A Selected Chronology of Computer Art: Exhibitions, Publications, and Technology

By Copper Giloth and Lynn Pocock-Williams

The following time line presents a historical review of computer art from 1960 to 1990 with an encapsulated summary of technological developments from the preceding fifteen years. To provide a context in which to see computer art, each year in the time line has been subdivided into three categories: exhibitions, publications, and technology. Following the time line is a selected bibliography of exhibition catalogues, books, and articles, and a glossary of common technical terms. Due to limitations of space, it is possible to list only a selection of exhibitions and publications.

The chronology of technical achievements is meant to give an overview of the most significant events. While dates are given as specifically as possible for the introduction of these technologies, many are only approximate. There are several reasons for this; many of the technologies were borrowed from other fields and their true origins are therefore somewhat obscure. Another complication arises from the fact that many of the ideas were "invented" several times for different classes of problems; that is, a new idea was commonly tried first in a research environment, then modified for use by computer professionals, and then changed again before being made available to artists.

Given current concerns with taking art in context, it seems impossible and unwise to separate any art from its economic, historical, social, political, or ethnic context; likewise, it is inadvisable to try to separate computer art from technological development and the intellectual history it implements and influences. The time line is an attempt to present computer art as a part of the interrelated cycle of technological innovation → application of technology → effect on culture → technological opportunities for artists → experimentation → art theorizing → education → intellectual evolution of culture → technological innovation, and around again. By placing this information in a time line we hope to reveal connections between the entries and provide a starting point for further personal investigation by the reader. Finally, the time line is meant to promote communication about events happening in different international cultures and within the realms of art, science, and technology.

Research for the technology portion of the time line and the glossary was done by Chris Dobbs; others who contributed include Jane Veeder, Justin P. West, Patric Prince, Suzan Shutan, Tekla McInerney, and Terry Gips.

Time Line

Note: An asterisk after an exhibition listing means that a catalogue was produced. Complete citations for exhibition catalogues, articles, and books appear in the bibliography. Additional books and articles are listed in the bibliography but not mentioned in the time line.

1945–1959

1945

Electronic Numerical Integrator And Computer (ENIAC) is completed (developed by John W. Mauchly and J. Presper Eckert)—the first general-purpose fully electronic computer.

1946

First point plotters are developed by Benson-Lehner and Electronic Associates, Inc.

"Light Gun," precursor of the light pen, is developed by the military for the Whirlwind project.

1950

RCA develops a version of color television compatible with black-and-white technology (to become NTSC).

1951

CRTs begin to be used as output devices for computers.

1952

Ben Laposky photographs an image from an analog screen.

1954

D. Ross creates "Scope Input Program" on Whirlwind, the first example of free-hand drawing with a computer.

mid-1950s

Line drawing plotters are developed by Benson-Lehner and Electronic Associates, Inc.

1959

Massachusetts Institute of Technology (MIT) Lincoln Labs develops first light pen for the TX-2 computer.

late 1950s

California Computer Products (CAL-COMP) develops plotters using stepping motors and moving-paper/fixed-pen designs.

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<table>
<thead>
<tr>
<th>Year</th>
<th>Publications</th>
<th>Technology</th>
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<tbody>
<tr>
<td>1960</td>
<td>Dennis Gabor, “Inventing the Future.”</td>
<td>William Fetter coins the term “computer graphics” to refer to plotter drawings.</td>
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<tr>
<td>1962</td>
<td>W. Clark and C. Molnar of MIT design the LINC (Laboratory Instrument Computer)—the first work station.</td>
<td>I. Sutherland develops his “Sketchpad” system, the first truly interactive computer-graphics system.</td>
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<tr>
<td>1963</td>
<td>L. Roberts develops the first practical hidden-line removal algorithm.</td>
<td>ASCII (American Standard Code for Information Interchange) is established as a standard.</td>
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<tr>
<td>1964</td>
<td>John Kemeny and Thomas Kurtz develop BASIC (Beginner’s All-Purpose Symbolic Instruction Code) programming language. Douglas Engelbart invents the mouse.</td>
<td>Rand Corporation develops the first positioning tablet. Kenneth Knowlton writes BEFLIX, the first general-purpose programming language for computer animation.</td>
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1966

**Exhibitions**

“P. Hertwig, K. Alslaben, Frieder Nake and Georg Nees,” Frankfurt am Main, Germany: Galerie d.

