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ADAGE GRAPHICS SYSTEMS

GENERAL INFORMATION MANUAL



adage

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ADAGE GRAPHICS SYSTEMS

Adage Graphics Systems are the most advanced computer graphics systems now available. They combine the latest in computer/cathode ray tube technology with a full range of powerful, easy-to-use software designed to minimize the time and effort required to tailor the capability of the hardware to the user's particular application.

Adage Graphics Systems have for the first time reduced the price, increased the power, and simplified the use of computer graphics to the point where they are now economically useful in a wide variety of applications areas.

These include mechanical and structural design, placement and routing of components, structural analysis, signal analysis, situation display, and simulation of complex and dynamic situations.

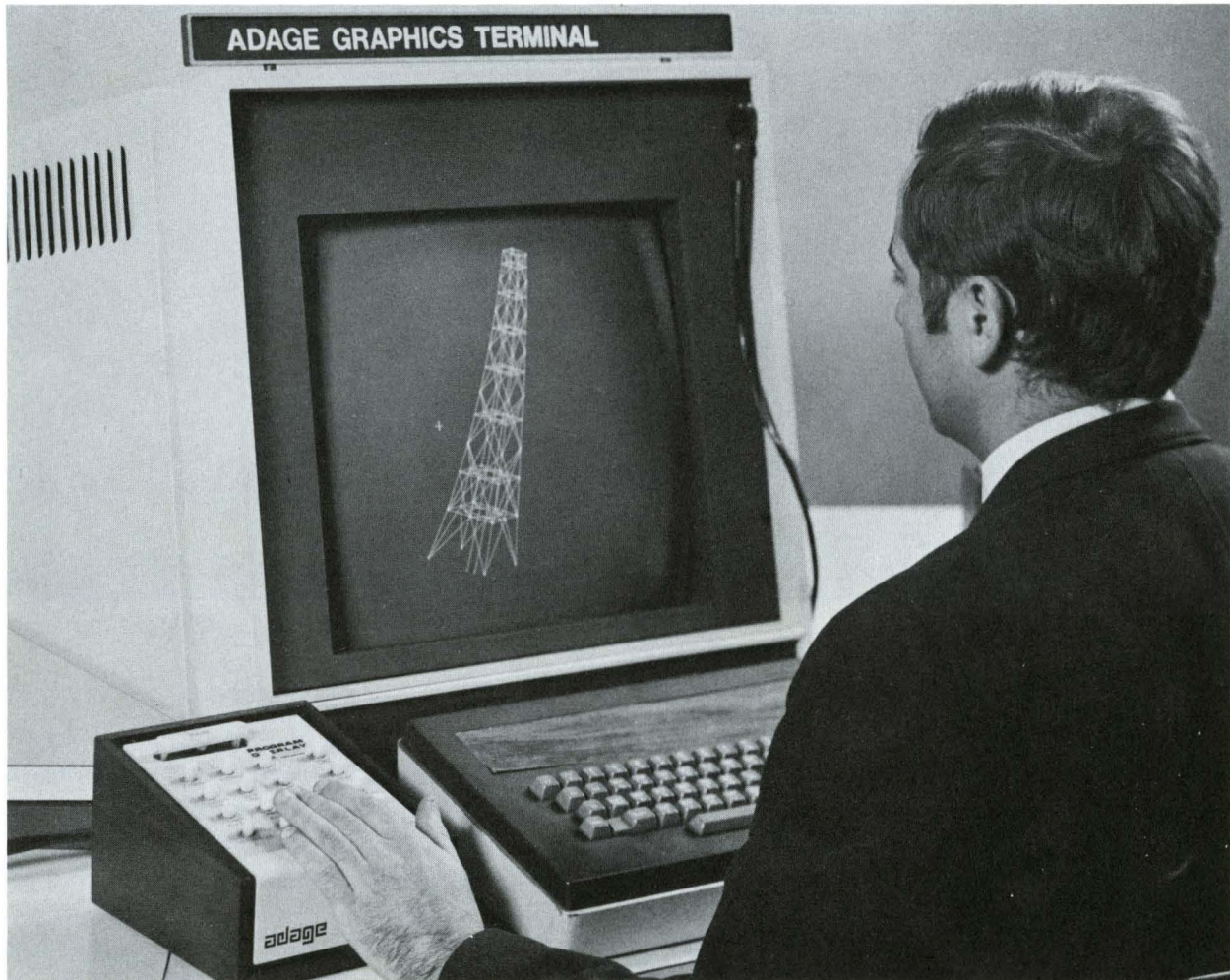


Figure 1.

COMPUTER GRAPHICS CONCEPTS

