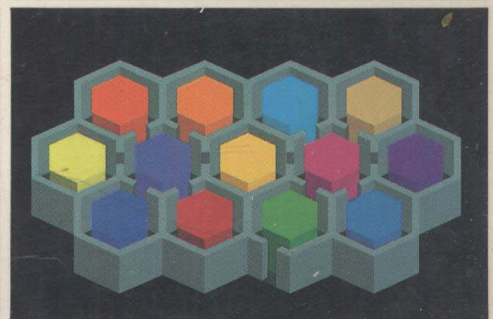
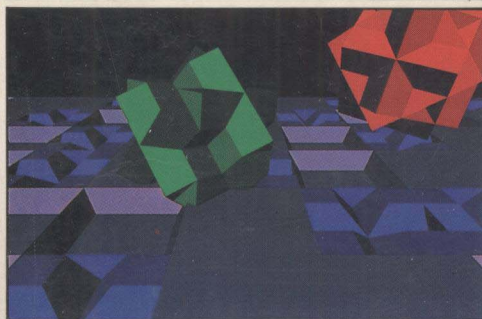
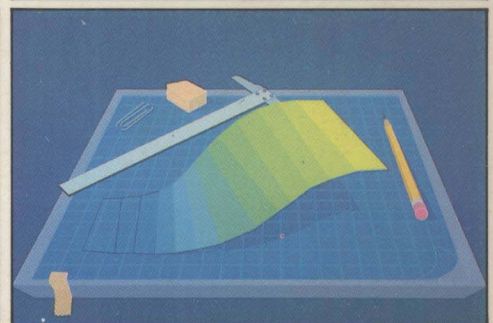
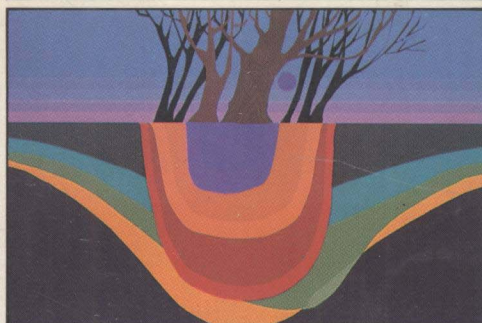
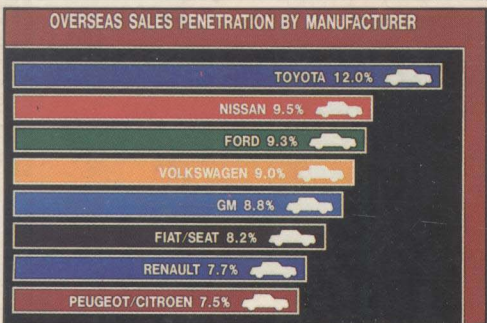
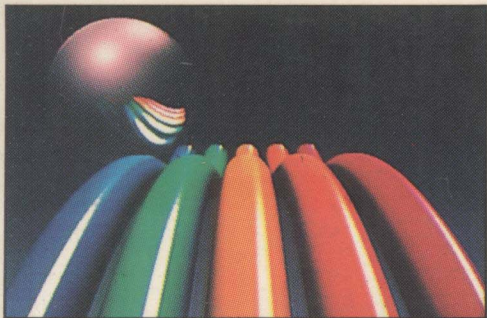


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A-Z GUIDE TO COMPUTER GRAPHICS

by John Lewell



A-Z

GUIDE TO

Computer Graphics

JOHN LEWELL

McGRAW-HILL BOOK COMPANY

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Madrid Mexico Montreal Panama Paris San Juan São Paulo Tokyo Toronto

*to my sisters
Pam and Mary,
and to their families*

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PREFACE

In this *A-Z Guide to Computer Graphics* I have attempted to write a book that will be truly useful to people who are becoming involved, either remotely or intimately, with computer graphics. Since it is a new concept in A-Z guides, combining both technical and commercial information, a few words of introduction may help the reader to use the book effectively.

First, every reader will be aware that there is already a mountain of information on computer graphics. It is the job of experts to burrow into the mountain, to find what it contains, and then to contribute some unique portion of their own. However, this book is not the result of burrowing but of climbing. I have tried to climb the mountain of information, sifting through several tons of product literature, lecture notes, magazine articles, interviews, and extraneous material, in order to gain a better view of the surrounding territory. In so doing, I have made what I hope can serve as a "road map" to the subject. With this book the reader need be only one step away from all the information he or she might require.

Computer graphics is a technology that has revolutionized the ways in which we create images. Its impact on image making is certainly greater than that of word processing on writing. Although it is too early to put computer graphics into a true historical perspective, we can at least judge its significance by making some comparisons.

In one sense, there can be only two types of images: those that move (on video, television, and film); and those that remain static (on paper, canvas, or some other material). Equally, there are only two ways of creating them: by taking pictures of real objects (recording them), or by making representations of objects by virtue of drawing or painting their images on some kind of surface (constructing them.)