**Technology**

Experiments in Art and Technology (EAT) is founded by Robert Rauschenberg and Billy Klüver (physicist in laser research at Bell Labs) to promote collaborations by artists and scientists. F. Alterio and R. Dunlarey of Teletype Corporation develop Inktronic, the first ink-jet printer.

1967

**Publications**

*Exakte Aesthetik*, special issue on “Art from the Computer.”
Michael Noll, “The Digital Computer as a Creative Medium.”

**Technology**

Center for Advanced Visual Studies (CAVS) is established at MIT by Gyorgy Kepes to provide collaborative environment for artists and scientists. R. Masters and H. Fretheim of Control Data Corporation develop first touch-sensitive screen.

1968

**Exhibitions**

“On the Path to Computer Art,” Berlin: the parallel group in conjunction with a joint conference of MIT and the Technical University, Berlin.

**Publications**

Jack Burnham, *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century.*
Kawano Hiroshi, “The Aesthetic for Computer Art.”
*Leonardo* begins publication. (Numerous articles on computer art have appeared in this journal, which continues to be published.)

**Technology**

Oki Electric Industry Company of Japan develops a dot-matrix printer in order to produce Oriental characters.
Ilford introduces the Cibachrome process.
Robert Mallary develops TRAN2, the first program for the computer-aided design of sculpture.
First attempts at 2-D animation software take place.

![Robert Mallary, *Quad III*, 1968, laminated wood veneer, 86 x 16 x 16 inches. Private collection.](image-url)
1969

▼ Exhibitions
Galerie Franzius—a gallery specializing in computer-graphics art—is founded in Munich.

▼ Publications
Robert Mallary, “Computer Sculpture: Six Levels of Cybernetics.”

1970

▼ Exhibitions
“Interactive Sound and Visual Systems,” Columbus: College of Arts, Ohio State University.*
Venice Biennale, includes computer-graphics works by A. Lecci, Frieder Nake, Georg Nees, H. Ph. Peterson, Herbert Franke, and the Computer Technique Group of Japan.

▼ Publications
Gunther Pfeiffer, “Art and Computer.”
Jasia Reichardt, The Computer in Art.
Gene Youngblood, Expanded Cinema.

▼ Technology
Popularity of raster displays increases; vector displays decrease.
Color videotape recorders become available.
Nam June Paik and Shuya Abe develop Paik/Abe video synthesizer.

1971

▼ Exhibitions
“Arteonica,” Sao Paulo.
“Arte y Cibernetica,” Buenos Aires: Centro de Estudios de Arte y Comunicacion.


▼ Publications
Jack Burnham, “Problems of Criticism: Art and Technology.”
Jasia Reichardt, ed., Cybernetics, Art, and Ideas.

▼ Technology
First microprocessor is developed by Intel.
Michael Noll develops first random-access frame buffer.
Thomas Defanti develops GRASS (Graphics Symbiosis System), the first easy-to-program animation language.
1972

Exhibitions

Publications
Sonia Landy Sheridan, “Generative Systems.”

Technology
Noland Bushnell invents PONG—the first videogame; he founds Atari.
Dan Sandin builds the Image Processor and distributes plans for this user-built artist-oriented video synthesizer.

1973

Exhibitions
“Art y Computadoras,” Buenos Aires: organized by Jorge Glusberg as part of the first International Conference on Computing in the Humanities (ICCH) held also in 1975 and 1977.
“Art et l’ordinateur,” Bordeaux, France.

Publications

Technology
Videodiscs developed.
Thomas DeFanti and Dan Sandin establish the Electronic Visualization Lab at the University of Illinois at Chicago.

1974

Exhibitions
“Aesthetik als Informationsverarbeitung,” Vienna and New York.
“Art et informatique,” Angers, France.

Publications
Stewart Kranz, Science and Technology in the Arts: A Tour through the Realm of Science/Art.

Technology
Betamax—first home half-inch videocassette recorder—is introduced.
First truly personal computer, Altair Microcomputer, becomes available for $350.
Alvy Ray Smith (at New York Institute of Technology) develops PAINT, the prototype of most modern paint programs.
Benoit Mandelbrot begins development of the mathematics of fractal geometry.