Graphics processing involves the use of a computer, a cathode ray tube display, and various control instruments to look at and modify pictures in different ways. A picture may be displayed in an original position, transposed to a different location, rotated to a new orientation, scaled to a new size, or any combination of these. The picture may be two- or three-dimensional. Parts of the picture may be handled independently, or the whole picture all at once.

Pictures are drawn from data stored within a computer which are combined with parameters specifying orientation to control the electron beam of a cathode ray tube and produce an image on the screen.

Data to define the picture may be derived by extraction from a large mass of data which has been previously recorded and entered into the computer for analysis. Examples of this use are signal analysis of oil well logs (Figure 2), and radar traces (Figure 3). Here tremendous amounts of data are recorded, representing a physical event, and entered into a computer, where analysis is done to select information of interest.

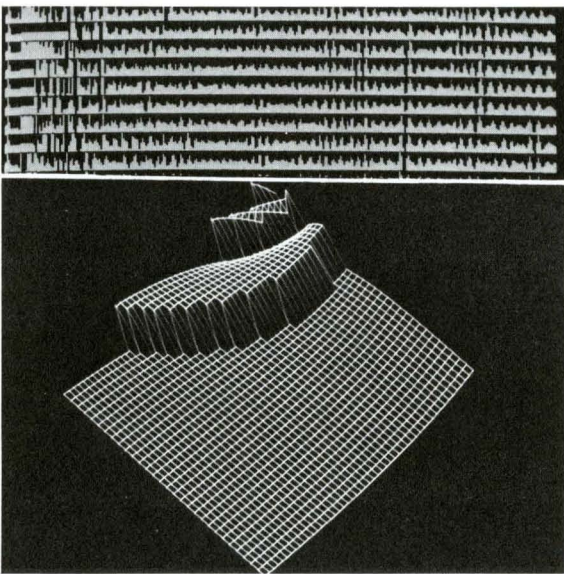


Figure 2.

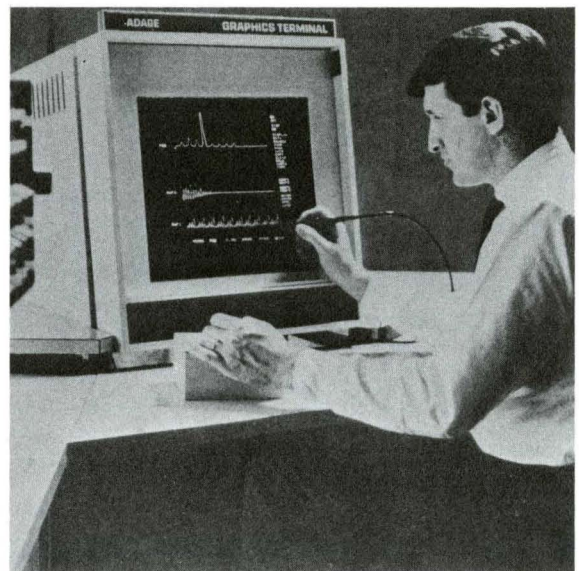


Figure 3.