Regardless of meaning, quality, or application, these four categories not only hold true, but they also have four possible permutations. Twenty thousand years ago, we were *constructing* images that were *static* on the walls of our caves. One hundred thirty years ago, we were already quite accomplished at *recording* static images, as we can see from the photographic record of the American Civil War. With the birth of cinematography, just as the nineteenth century was ending, we began to record *dynamic* images for the first time. Indeed, so spectacular was this new technique, especially in its electronic manifestation (television), that not everybody noticed when the fourth and remaining permutation was finally cracked in the early 1960s. Suddenly, for the first time in history, we could *construct dynamic* images by using an interactive graphics display.

It may be argued that professional animators had been constructing dynamic images for years prior to the advent of computer graphics. However, professional animation is a time-consuming and exacting craft—definitely not a pursuit for anyone engaged in some other area of activity. By contrast, the great strength of computer graphics is its broad generality. It can be applied within 1001 professions and to an almost unlimited range of tasks. It has already made significant and often revolutionary contributions to engineering, architecture, industrial design, medicine, astronomy, cartography, demography, physics and chemistry,

statistical analysis and display, film and television production, printing and publishing, and even to the fine arts. The list could be extended to cover every activity where models and images are an essential means of communicating information.

Furthermore, computer graphics encompasses the other permutations. It can be used for generating static images, such as charts, graphs, or fully pictorial illustrations. It can also be used for manipulating images that have been recorded by some other means. Photographs can be digitized; ultrasonic images such as those from CAT scanners can be entered into a computer; remotely sensed images from outer space can be turned into digital data and, like the other examples given, be manipulated using the full range of computer graphics techniques.

Since there are so many possibilities, the graphics industry itself has become very large, very quickly. There are now literally thousands of products on the market in response to an unprecedented demand that began to gather momentum at the beginning of the 1980s. In fact, the total number of *potential* computer graphics users in the United States alone is now estimated to be over 30 million people. It is to these people, as much as to the existing 1.5 million (or so) users, that this book is directed.

Not only architects, engineers, and others who have extensive technical training, but also artists, illustrators, and designers who may have little or no knowledge of computing are having to address the new terminology of computer graphics. The questions that all these people are asking can range from the basic (“What is a raster display?”) to the more complex (“What is octree encoding?”), and from the general (“What is micrographics?”) to the specific (“What is the telephone number of Pacific Data Images?”)

These are the sorts of questions that the *A-Z Guide to Computer Graphics* tries to answer. Of course, a single book cannot answer every question, no matter how encyclopedic its contents. There are many omissions, some (no doubt) accidental, others intentional. In the Information Age, the only intelligent approach to such a project is to be selective rather than to be doggedly encyclopedic.

Despite the omissions, the book contains hundreds of “signposts” to further sources of information. It lists books, magazines, professional societies, on-line databases, computer graphics conferences, newsletters, and corporate publications. It is extensively cross-referenced, and readers are urged to follow-up these references in order to find the master entry: such as *conference calendar* or *periodicals*. I have extended this concept to the technical terminology—where some entries are cryptic, while others are much more explanatory.

One special challenge in writing this book was in deciding whether or not to include actual product information within the company profiles. The graphics industry is highly volatile, this year’s “hot product” rapidly being replaced by another system that performs the same task ten times as efficiently. Magazine reviews of computer graphics books regularly complain about texts being “dated,” even though one or two excellent texts have continued to be useful for a full ten years after their publication. On this subject, I might note that a few of my own magazine articles (although not those that appear regularly in the specialist computer graphics press) have spent up to twice as long “in production” as this particular A-Z guide.

In fact, thousands of products have been mentioned, and in some cases described at length. Without them, the book would not be a real guide to the industry. Although many of these products may soon be replaced by more elaborate, more cost-effective systems, nearly all of them will still be in use (if not on sale) in 1990 and beyond. Furthermore, most

manufacturers' product lines have their own ongoing momentum. Via Video's System One has been upgraded to System Two, and we can reasonably expect to see, eventually, a System Three and a System Four occupying similar niches in the market. Fortunately, radical changes of product policy, such as that by Computervision in 1983–1984, are relatively rare, and even amid the glut of new software, major packages such as EUCLID, TEMPLATE, DISSPLA, and MOVIE.BYU have life spans over many years.

Rather than include any corporate financial information, I have simply indicated the approximate status of each (leading) company within the industry. Other directories can be consulted for the names of senior personnel if these names should be needed. More important, and unlike other directories, greater space has been given to those corporations that have correspondingly greater volumes of production. Again, although this book lists more companies than can (at the time of writing) be found in any other comparable source, there are still many fine companies with graphics products and services that have not been included. Their omission is entirely my fault, and efforts will be made to include them in any subsequent editions.

Finally, I should mention that the *A–Z Guide to Computer Graphics* contains terminology from areas that are more loosely related to the chief topic and focus of the book. These terms have been taken from graphic design, printing, animation, cinematography, and the study of visual perception. For newcomers to the industry I have also added some general computing terminology, once again curbing the urge toward “completeness” in favor of carefully selected information.

