for the background. The Smithsonian tour (b) provides surrogate travel through the museum, and the oldies jukebox (c) album covers selections, liner notes, and lyrics from 39 old songs.



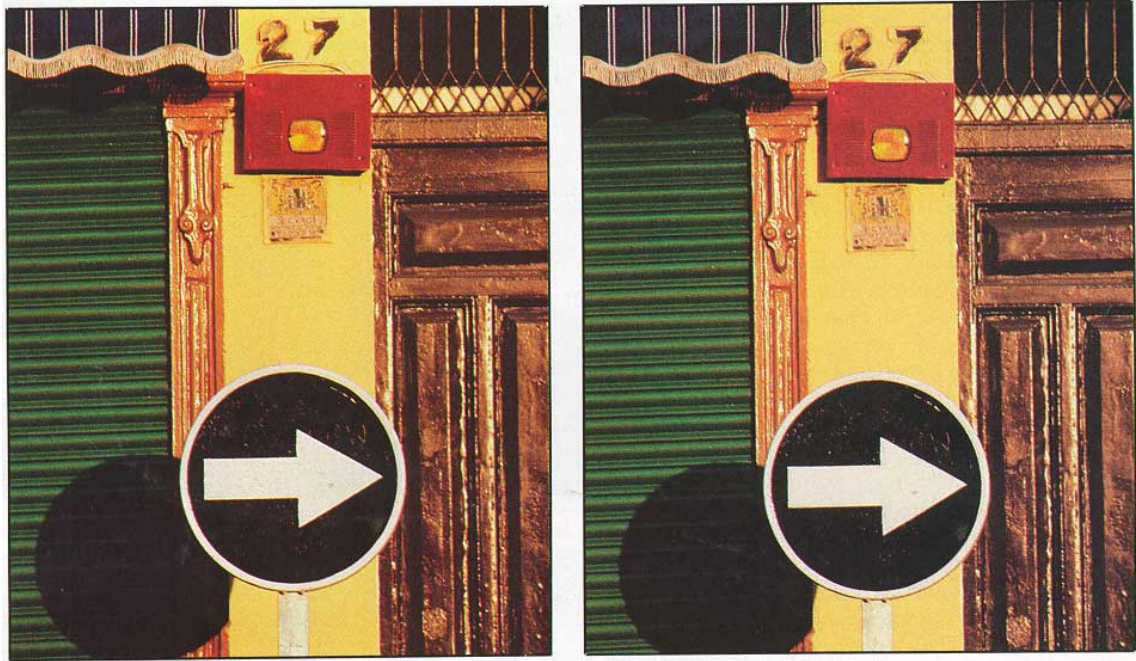


FIGURE 4. JPEG Compression. One of these photos was reproduced from an original negative, one from a 24:1 time compression. Can you tell which is which? (The answer is at the end of the article).

break the sound barrier or walk around a statue. If this disc is successful, one can imagine similar tours of many other museums.

The Oldies Jukebox disc (3c) has 39 songs from 1950s and 60s performers such as the Platters, the Diamonds, and Roy Orbison. You can see the album covers, liner notes, background trivia, light shows, and lyrics while the music plays. Control options let you start, stop, and replay, using interactive controls or with a simply scripted play list for unattended listening. *The Classical Jukebox* will offer classical music in the same format. Once the format is worked out, it will be easy for companies owning the rights to the material to produce other jukebox titles.

I would not presume to evaluate the content of these early discs, but after trying CD-I out, I still have the same concern that I had in 1986—the point-and-click input device. The demo players I have seen use mice,

but a mouse will not work while sitting in an easy chair or in the hand of a child on the floor. The world will beat a path to the inventor of a good easychair point-and-click device. (Recliner chairs with trackballs!)

AIM has learned a lot about developing for CD-I. For example, Seth Meyers, director of production of interactive technology at the Children's Television Workshop, noted that in developing the *Sesame Street* disc, they learned that while children will watch a muppet on TV for a long time, they want to *do* something as soon as you give them a mouse. That means you cannot write anything that is longer than about 15 seconds for children's CD-I. (Will today's TV news clips seem like in-depth coverage to these children?) AIM has formed a sister company to market the development systems they use in-house, and they are available for Mac, PC, and Sun workstations.