The selected information is presented in picture form for further analysis by the trained eye of an expert, having at his disposal full capability to look at the picture in a variety of different ways. This usually becomes an interactive process in the sense the analysis done by the expert on the pictures selected often results in modifications to the selection procedure. Pictures are of value here because there is too much data gathered at each moment of real time to make sense of their interrelationships by reading a list of numbers. Computer analysis is of value to reduce the number of pictures displayed to those which are of more than routine interest. Graphics processing is of value in seeing the information which has been determined to be of interest in a variety of different perspectives and relationships.

Another source of pictures might be the rough sketch of a designer. Entered into the computer, it can then be displayed, manipulated, and modified until it satisfies the aesthetic and engineering requirements of the designer. More and more complex designs can be constructed using sections previously built up in this manner. Examples of this use are structural design (Figure 4), and circuit design (Figure 5).

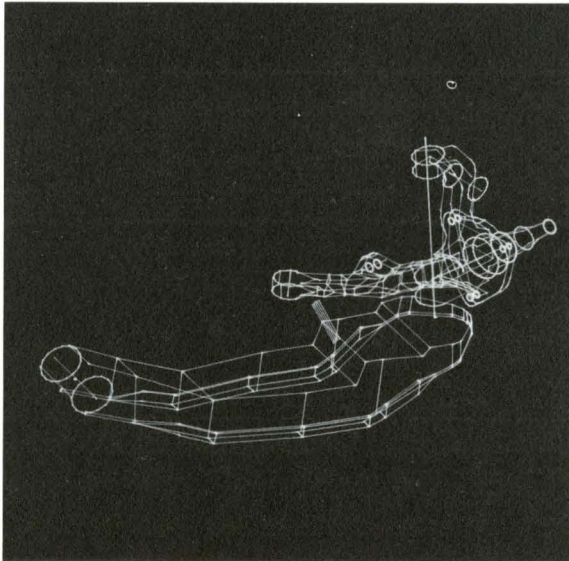


Figure 4.

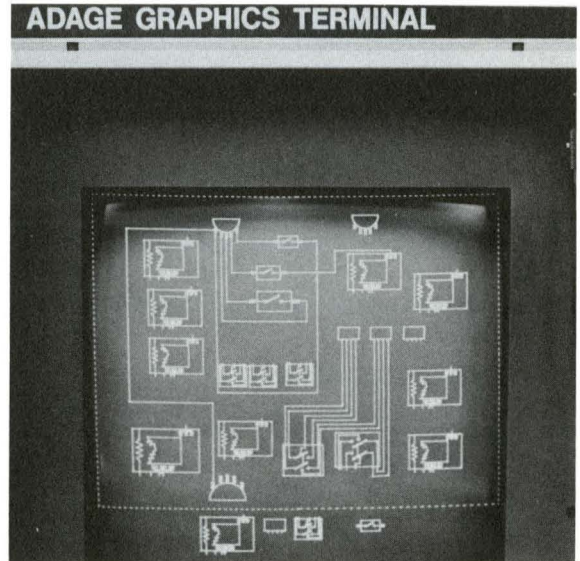


Figure 5.

A third major source of pictures is data generated by the computer to simulate a physical system. Here the pictures presented show graphically what would happen in a variety of "what if" situations, without the need for a live test. Simulations can also be used to test an individual's reaction to a situation, or to train him to react in a certain way, where the cost or hazard of real-life training is excessive.

One example of this use is the presentation of simulated air traffic control data to airline pilots (Figure 6).



Figure 6.

Some situations combine elements of all these examples. The picture displayed may be derived partially from data sketched in, partially from data generated by the computer based on the sketches, and partially from a data base previously recorded, entered, and stored.

The size and complexity of the problem will determine the components of the graphics system required to handle it. The size and power of the computer required relates to the amount of data being processed, the complexity of the processing, and the speed in which it must be done. The cathode ray tube display depends of the resolution required in the picture, the speed at which it must operate, and the type of data to be displayed. The control units selected are determined by the type of manipulation to be done to the picture.