Here, then, is the *A–Z Guide to Computer Graphics*. If you find it useful, it will have fulfilled its purpose.

John Lewell
Irvine, California

A

Abel Graphix: Robert Abel & Associates Abel Graphix is the software marketing arm of Robert Abel & Associates, a leading television commercial production company which pioneered the use of computer graphics techniques in animation. It was the first production company to install an Evans & Sutherland Multi Picture System II, originally for the purpose of creating electronic storyboards to show clients dynamic compositions that would later be realized by live-action, motion-control, or conventional special-effects animation (see figure). However, the system soon became one of the favored tools for generating the animation itself. Later, adding raster capability to the studio, the company has continued to develop new techniques with computer graphics. Some of the software has been packaged and is sold through Abel Graphix for machines with 32-bit architecture. Abel Graphix, 953 North Highland Avenue, Hollywood, CA 90038 (213) 462-8100

aberration Departure from an ideal light-ray path, causing an imperfect optical image.

abscissa The horizontal distance of a point from the y -axis (see figure). Compare: *ordinate*.

absolute coordinates Coordinates specifying absolute positions in *world coordinate* space. See also: *relative coordinates*.

absolute vector A *vector*, the *endpoints* of which are defined in terms of units from a specified *origin*.

ACADE Association for Computer Art and Design Education. A nonprofit organization conceived by executives of Artronics, Inc., to promote the use of computer graphics products in art and design. ACADE, 300-C Corporate Court, P.O. Box 408, South Plainfield, NJ 07080 (201) 756-9278

acceleration voltage In a CRT, the very high electrical voltage applied to the metallic coating on the interior sides of the tube to propel electrons toward the surface of the display. The velocity attained by the electrons is a function of the acceleration voltage. See also: *cathode ray tube (CRT)*; *thermionic emission*.

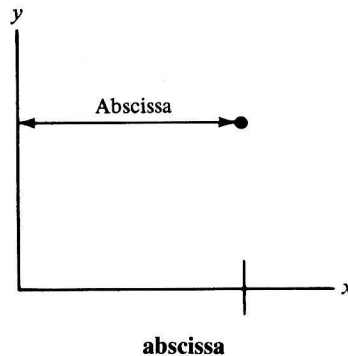
Accent Software, Inc. Developers of personal computer software packages, especially for Apple computers. The Graphic Solution is a general-purpose graphics system that has a true animation capability and can be interfaced with a KoalaPad for freehand drawing. It is intended for business graphics applications rather than professional animation. Accent Software, Inc., 3750 Wright Place, Palo Alto, CA 94306 (415) 856-6505

access time The elapsed time between the application of an input pulse and the availability of output signals.

accuracy aids Preprogrammed techniques in interactive graphics to help the designer achieve positioning accuracy on the screen. Accuracy aids are necessary in computer-aided drafting and design (CADD) where the hardcopy output of a plotter is usually more accurate than the display monitor. They include: *constraints*, screen grids (see: *grid constraints*), *distance roundoff*, and point placement by numeric coordinates.



Abel Graphix Frame from a TV commercial made for TRW by Robert Abel & Associates. A whole series of commercials for TRW has featured advanced computer animation and has been seen by millions of viewers.



achromatic color “Color” which has only gray levels but no *hues*. It is measured in terms of *intensity*, on a scale ranging from black to white.

achromatic point In the *CIE Color System*, the point at which the relative strengths of the three color components are equal. The point is achromatic because it represents a color shade of neutral gray.

acoustic radar The use of ultrasound (ultrahigh-frequency sound waves) to determine the position of an object in space. Acoustic radar techniques have been used in the design of graphic input *data tablets*. Such a tablet consists of two sets of *transducers*, positioned at right angles, for transmitting and receiving the ultrasound waves, together with control electronics (see figure). Sound is generated by the transmitting transducer. It travels to the hand-held stylus or cylindrical cursor—from which it is reflected—the returning wave being picked up by the receiving transducer.

There are several applications for the acoustic radar data tablet. It allows rear projection onto an evenly translucent surface without the interference of embedded wires. The stylus itself needs no connecting cable. Work on acoustic radar tablets has been carried out at the Federal Institute of Technology, Zurich, Switzerland.