1975

Exhibitions
“First Electronic Visualization Event,” Chicago: University of Illinois at Chicago Circle (interactive computer performances are also held in 1976 and 1978).

Publications
James Gips, Shape Grammars and Their Uses: Artificial Perception, Shape Generation and Computer Aesthetics.
George Stiny, Pictorial and Formal Aspects of Shape and Shape Grammars.

Technology
Bally introduces “Baseball” and “Gunfight,” the first videogames with animated human characters.
Sony introduces the Mavica (Magnetic Video Card) Video Card and Player—precursor of Mavica Videodisc.
First attempts at 3-D modeling and animation software take place.

1976

**Publications**

**Technology**
Steve Jobs and Steve Wozniak develop the Apple I and found Apple Corporation.

James Blinn develops “bump-mapping” algorithm for mapping texture onto virtual surfaces.
Society of Motion Picture and Television Engineers (SMPTE) forms High-Definition Television (HDTV) study group.

1977

**Exhibitions**
“Computer Genesis: A Vision of the ’70s,” Syracuse, N.Y.: Joe and Emily Lowe Art Gallery, Syracuse University.*

**Publications**
Charles Csuri, “3-D Computer Animation.”

**Technology**
Apple introduces the Apple II.
Alan Kay and Adele Goldberg of Xerox Palo Alto Research Center (PARC) publish “Personal Dynamic Media,” which introduces the idea of the “Dynabook” and contains the original ideas embodied in the Macintosh.
Victor Company introduces VHS (Video Home System) format.
Half-inch video cassettes emerge as the consumer format of choice.

1978

**Exhibitions**

**Publications**
*Computer Graphics World* begins publication.

**Technology**
Thomas DeFanti develops ZGRASS, a programming language for artists and educators.
Magnavox introduces the laser-vidodisc player.

“Space Invaders,” “Asteroids,” and “Pac Man” spark the videogame craze.
Aspen Movie Map Project—a videodisc-based project that allows a user to drive around a database of Aspen, turn corners, change seasons, and go into buildings—is designed by Architecture Machine Group at MIT.

1979

**Exhibitions**
“Ars Electronica,” Linz, Austria: International Bruckner Festival is initiated and continues as a yearly event.
“Cybernetic Symbiosis,” Berkeley: Lawrence Hall of Science.

**Publications**

**Technology**
Scitex Color System—allowing for electronic image color correction, text input, and layout design and manipulation—is developed.

Larry Cuba, *Two Space*, 1979, still frame from film.
1980

▼ Exhibitions
“Art In/Art Out,” Chicago: Ukrainian Institute of Modern Art.

▼ Publications

▼ Technology
Turner Whitted develops first ray tracer.
3M offers Scan-A-Mural service.
Quantel introduces its first digital video-effects device.
First “Symposium on Small Computers in the Arts” is held in Philadelphia.

1981

▼ Exhibitions
“SIGGRAPH '81 Art Show” is inaugurated in Dallas. (Exhibitions are now annual events, sometimes with a special focus. A catalogue and a slide set are produced.)

▼ Publications
Symposium on Small Computers in the Arts (first conference proceedings).

▼ Technology
IBM introduces the PC.
Music Television (MTV), the first 24-hour satellite-distributed cable-television program based on the visual interpretation of popular music (“rock videos”), is introduced.


1982

**Exhibitions**


**Publications**


Yochiro Kawaguchi, *Digital Image.*

**Technology**

Ampex introduces the ADO digital-video-effects device, the first system able to move two-dimensional images in three dimensions.

The Sony Mavica—the first still-video camera to be able to store images on a magnetic disc—is invented.

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1983

**Exhibitions**


“DIGICON ’83”—International Conference of Computer Arts, Vancouver.


**Publications**

Jean Baudrillard, *Simulations.*


Lucinda Furlong, “Notes toward a History of Image-Processed Video: Eric Siegel, Stephen Beck, Dan Sandin, Steve Rutt, Bill and Louise Etra.”

Grace Glueck, “Portrait of an Artist as a Young Computer.”


Gene Youngblood, “Computer Art as a Way of Life.”

**Technology**

Apple introduces LISA (Local Integrated Software Architecture) and Apple IIe.