Adage Graphics Systems are a combination of advanced hardware and software capable of performing these applications. Adage manufactures a full range of graphics hardware, allowing the user to configure a system that meets current needs and can be easily adapted to meet changing requirements. Adage also supplies extensive system software, matched to the hardware configuration, to allow the user to generate applications programs quickly and easily.

ADAGE GRAPHICS TERMINALS - THE HARDWARE

The Adage Graphics Terminal (AGT) provides the capability for fast, efficient, and flexible display and manipulation of images. The AGT configuration is shown in Figure 7. An AGT consists of three major elements -- a digital processor, a display generation system, and facilities for interaction.

THE DIGITAL PROCESSOR

The AGT contains, as an integral part, a powerful computer, the DPR4, especially designed for efficient image processing while retaining the full capabilities of a general-purpose digital processor. The AGT can be operated as a stand-alone system, using its own computer to perform all processing. It can also be connected via data channel or telephone line to a larger processor whose greater power, speed, and capacity are used for the data processing while the AGT more effectively and economically handles the graphic display and interaction.

The standard digital processor used in the AGT contains 8,192 30-bit words of core storage, with a 1- μ s cycle time. Additional core storage up to 32,768 words is available. Appropriate magnetic tape and disk storage units can be added, as well as a wide variety of peripherals. Communications and software interfaces are available to couple AGT Terminals with the most widely used large-scale computers and their operating systems. Software systems are supplied to match the hardware configuration selected.

An ASR-33 Teletype Unit is provided as standard equipment for operator communication. This unit includes a keyboard, a teletypewriter, and an eight-level paper tape reader/punch.

The following input/output, storage, and communication devices are available as standard options on the DPR4. Additional devices can be specially interfaced, if required.

Disk Storage

The DMS3 Disk Memory System provides fast access mass memory, with an average seek time of 35 ms. Up to four disk drives can be attached through a DMS3-P1 Disk Controller. The disk drives can be any combination of DMS3-P2 or DMS3-P3 Disk Drives. These have character capacity of 6.75 million and 13.5 million characters, respectively. Both drives contain two disks of equal storage capacity, one fixed and one in a removable cartridge or "pack."