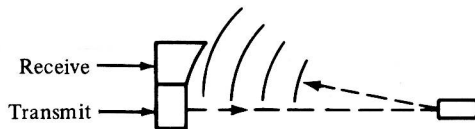
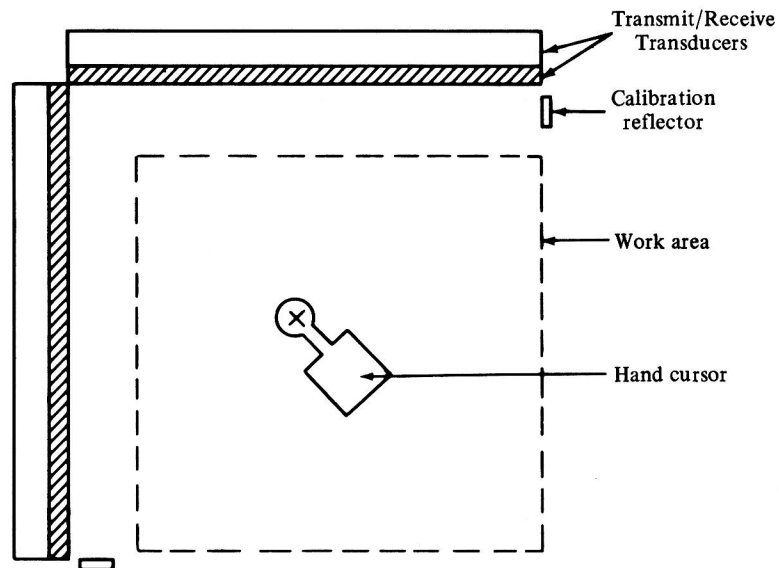
active-edge table In finding pixel values of polygons for storage in a raster refresh buffer (scan conversion), a table defining the set of edges intersecting a scan line.

acuity A measure of an observer’s ability to distinguish detail on a test target. It is a numerical value, expressed as a ratio of distances. For example, it might be 8/12, meaning that the observer can distinguish an object at 8 meters with the same resolution that a person of normal vision can distinguish at 12 meters.

acutance A measurement of image definition derived from calculating the average slope from a trace across an edge made with a *microdensitometer*.

Adage, Inc. A major manufacturer of interactive color raster and vector refresh computer graphics workstations. Formed in 1957, Adage has gained more experience than most companies in this competitive field and has become the leading manufacturer of plug-compatible workstations for IBM mainframe computers. Its products are used primarily for CAD/CAM and image processing applications.

Some of the Adage vector and raster systems share many of the same subassemblies, enabling the company to achieve economies of scale in manufacturing. The 3000



acoustic radar Using ultrasound to determine a cursor or stylus position.

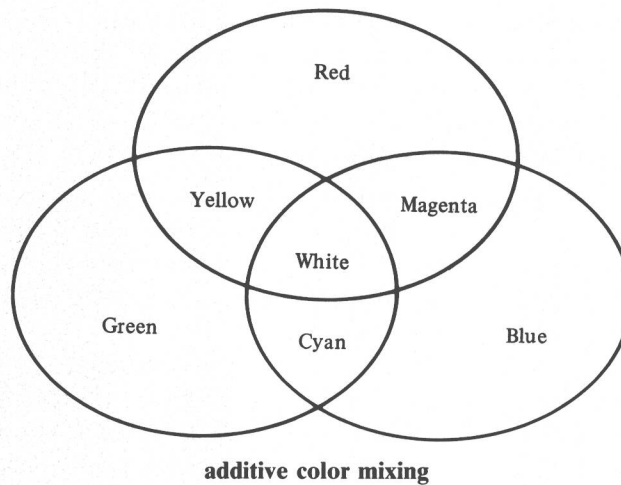
and 4000 series of raster workstations are both extensive ranges for users in most application areas. They are both supported by a wide choice of application development software. For example, SEISMIC 3000 is a graphics package for geophysical professionals; and SOLID 3000 is a solids modeler which allows the 3000 to be integrated into existing CAD/CAM, simulation, molecular modeling, and medical imaging applications, in addition to in-house software development. Adage, Inc., One Fortune Drive, Billerica, MA 01821 (617) 667-7070. Europe: Adage GmbH, Mainzer Strasse 75, D-6200 Wiesbaden, West Germany. (6121) 700034

ADC See: *analog-to-digital converter*.

addend One of two *operands* used in addition. The addend is added to the *augend*, producing a *sum*. Whereas the addend remains in its original form after addition, the augend is replaced by the sum.

additive color mixing Reproducing colors by the mixing of red, green, and blue light (see figure). Additive color mixing is widely used in video and computer graphics display technology.

additive primary colors Red, green, and blue are the three additive primary colors. When RGB light sources are mixed, additive primaries produce white. However, additive primaries do *not* produce white when printed on a reflective surface. Their complements



are the *subtractive primaries*: cyan, magenta, and yellow—and it is these colors that are used in printing.

address A character, group of characters, or some other bit pattern that identifies a particular storage location in a computer memory. It also identifies the destination of a data item that is being sent from one part of a computer system to another.

addressable point Any (screen) position which can be expressed in *device coordinates*. The smallest addressable point in a raster display is the *pixel*.

address space The area defined by the coordinate system representing the internal digital limits of the display device (CRT, plotter, etc.)