Who will dominate the "computer entertainment" industry in the long run? It may be one of these groups or someone else. Maybe it will be the phone companies or Nintendo.™ Perhaps the pie will be evenly divided. At this point, the entertainment

companies, with their focus on software and their proven expertise at producing and marketing consumer electronics, may be in the lead.

Multimedia Today

We can speculate on the year 2000, but much is happening today. Intel and Phillips are not the only ones working on image-recording formats and compression techniques. ISO and CCITT have committees for international image compression standards. They have formed The Joint Bi-level Image Group (JBIG) for fax or line-art images, the Joint Photographic Experts Group (JPEG) for continuous tone stills, and the Moving Picture Coding Expert Group (MPEG) for motion sequences.

The JPEG Committee has been meeting since 1986, and Chairman Gregory Wallace estimates that a final standard may be available around the middle of 1991. Two companies, C-Cube Microsystems and Electronics for Imaging (EFI), have developed products based on the current draft of the standard. EFI is marketing source code for JPEG software, and C-Cube markets a JPEG chip and software package. Figure 4

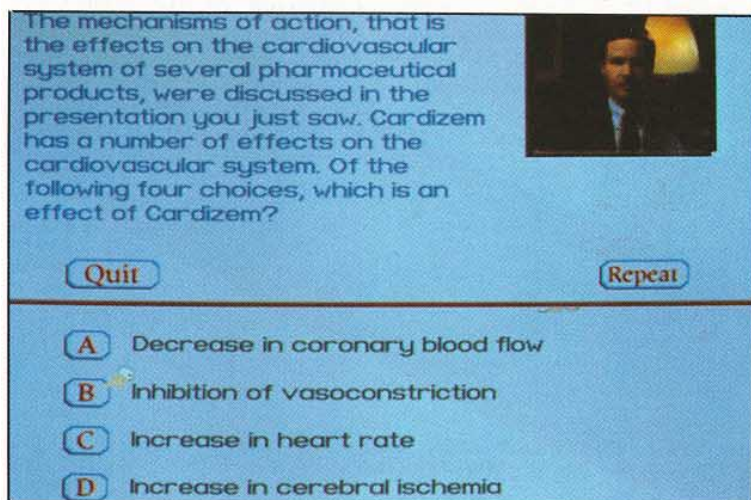
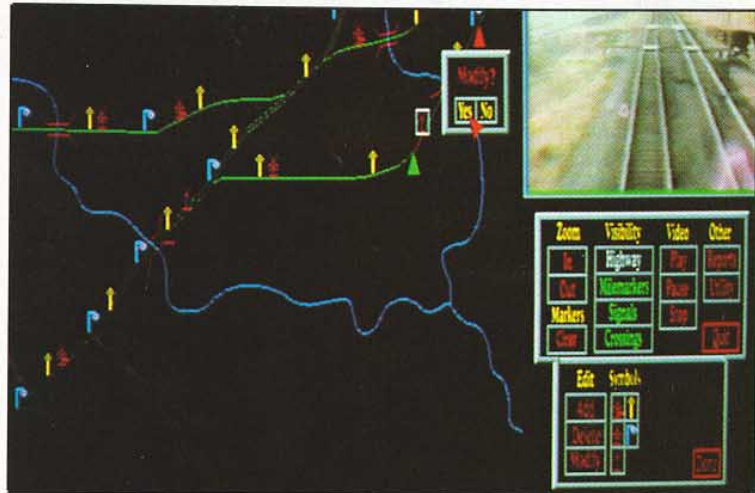
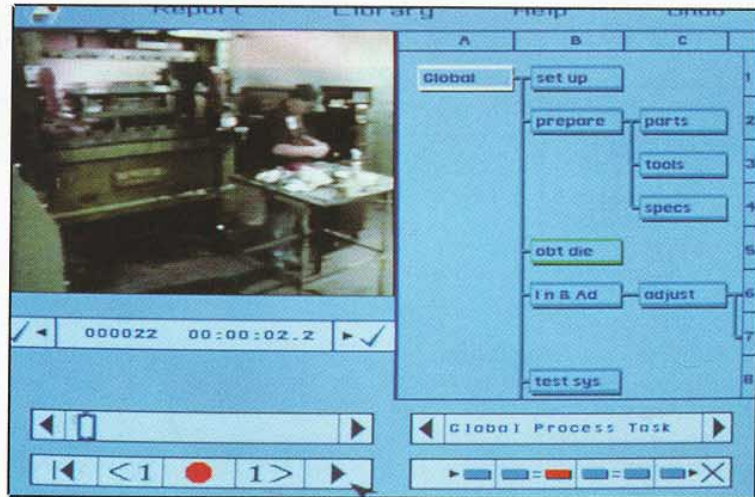
shows an image before and after, 24:1 times JPEG compression using EFI's software. Can you tell which is "before" and which is "after?"