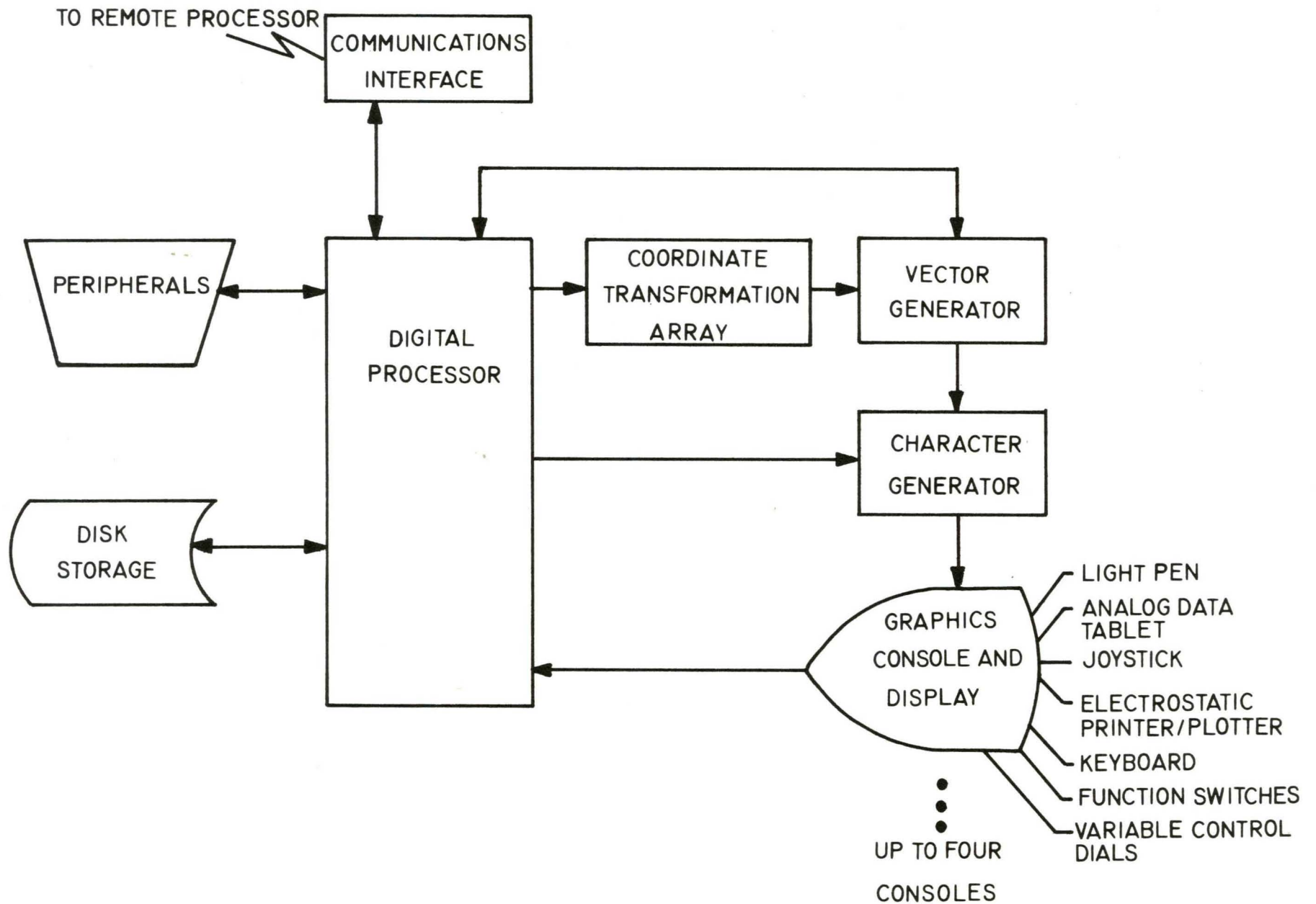


Figure 7.

Magnetic Tapes

Up to four magnetic tape units, of three types, can be attached to the AGT system. An MTC1-NP1 Magnetic Tape Controller is required to interface to the processor and works through a Tape Formatter to control tape units, as follows:

<u>Tape Unit</u>	<u>Tracks</u>	<u>Bits per Inch</u>	<u>Inches per Second</u>	<u>Formatter</u>
MTP9-P1	9	800	45	MTP9-P4
MTP9-P2	7	556/800	45	MTP9-P4
MTP9-P3	9	1600	25	MTP9-P5

An MTP9-P4 Tape Formatter is required wherever either one or more MTP9-P1 or MTP9-P2 Tape Units are attached. An MTP9-P5 is required wherever one or more MTP9-P3 Tape Units are attached.

Card Reader

The CDR1 Card Reader reads 80-column IBM punched cards at the rate of 200 cards per minute. Both BCD and binary cards may be read.

Paper Tape Facilities

Three devices are available to provide eight-channel paper tape handling capability. Reading speed is up to 300 characters per second, punching speed is up to 60 characters per second. All units have fan-fold bins. The PRP1-NP1 is a reader only, the PRP1-NP2 is a punch only, and the PRP1-NP3 is both a reader and a punch.

Communications Interfaces

Several options are available for communications with external systems or devices.

Data Phone Interface

The DPI1-NP1 provides full-duplex transmission/reception of eight-bit USASCII characters in conjunction with a communications modem equipped with an Electronics Industry Association (EIA) interface. Data is sent and received in bit-serial format between the DPI1-NP1 and the modem. The DPI1-NP1 is designed to operate on voice-grade channels.