Adobe Systems, Inc. Developers of the POSTSCRIPT page image description language for text/graphics systems. Adobe was formed in 1982 by leading industry professionals to address the need for printing text, graphics, and photographic images in an integrated manner. With Adobe's printing systems, output can be generated for laser printers, film recorders, and displays. Both text and graphics can be scaled and rotated, allowing business graphics, forms, and other documents to be edited before high-quality (300 dots/inch, or better) printing. This powerful Adobe software has evolved from original work done at Xerox Palo Alto Research Center—which also led to the well-known Apple Lisa and Macintosh approach to text/graphics manipulation. Adobe Systems, Inc., 1870 Embarcadero Road, Palo Alto, CA 94303 (415) 852-0271

Advanced Color Technology, Inc. An early leader in color ink-jet printing for computer graphics, ACT has continued to refine this technology and offers a range of low-cost ink-jet printers. Following the successful ACT I, the first of the Chromajet Series was called ACT II. It is a small (18-kilogram) desktop machine which uses replaceable ink cartridges for up to 3000 copies between changes. It will print an 8 × 11 inch page with solid area fill in 90 seconds. Three groups of four jets each spray yellow, magenta, and cyan ink, yielding up to 125 shades, with horizontal resolution of up to 140 dots/inch; vertical, 85 dots/inch. Advanced Color Technology, Inc., 21 Alpha Road, Chelmsford, MA 01824 (617) 256-1222

Advanced Computer Graphics, Inc. A service bureau founded in 1978 to address the needs of utilities and municipalities in computerized mapping and records conversion. It now offers a full range of services, from aerial photogrammetry and planimetric mapping to sophisticated database development and data conversion. Advanced Computer Graphics, Inc., 9316 North 107th Street, Milwaukee, WI 53224-8880 (414) 354-8880

Advanced Electronics Design, Inc. A leading supplier of color graphics terminals, DEC-compatible Winchester disk controllers and other products. Formed in 1973, AED initially focused on the market for disk storage components and subsystems. The disk product line grew extensively and (in 1979) provided a base for AED's entry into CAD with the first of its raster terminals: Model 512.

The enormous success of Model 512 led to development of higher-performance models: 767 and 1024 (note that these numbers correspond to vertical resolution). Complete workstations followed, the first being the AED-S11, based on the 767 terminal, and incorporating a dedicated CPU for local processing and storage. The Colorware System 23 was launched in 1984: a DEC-based family of workstations with LAN capability via DECNET. AED has worldwide distribution and support services. Advanced Electronics Design, Inc., 440 Potrero Avenue, Sunnyvale, CA 94086 (408) 733-3555

Advanced Technology Center Software developers, marketing a wide range of interactive computer graphics and image processing tools. GRAFPAK-CORE is a library of user-callable routines for building graphics applications. P-CUBED is a general-purpose tool for image processing R&D, with a library of routines and a powerful command interpreter. Advanced Technology Center, 5183 Overland Avenue, Culver City, CA 90230 (213) 836-5852

A/E Architecture and Engineering.

AEC Architecture, Engineering, and Construction. A sector of the CAD systems market.

AED, Inc. See: *Advanced Electronics Design, Inc.*

AET See: *active-edge table.*

aftereffect In visual perception, an effect which gives the impression that a visual stimulus is larger, smaller, or otherwise altered, owing to the influence of a prior stimulus. For example, staring at a large rectangle will make a smaller rectangle appear even smaller than normal when attention is immediately shifted to it. Psychologists found (in one experiment) that the perceived size of a circle varied by as much as 18 percent when preceded by other larger and smaller circles. Kohler's famous experiment with "inverting eyeglasses" showed that an aftereffect could persist for several minutes. If a subject wore inverting glasses for a number of days he or she would eventually see the world as being the "right way up." But when the glasses were removed, an aftereffect (seeing the world upside down) was experienced.

afterimage In visual perception, an image which resembles the stimulus but is seen after the image has been removed. An afterimage is distinct from a *persistent image* in that its duration tends to increase with a corresponding increase in luminance. For a persistent image, the opposite holds true. Afterimages can best be seen when the eyes are closed immediately after receiving the stimulus. They may be positive or negative, that is, seen

in their original colors or in complementary colors. These two types are thought to have different causes: positive afterimages being the result of continued firing of nerve cells; negative afterimages being the result of temporary "bleaching" of photopigments in the eye.

AGI Alliance Graphique Internationale. An international organization of graphic designers and illustrators.

AI See: *artificial intelligence*.

AIGA American Institute of Graphic Arts. The AIGA was founded in 1914 in New York City, to "do all things which would raise the standard and the extension and development toward perfection of the graphic arts in the United States."

aiming symbol A movable *cursor* on a display screen, indicating where a *pick device*, such as a *light pen*, is pointing. A *screen cursor*.

air brush In graphic arts, a small compressed-air paint spray for producing smoothly shaded illustrations. The term is also used in computer graphics paint systems to describe an effect that simulates painting with an air brush. In this technique, *pixels* appear to be "sprayed" onto the image area that is being "painted."

albedo In astronomy (and hence: *image processing*): surface whiteness. Albedo is defined as the proportion of solar light incident upon an element of the surface of a planet, which is again reflected from it.

algorithm A series of instructions or procedural steps for the purpose of solving a specific problem.

aliasing The occurrence of unwanted visual effects, particularly jagged lines and edges (*jaggies*) in raster images, caused by improper sampling techniques. Other examples are: *Moiré patterns*, and, in animation, the illusion of backward-spinning wheels caused by a conflict of frequencies between spoke patterns and the film running speed of 24 frames/second.