The JPEG compression algorithm runs in two steps, a discreet cosine transform on a sliding 8×8 pixel window followed by Huffman encoding. The first stage discards some information, so reproductions are not exact. Color information is sampled at a lower rate than luminance information (since color changes are more gradual in natural images than luminance changes), and high-frequency color information, to which the human eye is relatively insensitive, is discarded. Software compression on a Macintosh IIcx takes long enough for one to have a cup of coffee or perhaps lunch, depending on the degree of compression and the resolution and uniformity of the image, but C-Cube's chip compresses a 25MB, 8.5-by 11-inch 300-dot-per-inch, 24-bit color image in less than a second.

The compression ratio is under program control, and 20 times compression shows little visible loss. The JPEG standard is being widely adopted in communication, computer, and consumer products. JPEG will probably be part of the standards for color and gray-scale FAX, PostScript, wire photos, and compound documents. Intel and Philips have gone their own proprietary ways thus far, but both are committed to supporting JPEG and MPEG. It will take time (telephone unification in the United States took about half a century), but eventually there will be common standards.

Like CD-I, DVI is beginning to be used for industrial applications. At

FIGURE 5a-c. Andersen Consulting, a DVI Alpha-Test sight, has aggressively pursued application demonstration and development. The applications shown here are (a) the Process Analysis Workbench, for use by Andersen consultants in advising clients on setup and operating procedures for complex machines, (b) a geographic information system for surrogate travel over a train system, and (c) a product information and training system for pharmaceutical sales representatives.



the conference, Reinhard Ziegler of Andersen Consulting spoke of DVI applications. Zeigler's approach to finding potential DVI applications is to look at areas where video tape is already being used (See Figure 5). One example is analyst tape operators setting up complex production machinery. In a modern-day version of Taylor and Gilbreth's time and motion study, they capture several hours of setup time and analyze the constituent steps. Figure 5a shows an analyst building a flow diagram of a setup operation and associating an automatically timed segment of video footage with each step. The video is displayed in the upper left, VCR-style controls are under the video, and the evolving process diagram is on the right.

Another application is a railroad geographic information system (5b). Video footage of their track routes was made by mounting a camera on a train. The user makes surrogate trips over train routes, while controlling movement and monitoring progress on a map. Objects, for example, can be bridges, can be visually inspected, and engineering diagrams and other data can be retrieved from a database.

Andersen has also transferred video training material for Marion Merrell Dow pharmaceutical sales people to DVI (5c). The user selects a topic, and training material is displayed. If he or she clicks on the "define" button during a presentation, the index of a video glossary is presented, with the last term used highlighted. After watching a glossary clip the user would resume the presentation. The system can also quiz the user. Of these three systems, only this one is in actual use; however, like AIM, Andersen has learned a lot by these early efforts.

IBM is making significant inroads into Apple's territory. Nearly every multimedia presentation one sees on the Macintosh uses audio recording and editing hardware and software from Farallon Computing or MacroMind's Director, an audio-video scripting system. Both of these companies, and others, announced that

they are working on PC-compatible products. Many other Macintosh developers are working on applications using Microsoft Windows, and the runtime portion of MacroMind Director will be included in a future "multi-media" release of Windows. MacroMind demonstrated a Director application that had been developed on a Mac running simultaneously on a Mac and a PC. Apple's window of uniqueness may be sliding shut, and they must innovate and cut prices.