The DPI1-NP2 is identical, except that it transmits eight-bit EBCDIC, rather than USASCII character codes.

Graphics Terminal Interface

The GTI2 Graphics Terminal Interface (Basic) provides a blocked, half-duplex, parallel data transfer between an AGT and another computer. The basic interface contains a logic section for control of word transfers in both directions, a data register, and a logic section to provide level changing and data synchronization between the two computers. Data paths of 8, 12, 16, 18, 24, or 30 bits can be accommodated. The peak word transfer rate (assuming less than 3 μ s response time in the remote computer) is 66 KHz. The basic GTI2 provides an interface to DEC PDP-8/PDP-9/PDP-10/PDP-11/PDP-15, Univac 1108, XDS Sigma Series, or Data General NOVA/SUPER NOVA. Where the basic GTI2 is not sufficient to handle the interface with an external computer, it can be expanded on a special order basis to include whatever additional features are required. For IBM 360/370 channel connection, a special interface, the GTI2-360, is required. AGT-to-AGT connection is available via GTI2-AGT interface.

CDC 6673/6674 Telephone Interface

The TCI1-NP1 Telephone Communication Interface controls full-duplex data transfers to a remote CDC 6673 or 6674 Data Set Controller, and is designed to operate with common-carrier broadband equipment. The TCI1-NP1 operates at any broadband serial rate up to 50 kilobaud.

Wideband Telephone Line Interface

The TLI1 Wideband Telephone Line Interface controls full-duplex transfers to communication modems at speeds from 2 to 50 kilobaud. Versions are available compatible with most computer communications requirements and interface standards, as follows:

	<u>Bell 301/303</u>	<u>MIL STD 188B</u>	<u>RS232 (Bell 201)</u>
USASCII*	NP1	NP6	NP11
EBCDIC*	NP2	NP7	NP12
Transcode*	NP3	NP8	NP13
CDC 6673/6674	NP4	NP9	NP14
Univac 1108	NP5	NP10	NP15

*Binary Synchronous Communications (IBM Systems Reference Manual A27-3004-0).

DISPLAY GENERATION

The second major component of an Adage Graphics Terminal is the display generation subsystem. Patterns on the face of a cathode ray tube are formed when an electron beam is directed to strike certain phosphor elements on the face of the tube. The beam is switched on and off and moved by a sequence of changing voltages to form the desired shapes or characters. Digital signals from the processor must be fed into a digital-to-analog converter to produce these voltages. A pattern could be formed by plotting individually from data stored in the processor each individual point required to make up the

desired image. This would, especially where the patterns are complex, or complex and dynamic transformations of the patterns are continuously required, place a considerable storage and processing burden on the processor and cause the display to operate slowly. To relieve this burden on the processor, as well as the programming that would be required to generate pictures in this manner, Adage Graphics Terminals are provided with several hardware features and options.

Each AGT contains a vector generator and a character generator. The vector generator automatically generates the voltages to draw either solid or dashed lines between successive coordinates supplied to it. One of several drawing modes available is automatically selected to maximize the drawing rate according to the types of vectors to be drawn. The character generator, similarly, needs only the symbol representation of the character to draw all the points making up that character.

At an even more sophisticated level, each AGT has a hardware Coordinate Transformation Array. This device allows a pattern, which has been stored in the digital processor as a list of successive coordinate points, to be displayed on the scope with any desired scaling, translation, and/or rotation, without the need for the processor to recompute new coordinates.

Coefficients loaded by the processor into the coordinate transformation array cause it automatically to generate from the original set of coordinates a new set, reflecting the transformations. These coordinates are then passed to the vector generator for display.

The coordinate transformation is done "on the fly" between the processor and the vector generator, and does not decrease the data rate. Included also on the AGT/130 and AGT/150 arrays is a high-accuracy analog-to-digital converter driven from a multiplexer. The ability to digitize the output of the array allows the beam position to be determined. This allows complex pictures to be "frozen" or converted to simple display lists.