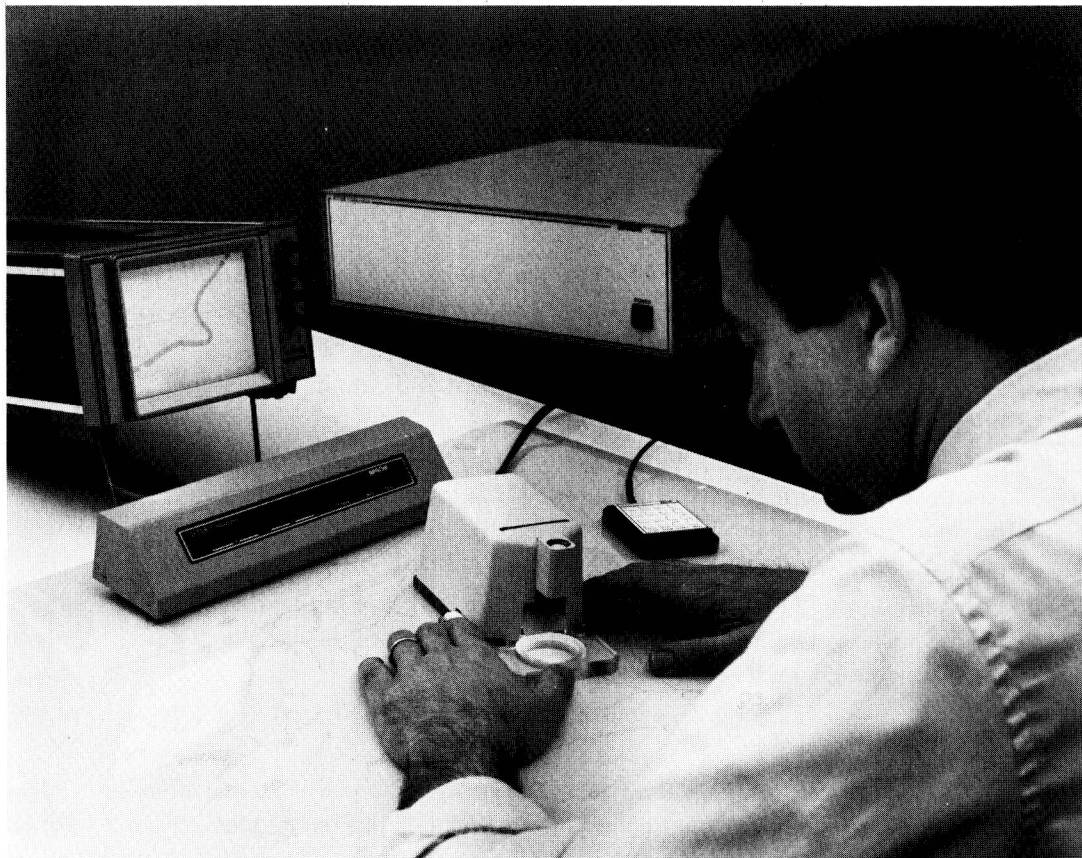
The word alias means "masquerade" (to appear as something else). In computer graphics, aliasing is cured by *antialiasing* algorithms, which can greatly improve the quality of a display.

alignment whites A range of accurately specified color reference points, used in the factory alignment of color CRT monitors. Most monitors are aligned to the CIE Illuminant D6500. See: *Illuminant D*.

alphanumeric (Having) letters of the alphabet, together with numerals and symbols: as on an alphanumeric keyboard.

alphanumeric display A CRT that displays *text strings* of alphanumeric characters rather than fully *bit-mapped* graphics.

Altek Corporation Designers and manufacturers of digitizing equipment for both general and specialized applications. Founded in 1970, Altek offers a wide range of products, including the world's largest digitizing table: the 42 × 130-inch DATATAB. Altek's specialized cursors, controllers, and tablets are widely used in photogrammetry (see figure). Altek Corporation, 2150 Industrial Parkway, Silver Spring, MD 20904 (301) 622-3906



Altek Corporation The Apache Scanning Cursor with separate 16-button function keyboard, controller, and calibration unit.

Alternate View Corporation Developers of business graphics software, including design-support graphics. Founded in 1982, Alternate View developed the IMAGE software package which will run on Prime computers. Alternate View Corporation, 1653 East Main Street, Rochester, NY 14609 (716) 654-9030

ALU Arithmetic Logic Unit: the components of a CPU that perform arithmetic and logical operations.

alychne In color diagrams, the straight line representing hypothetical colors of zero *luminance*.

ambient light Light that is assumed to be uniformly incident from the environment, and reflected equally in all directions by the surface.