Microsoft and Hewlett-Packard have taken a lead in CD-ROM distribution of software and documentation. Last year HP reported customer satisfaction with the distribution of UNIX™ documentation on CD-ROM. Now they offer software and documentation for the HP-3000 minicomputer on CD-ROM. Customers who need several manuals will find it convenient, while also saving money.

Microsoft has bundled three Macintosh applications, *Word*, *Excel*, and *PowerPoint*, on a CD-ROM. The disc includes manuals, training material, and third party add-on software and data files, and it costs considerably less than the three programs purchased separately. Customers have the option of paying \$15 for printed copies of the manuals, but according to product manager Eileen Hart, less than one percent have ordered them. Presumably they find the on-line documentation convenient. Three other companies announced plans to distribute software, manuals, and complementary material on CD-ROM. Letraset will distribute publishing software, SuperMac will distribute image processing software, and Farallon will distribute multimedia presentation software.

Apple has not yet committed to support of a high-tech digital format such as CD-I or DVI, but they have the low-tech lead in using a computer to control conventional audio CD and video disc players. In one session, Tyler Poppel, manager for Media Integration at Apple, stated that VCRs would become standard

Mac output devices. There will be direct video output on all products next year, and users will "print" to video tape instead of paper, using the Macintosh *Chooser* to select the VCR. Toshi Doi of Sony hinted that by the time Macs have video output, Sony will have a three-to-four-hundred dollar VCR that is sufficiently precise to use it. Low-cost video output and a beefed up HyperCard-2 scripting language will help Apple to remain competitive with Windows-based PCs for low-end multimedia applications.

Robert Abel's presentation was the creative highlight of this year's conference, as it was last year. Abel and his collaborators demonstrated a multimedia explication of Tennyson's poem "Ulysses." The interactive disc includes literary critics, actors, and students all performing original material, and a wealth of prerecorded images and video, such as Bill Moyer's PBS interviews with Joseph Campbell. The disc deals with the poem, acting, poetic concepts, mythology, and heroism. For example, the disc includes Campbell talking about mythological heroism, critics talking about heroism in the poem, and a montage of images of modern day heroes which ends with the Chinese student stepping in front of a tank during the Beijing protests.

Abel uses widely available technology—an IBM PS/2 controlling a standard video disc player—but creative filmmaking skill such as his is not widely available. I was moved by his photomontage. Have you ever laughed or cried while running a computer program? If you want inspiration, order a video tape of Abel's presentation from GT Recording.

There are also new multimedia computers from Commodore and Tandy (Figure 6). Since 1985, Commodore's Amiga has led in interfacing with television production equipment and MIDI music instruments, and it has had custom sound and video-processing chips. Their latest multimedia computer is the Amiga 3000 (6a). The top model has a 25Mhz 68030, a math coprocessor, up to 16MB of memory, 9 100MB hard drive, and several cus-

tom chips. The price is well below comparable Macintoshes. Options for Ethernet, Novell Netware, and UNIX are available.

Perhaps more important, Commodore will bundle *AmigaVision*, a multimedia authoring system, with every Amiga 3000. AmigaVision is an iconic programming language in which you build a program by stringing together icons that represent commands. Command parameters are specified by filling in dialog boxes. The imperative commands typically play a video or audio sequence, and there are control constructs for looping, branching, and user interaction. Commodore is like IBM's competitors in the 1960s—their hardware is a very good deal for the price, but hardware is only the tip of the iceberg (see Figure 7).

Tandy has taken a more mainstream approach than Commodore. They listened to Bill Gates' description of phase-one multimedia PCs and built the 2500 XL (6b). It is a typical AT-compatible but adds DOS in ROM, a CD-ROM drive, and an 8-bit, bi-directional, digital-analog converter for sound and speech. In order to test its mettle as a multimedia machine, I tried it out with Britannica Software's *Compton's Multimedia Encyclopedia*, which won the Software Publishers Association Award for best new use of a computer and the first annual Creative Applications Award from Philips-DuPont Optical Company.