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1984

\section*{Exhibitions}

"Artist as a Young Machine," Toronto: Ontario Science Center.
"CADRE '84," San Jose, Calif.: San Jose State University Art Department.*
"Immagini da Computer, Mostra di Computer Grafica," Prato, Italy.*

\section*{Publications}

Stan Augarten, Bit by Bit: An Illustrated History of Computers.
Herbert W. Franke, Computergrafik-Galerie; Bilder nach Programm: Kunst im elektronischen Zeitalter.
Hiroshi Inose and John Peirce, Information Technology and Civilization.
Lee Silverman, "Inside the Loop: Computer Graphics within the Technological Highway."
Thomas Defanti, "The Mass Impact of Videogame Technology."

\section*{Technology}

Apple introduces the Macintosh with a commercial that emphasizes its totalitarian control of information. This 60-second spot airs only once but is replayed as a news item.
Canon introduces the first consumer-grade laser-print engine.
IBM develops a one-million-bit RAM (random-access memory).
Mitsubishi video printer is introduced; it prints black-and-white images from video signals.
Wavefront Technologies introduces first comprehensive, commercially available software system incorporating modeling, motion choreography, and rendering.
(All 3-D animation software had been available only in research areas of industry and academia.)

1985

\section*{Exhibitions}

"The Artist and the Computer II."
Louisville, Ky.: Louisville Art Gallery.*

\section*{Publications}

Roy Ascott, "Concerning Nets and Spurs."
Katherine Dieckmann, "Electra Myths: Video, Modernism, Postmodernism."
Lucinda Furlong, "Tracking Video Art: 'Image Processing' as a Genre."
Copper Giloth and Jane Veeder, "The Paint Problem."
Joan L. Kirsch, "When Will Computer Art Be Taken Seriously?"
Joachim Schmid, "The Electronic Photographer is Coming."
Visual Computer begins publication.

\section*{Technology}

Amiga PC is introduced and used by many artists and educators as a personal instrument.

1986

V Exhibitions
“The Computer as an Art Tool,” Greenwich, Conn.: Hurlbut Gallery.

V Publications
René Berger and Lloyd Eby, eds., Art and Technology.
Nancy Burson, Richard Carling, and David Kramlich, Composites: Computer-Generated Portraits.

V Technology
Megaprint, a laser-scanning computer-airbrush system, produces billboard-scale prints.

1987

V Exhibitions

V Publications
Cynthia Goodman, Digital Visions.
Hal Foster, ed., Discussions in Contemporary Culture: Number One.
Catherine Richards, “Virtual Worlds, Digital Images.”

V Technology
Apple introduces the Mac II.
Scanners for PCs become available.
AT&T shows the Pixel Machine at SIGGRAPH, demonstrating its capability to manipulate ray-traced objects in real time.
Hypercard—a personal-computer implementation of hypermedia concepts—is released by Apple.
SMPTE Working Group on High-Definition Electronic Production gives unanimous endorsement to the 1125/60 HDTV production standard.
The Fine Art, Science, and Technology (F.A.S.T.) Electronic Bulletin Board is founded by Ray Lauzzana at the University of Massachusetts at Amherst.

1988

V Exhibitions

V Publications
Timothy Binkley, “Camera Fantasia.”
Christopher Burnett, “Computers and Art in the Age of the World Picture.”
Timothy Druckrey, “User Friendly?”
David Ross, The Art of David Em: 100 Computer Paintings.
Wim Van Der Plas, ed., Electronic Art.

V Technology
FAX machines are mass marketed.
1989

**Exhibitions**


**Publications**

John Lansdown and Rae A. Earnshaw, eds., *Computers in Art, Design, and Animation.*

Martha Rosler, "Image Simulations, Computer Manipulations: Some Considerations."

**Technology**

Intel introduces the 80860 microprocessor chip—equivalent power of a Cray I supercomputer.
Mass marketing of still video cameras begins.

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1990

**Exhibitions**

"Computers and the Creative Process."
Venice Biennale, United States Pavilion—Jenny Holzer.

**Publications**

Renee LeWinter and Cynthia Baron, "Artistic Challenge."
Fred Ritchin, *In Our Own Image: The Coming Revolution in Photography.*
Dorothy Spencer, "Computer Art—An Oxymoron? Views from the Mainstream."