AM-Bruning A division of the Chicago-based corporation AM-International, Inc., and a major supplier of CAD software, drafting materials, and equipment. Among other products, the company offers sophisticated general-purpose CAD software for the HP200 computers. Am-Bruning, 1800 Bruning Drive West, Itasca, IL 60143 (312) 351-2900

American Intelliware Corporation A software developer, producing packages for personal computers, for a variety of business and other applications. MACFACTS is a complete

package for filmmakers that runs on the Apple Macintosh computer. It combines graphics and word processing to help the user with scriptwriting; editing; storyboarding; production, budget, and travel planning; drawing up contracts; and creating a "talent database." American Intellware Corporation, 330 Washington Street, Marina del Rey, CA 90292 (213) 827-0803

AMF Logic Sciences, Inc. A specialist in raster conversion and raster display, being a significant manufacturer of board-level products (such as video controllers and raster conversion boards), and off-line plotters and seismic workstations. Founded in 1973, the company is a subsidiary of AMF, Inc. (White Plains, NY), a corporation with diversified interests.

The HSR-11 is a bit-slice rasterizing device which converts seismic data and vectors into raster data for plotting. It forms a part of both the OPS-11 off-line plotting system and of the Remgraph III seismic workstation. A user of Remgraph III can call up data stored in the HSR-11 for display, evaluation, and analysis. AMF Logic Sciences, Inc., 10535 Rockley Road, Houston, TX 77099 (713) 879-0536

AM/FM Automated Mapping and Facilities Management. A term, coined by Henry Emery, to help communication between people using computer graphics for geographical purposes. "Automated mapping" refers to the graphical representation of ground features and their relationship to each other, including all constructed features such as buildings, roads, sewers, and electrical installations. "Facilities management" refers to the management of all information in land facility databases.

An AM/FM project is one in which the records of a local government or utility are changed from conventional paper- or film-based systems to computer graphics systems. It implies an ongoing project with continued updating once the information is organized into a substantial and structured database. Other users of AM/FM systems include site developers and planners, airport authorities, and military and industrial designers.

Specialist consulting and management firms can advise users on AM/FM projects. Among manufacturers of AM/FM systems are Calma, Computervision, IBM, Interactive Systems, Intergraph, and Synercom.

AM/FM International is a nonprofit educational organization devoted to this field. See also: *Keystone conference*.

Amtron Corporation Manufacturers of color graphics monitors for the OEM market. The Amtron CD Series color video display yields flicker-free, noninterlace performance for 1280 × 1024 format. Amtron Corporation, 2260 De La Cruz Boulevard, Santa Clara, CA 95050 (408) 748-8500

analog Class of computers using numbers represented by continuously varying (but measurable) physical quantities. As contrasted with "digital computers," which use numbers expressed directly as digits.

Analog Technology Corporation Designers and manufacturers of performance-enhancement printer controllers for serial dot-matrix and other types of printers. For example, ATC's Model 2000 series provides a range of specialized functions, such as forms, label, and barcode printing and vector mapping. It plugs into CIE 300 and 600 line printers, Siemens DT80 ink-jet printer, and many other systems. Analog Technology Corporation, 15859 East Edna Place, Irwindale, CA 91706 (818) 960-4004

Analog-to-Digital Converter (ADC) An A/D converter or (ADC) is a device that converts continuous electrical signals to digital form. It is frequently used in graphics computers to convert signals from such devices as *track balls* and *joysticks* into digital signals that can be handled by a computer. See also: *digital-to-analog converter*.

analog vector generator A device which takes *endpoint* coordinate data from a *display list* and converts it into analog deflection signals for controlling an electron gun in a CRT.

anamorphic image In cinematography, an image having lateral compression (i.e., optically squeezed in the horizontal dimension) produced by an anamorphic lens. Enables wide-screen ratios to be printed on normal 35mm film (see figure).

Anderson Report See: *newsletters*.