The encyclopedia is truly a multimedia product. According to the publisher, it includes the full text of the 19-volume, 5,200-article, 8,784,000-word, 1989 edition of the Compton's encyclopedia; 15,800 pictures, maps, diagrams; 60 minutes of recorded voice and sound; 45 animated sequences; *Webster's Intermediate Dictionary* (65,000 entries); and Jostens' word processing program. That is a lot of information, but there are many ways to find it. You can use keyword searches, an alphabetical title index, a timeline running from 1492 to the present, a map of the world, or a hierarchical topic tree.

With so much information and so



FIGURE 6a-b. New Multimedia Computers from Commodore and Tandy. Like the Macintosh, the Commodore Amiga 3000 uses the Motorola 68030 CPU, but the price is much lower than Apple's. Earlier Amigas have done well in television and music applications, and with the 3000, Commodore hopes to crack the business and education markets. The Tandy 2500 XL meets Bill Gates' specification for a low-end multimedia machine. It is an AT-compatible PC with a CD-ROM drive audio processing chip.

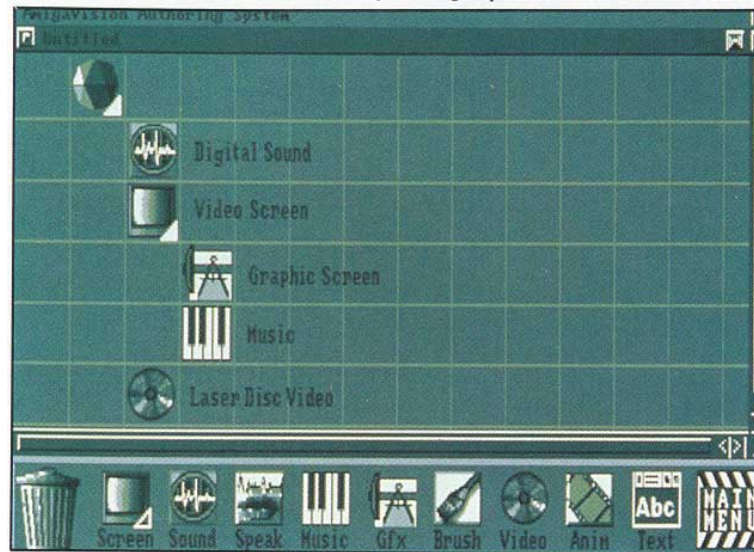


FIGURE 7. Commodore's AmigaVision. This Multimedia authoring system will be bundled with the Amiga 3000. The user chooses icons from the menu at the bottom of the screen and drags them to the top area. Each icon represents the playing of an audio or video sequence. The sequence is specified in dialog boxes and data files associated with each icon. AmigaVision may be as strategically important to Commodore as HyperCard has been for Apple.

many ways to retrieve it, one could become confused, but that is not the case. The user interface is very simple. I was able to sample each feature listed above without looking at the manual. There are also good navigational aids, such as an outline list of topics you have visited in the past, bookmarks, and hypertext links between related material. My major criticism of the user interface is that there are not enough of these connections. For example, to hear John F. Kennedy ("ask not what your country can do for you") or Richard M. Nixon ("I'm not a crook") speak, you must find them in the historical timeline. You cannot get to their speeches

by reading through the Kennedy or Nixon articles.

Of course, such cross-indexing is labor intensive, and as it is, this is a very ambitious project. It took over 100 person years to adapt the printed version to CD-ROM. The program is targeted to schools and carries a hefty price tag. If the price were lower, I imagine there would be a large consumer market for this disc. I would be among them.

The disc is also a test of Bill Gates' phase one multimedia computer, pointing out its limitations. For a start, audio retrieval times averaged four seconds for the ones I tried, and the sound quality through the 8-bit

DAC is poor. Britannica agrees that the built-in 8-bit sound is inadequate and will soon ship a version that uses audio CD recording. A digital signal processor à la the NeXT computer would be nice.

Photo quality is also limited. The 8-bit, VGA color photos are soft and blurry—definitely not television quality. Video speed could also be better. Displaying a page of text takes 3.1 seconds, switching to video mode and displaying a picture 4.8, and returning to text mode 2.6. The animated sequences are particularly poor. They are about 3% by 4% inches. The images are fuzzy, and calling up an animation takes about six seconds. The ones I tried ran at two to four frames per second, and they had from 14 to 23 frames. Dictionary access evidently requires an extra seek or two, because the average time to find a word was 7.7 seconds. Some of these limitations are due to the quality of the display and audio hardware, others due to slow CD-ROM access time, others to limited media capacity, and others to the speed of the 10Mhz AT. Each will improve with time, and there is room for them to do so.