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Charles Csur, Interactive Sound and Visual Systems (Columbus: College of Arts, Ohio State University, 1970).

Eighth European Systems-Engineering Symposium (Madrid: Palacio de Oriente, 1971).


Exposition d’art photoélectrique (La Chartreuse, Villeneuve-les-Avignon, France: Computer Culture, 1983).


Copper Giloth, ed., SIGGRAPH ’82 Art Show.

Copper Giloth, ed., SIGGRAPH ’83 Exhibition of Computer Art.

Patrick Whitney, ed., SIGGRAPH ’84 Computer-Supported Design Exhibition.

Louise Ledeen, ed., SIGGRAPH ’85 Art Show.

Patric Prince, ed., SIGGRAPH ’86 Art Show.

Joanne P. Culver, ed., SIGGRAPH ’87 Art Exhibition.

Lucy Petrovich, ed., SIGGRAPH ’88 Art Show (videotape catalogue).


Mark Resch, ed., SIGGRAPH ’89 Art Show: Computer Art in Context.


Roberta Williams, The Artist and the Computer II (Louisville, Ky.: Louisville Art Gallery, 1985).

Books


Jean Baudrillard, Simulations (New York: Semiotext(e), 1983).


Jack Burnham, Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century (New York: Braziller, 1968).


Hal Foster, ed., Discussions in Contemporary Culture: Number One (Seattle, Wash.: Bay Press in association with the DIA Art Foundation, 1987).


Herbert W. Franke and Horst Helbig, Die Welt der Mathematik: Computergrafik zwischen Wissenschaft und Kunst (Düsseldorf: VDI-Verlag, 1988).


### Articles


Timothy Druckrey, “User Friendly?” *Artforum* 9, no. 3 (Spring 1988).


Robert Mallary, “Computer Sculpture: Six


Gene Youngblood, “Computer Art as a Way of Life,” *Send*, no. 8 (Fall 1983).

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**Glossary**

**Algorithm**
A set of well-defined instructions for the solution of a problem.

**Analog**
A scale of measure that is continuous, like the volume control on a stereo, or a thermometer. The term refers also to signals that have not been sampled.

**Artificial intelligence**
The scientific field concerned with creating computer systems that can achieve “human” intellectual faculties such as the abilities to perceive, reason, and learn.

**Computer animation**
Use of the computer to make images with the illusion of movement.

**CRT**
Cathode ray tube. The picture tube of a television set, video monitor, or computer display.

**Cursor**
A small graphic symbol used as a pointer to indicate position on a display screen. The movement of the cursor is controlled by a keyboard, mouse, light pen, or tablet stylus.

**DataGlove**
A glove containing sensors, worn on the hand to detect the motion and position of the hand and feed that information to a computer. It is useful for virtual-reality applications.

**DataSuit**
The extension of the DataGlove for the whole body.

**Digital**
Using discrete numbers to represent information. On computers, these numbers are combinations of 0 and 1.

**Digital processing**
The task of taking digital information and changing (“processing”) it through the use of an algorithm.

**Digitizer**
An input device used to transform a graphic representation into a digital representation so that it can be processed by a computer. Types include video digitizers, laser scanners, and tablets.

**Display**
An output device that contains a CRT and interprets data from the computer, showing it as text and images. A computer screen is a display.

**Dot-matrix printer**
A printer that uses tiny hammers to strike an inked ribbon to produce dots on paper. Many dots together make up an image.

**Film recorder**
An output device that records data onto photographic film or paper.

**Fractals**
A term, coined by Benoit Mandelbrot, for a type of mathematics very useful for understanding and defining certain natural shapes and phenomena.

**Frame buffer**
A special type of computer memory that stores the image data required for a raster display.

**Graftal**
A type of modeling that creates plants and trees by describing them in mathematical terms. Alvy Ray Smith developed these algorithms based on the earlier work of Aristid Lindenmayer.

**Hardware**
The physical components or equipment that make up a computer system, such as scanners, printers, and displays.

**HDTV**
High-definition television. A proposed television system with significantly better picture quality than that of the current broadcast standard.

**Hypermedia**
An extension of the idea of hypertext to include other kinds of information, such as video images and sound.