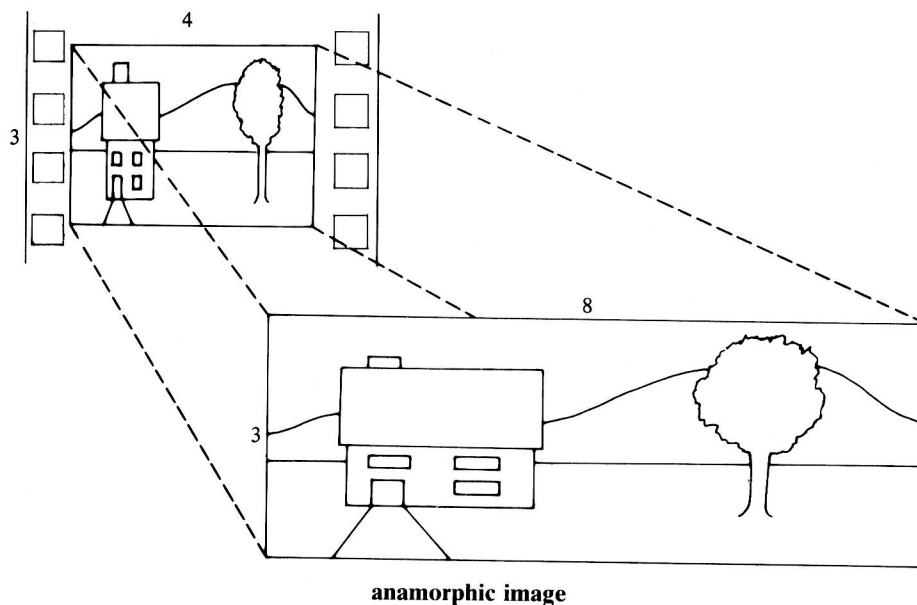
angstrom unit A measurement of wavelength, equal to one ten-billionth of a meter. There are 10 angstrom units in 1 nanometer.

animate To produce the impression of movement by the rapid presentation of a series of still drawings, slides, or video frames. See also: *computer animation*.

Ann Arbor Terminals, Inc. A leading manufacturer of computer terminals, including Graphics Master, a Tektronix-compatible graphics enhancement for the Ann Arbor Ambassador terminal. Ambassador is available in both portrait and landscape formats, has a 94-key detached keyboard and 15-inch screen, and displays 60 lines of text. Ann Arbor Terminals, Inc., 6175 Jackson Road, Ann Arbor, MI 48103 (313) 663-8000

anomalous trichromatism A form of defective color vision in which the *cone pigments* of the eye are not present in normal proportions. This results in reduced sensitivity to one of the three corresponding hues: red, green, or blue.

ANSI American National Standards Institute. The Institute has played a key role in seeking, examining, and encouraging *graphics standards*. ANSI Technical Committee X3H3 studied the SIGGRAPH 1979 report on Core Graphics Systems, later breaking up into



smaller "license plate" subcommittees. X3H33 examined VDI (Virtual Device Interface), and X3H35 looked at yet another proposed standard: PMIG (Programmers' Minimal Interface to Graphics). The latter has since been absorbed by the ascendant GKS (Graphics Kernel System) standard that originated in Europe.

answer print In filmmaking, the first projection print submitted to the production company by the processing laboratory for approval. If approved, bulk printing of release prints is made.

antialiasing Software techniques to reduce unwanted visual effects, such as those of jagged lines in raster images. In this example, a diagonal line is considered as having actual width as well as length. Values are then calculated for all the pixels overlapped by the line. These are switched to varying degrees of color and/or intensity, giving the appearance of smoothing the line. Other forms of antialiasing technique are required to reduce other types of *aliasing*.

Antics A computer animation package, developed in the United Kingdom by Alan Kitching and colleagues at Grove Park Studio Animations Ltd. Antics is a 10-megabyte FORTRAN program requiring a 32-bit processor and a virtual memory system. It has been implemented on VAX/VMS, Prime/PRIMOS, Cray 1, and Motorola 68000. Grove Park Studio Animations Ltd., 104 Grove Park, Camberwell, London SE5 8LE, England (01) 274-5395

ANTIOPE Acquisition Numérique et Télévisualisation d'Images Organisées en Page d'Écriture. The French national *videotex* system. Antiope has two main components: Antiope-Didon (the *teletext* component) and Antiope-Titan (the *viewdata* component). The latter is often referred to by its brand name: Teletel.

APAC Conference The annual Arabian Productivity Advancement using Computers/Graphics conference and exhibition, sponsored by the World Computer Graphics Association (WCGA) and several other organizations. The show receives the participation of top government officials from Middle Eastern countries. His Royal Highness Prince Saud Bin Naif Bin Abdul Aziz is chairman of the advisory board. APAC is held in Riyadh, Saudi Arabia, in February (date subject to change).

aperture cards Cards on which microfilm frames are mounted for more convenient scrutiny and handling. Card-mounted microfilm is something of a contradiction, the chief purpose of *microforms* being to reduce the storage bulk of documents. Although aperture cards have easy manual handling and updating characteristics, their advantages are gradually being eroded by the widespread use of graphics displays, computerized retrieval, and updatable films. See also: *microfiche*; *microfilm*; *microform*; *micrographics*.

APL Bibliography Commercial *on-line database* holding all references dealing with the APL programming language. Access: I. P. Sharp. Suppliers: I. P. Sharp Associates, Box 418, Exchange Tower, 2 First Canadian Place, Toronto, ON M5X 1E3, Canada (416) 364-5361.

Apollo Computer, Inc. A leading computer corporation, and the creator of DOMAIN processing, the concept of distributed computer power over a local area network of dedicated 32-bit engineering workstations. DOMAIN has been one of the most successful concepts in networked systems and enjoys exceptionally good software support.

The DOMAIN product family consists of two DOMAIN Server Processors (DSP 80