If it sounds as though I am closing on a negative note, let me point out that in spite of the limitations, this is a very useful disc. Looking up a dictionary word may take 7.7 seconds, but how long does it take with a printed dictionary? I am out of space, but I should say that there are other terrific multimedia CD-ROMs on the market. Warner New Media's disc on Mozart's *Magic Flute* and Voyager's disc on Beethoven's *Ninth Symphony* are the two best pieces of computer-assisted instruction I have ever seen. If you have doubts as to the eventual value of computer-based "edutainment," check them out. I will review some excellent multimedia discs in future columns, but if you cannot wait, these discs may justify a CD-ROM drive for your Mac.

The answer to the problem in Figure 4 is that the "after" or compressed image is on the right.

Pointers

Those considering in-house CD-ROM production should request a copy of the "Corporate Guide to Optical Publishing," a free 39-page booklet from Dataware. Although Dataware markets development systems, this booklet is highly informative and is not a sales pitch. Dataware Technologies, Inc., 222 Third Street, Suite 3300, Cambridge, MA 02142, (800) 344-5849.

"CD-I, A Designer's Overview," Philips International, Inc., McGraw Hill, New York, 1988. Written at the technical manager level, this book introduces CD-I, the recording formats and technology, applications, and application design and development. It is a good start if you are trying to decide between DVI and CD-I. For an introduction to DVI, see the July 1989 issue of *Communications*.

For more detail on JPEG see Gregory Wallace, "Overview of the JPEG (ISO/CCITT) Still Image Compression Standard," Proceedings of the SPIE Symposium on Electronic Image Science and Technology, Santa Clara, CA, February, 1990, or write ANSI for the preliminary specification.

Patrick P. Gelsinger, Paolo A. Gargini, Gerhard H. Parker, and Albert Y. C. Yu, "Microprocessors circa 2000," *IEEE Spectrum*, October, 1989. Written by four Intel engineers, this article presents the assumptions underlying David House's predictions about future CPU chips. An expanded version will appear in a forthcoming MIT Press book, *Computing at the Millennium*.

Ghost Dance Productions produced a one-hour videotape summary of the CD-ROM Conference. The tape covers product announcements made at the opening session (from Intel, Microsoft, MacroMind, and other development system manufacturers), a tour of the exhibit booths, and short interviews of several industry leaders (most notable, Toshi Doi of Sony). The major shortcoming is the absence of coverage of con-

ference sessions, which may have been off limits to the film crew (see GT Recording, below). Ghost Dance Productions, 2866 McKillop Road, Oakland, CA 94602, (415) 261-0128. The ACM Press has produced a videotape called "Interactive Digital Video," which introduces computer-controlled videodisc applications as well as digital multimedia. The videodisc portion of the tape highlights both historically important and present-day applications from MIT, and the digital portion stresses CD-I and DVI technology and applications. The most innovative of the latter is footage on Scott Steven's multimedia expert system for training programmers on code inspections (see the July 1989 *Communications*). This tape is a concise overview for newcomers to multimedia. ACM Press, 11 West 42nd St., New York, NY 10036, (212) 869-7440.

GT Recording sells audio and video tapes of the 1989 and 1990 CD-ROM conference sessions. If you order just one, make it Robert Abel's. GT Recording, 13100 Stone Avenue North, Seattle, WA 98133, (206) 364-9408.

C-Cube Microsystems, 399-A West Trimble Road, San Jose, CA 95131, (408) 944-6300.

EFI, 950 Elm Avenue, San Bruno, CA 94066, (415) 742-7300.

For information on *Compton's Multimedia Encyclopedia*, call Britannica Software at (800) 554-9862 for stand alone or library sales or Jostens Learning Corporation at (800) 521-8538 for networked versions for schools.

The Voyager Company, 1351 Pacific Coast Highway, Santa Monica, CA 90401, (213) 451-1383.

Warner New Media, 3500 Olive Avenue, Burbank, CA 91505, (818) 955-9999. 

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