**Hypertext**
A term coined by Ted Nelson (based on a 1945 article by Vanavar Bush) for an environment where information can be linked freely across conventional subject boundaries. An essential concept is that of “authoring,” the ability of each user to easily reorganize the information into a customized body.

**Ink-jet printer**
A printing device that creates an image by spraying a thin stream of ink onto paper. Colored ink can be used, resulting in color images.

**Interactive**
As applied to computer art, any computer, device, program, or artwork that relies on active communication with a human being.

**Laser printer**
A printing device that uses a laser beam to place images on a rotating drum. The drum picks up a toner powder on the laser-exposed areas, which are then pressed and fused into paper, forming the image.

**Laser scanner**
A digitizer that uses a laser beam for the conversion of an image into digital information.
Light pen
An input device, much like a writing pen, that is used to draw and manipulate information on a computer display by touching the tip of the pen to the display.

Microprocessor
The arithmetic, logic, and control elements required for processing information, usually contained on one integrated-circuit chip. Microprocessors are used inside most personal computers and in a wide variety of specialized applications, such as computer-controlled light signs.

Mouse
A device, connected to a computer by a cable, for moving a cursor or other object around on the display screen. As the mouse moves, the cursor moves correspondingly on the screen.

Network
A system of interconnected computers and other hardware that allow for the exchange of information. Networks can link computers in the same room or in various parts of the world.

NTSC
National Television Standards Committee. The standard for broadcast color television used primarily in North, Central, and South America, and Japan.

Pixel
An acronym for “picture element.” The smallest unit on the display screen that can be stored, displayed, or addressed. Pixels are the tiny dots that are seen when an image displayed on a computer screen is examined closely.

Plotter
An output device that draws lines or points on paper under the control of a computer. It was used extensively for early computer art.

Printer
An output device for the production of text and images that works much like a typesetter but is given instructions from a computer. Dot-matrix, ink-jet, laser, and thermal are the major types of printers.

Program
A set of instructions, written in a programming language, used to instruct a computer to carry out specific activities or tasks (algorithms).

Programming language
A scheme of formal notation used to spell out instructions for the computer. Programming languages include BASIC, Pascal, and C.

Raster display
A display device that stores and displays an image (data) as a two-dimensional grid of pixels.

Ray tracer
A computer program that produces realistic images from geometric models of objects. The surroundings appear in the surfaces of the reflective objects, enhancing the realism of the scene.

Scan-a-Mural
A service (offered for several years by 3M Corporation and now offered by Computer Image Systems) whereby a computer image can be transferred to a large-scale canvas.

Scientific visualization
Use of computer graphics and animation techniques to give visual form to complex numerical data.

Software
Another name for programs.

Still-video camera
A camera that does not require film but rather makes an electronic record of an image and stores it on a small magnetic disk. The image can then be displayed on a video monitor or put into a computer.

Tablet
A digitizer, normally consisting of a flat tablet, on which a pattern is traced over with a penlike stylus or other cursor device. The patterns traced by the operator are automatically entered into the computer’s memory for subsequent processing.

Thermal printer
A printer that produces output on heat-sensitive paper. It uses heat to melt wire particles that contain ink, which are then transferred to paper.

Three-dimensional modeling
The use of a computer system to create a three-dimensional object by defining its shape, dimensions, color, and surface texture.

Touch-sensitive screen
A display screen on which the user can enter commands by pressing designated areas with a finger or other object. The screen can detect the position where it is touched, and the computer then performs the function indicated.

Vector display
A display in which images are drawn on the screen of a CRT by a beam that constructs a series of lines, or “vectors,” of any length and at any angle.

Video digitizer
A digitizer consisting of a video camera with specialized hardware and software that enables the conversion of an image into digital information.

Virtual reality
A computer-generated interactive environment featuring stereoscopic 3-D graphic scenes. One or more players are immersed in this environment by headgear presenting a video monitor to each eye and blocking out the natural world. Interaction is provided by means of a DataGlove, which conveys gestural information to the computer. Current applications include telepresent operators in remote or dangerous environments, e.g., space and research in cognition and human interaction. Also called virtual environment.

Virtual surface
The surface of an imaginary object defined within a computer.

Work station
A relatively small but powerful configuration of computer equipment designed to be used by one person.

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