The AGT/110 has a 2 x 2 Coordinate Transformation Array designed to handle two-dimensional images. Both the AGT/130 and AGT/150 have a 4 x 3 Coordinate Transformation Array, providing full three-dimensional transformation with intensity modulation representing the Z dimension.

The AGT/110 array is shown schematically in Figure 8; the AGT/130 and AGT/150 arrays are shown schematically in Figure 9.

The AGT/150 has an additional hardware capability provided by its EIP2 Extended Image Processing Unit which allows increased display speed for complex graphics, and further reduces the load on the digital processor. It assures that both the array and the vector generator work at maximum efficiency to put as much data as possible on the display scope in the shortest possible time. The EIP2 features hardware addressing to speed up vector fetching, additional information formats which require less storage in the processor for complex images, and a point mode which allows drawing a point at any specified coordinates with a single command.

Characteristics of the display generation subsystems are shown in Figures 11 and 12.

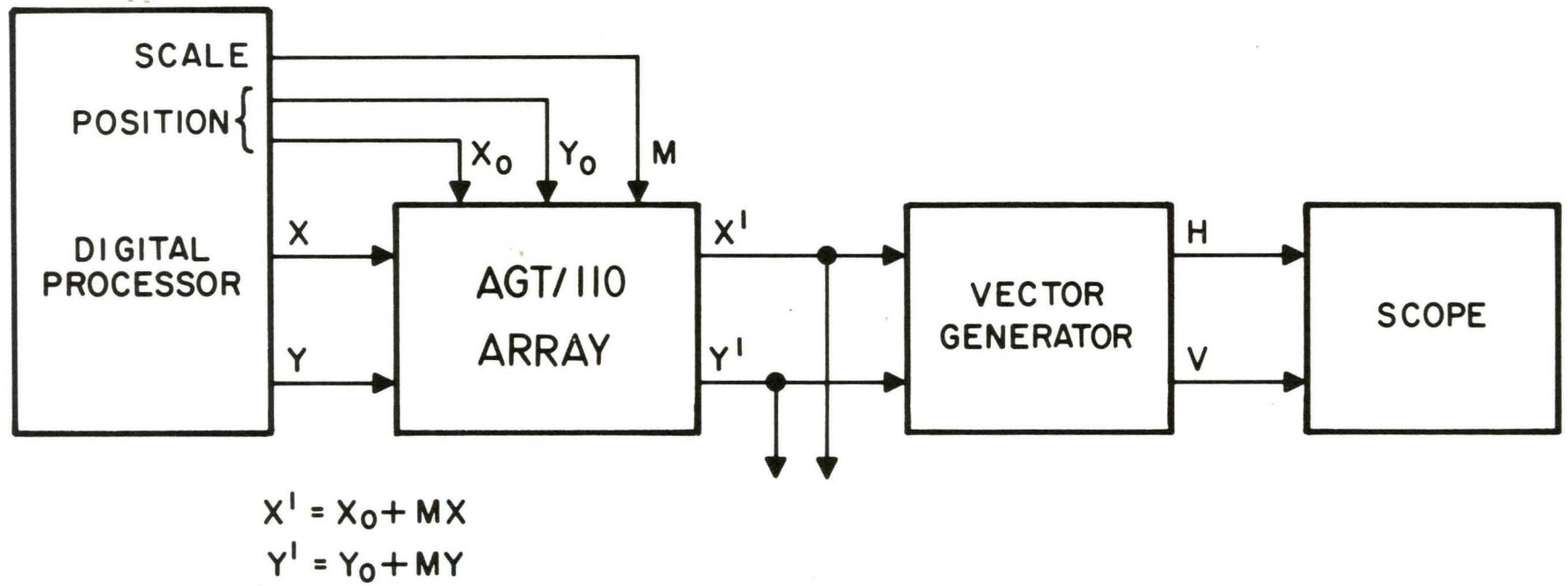
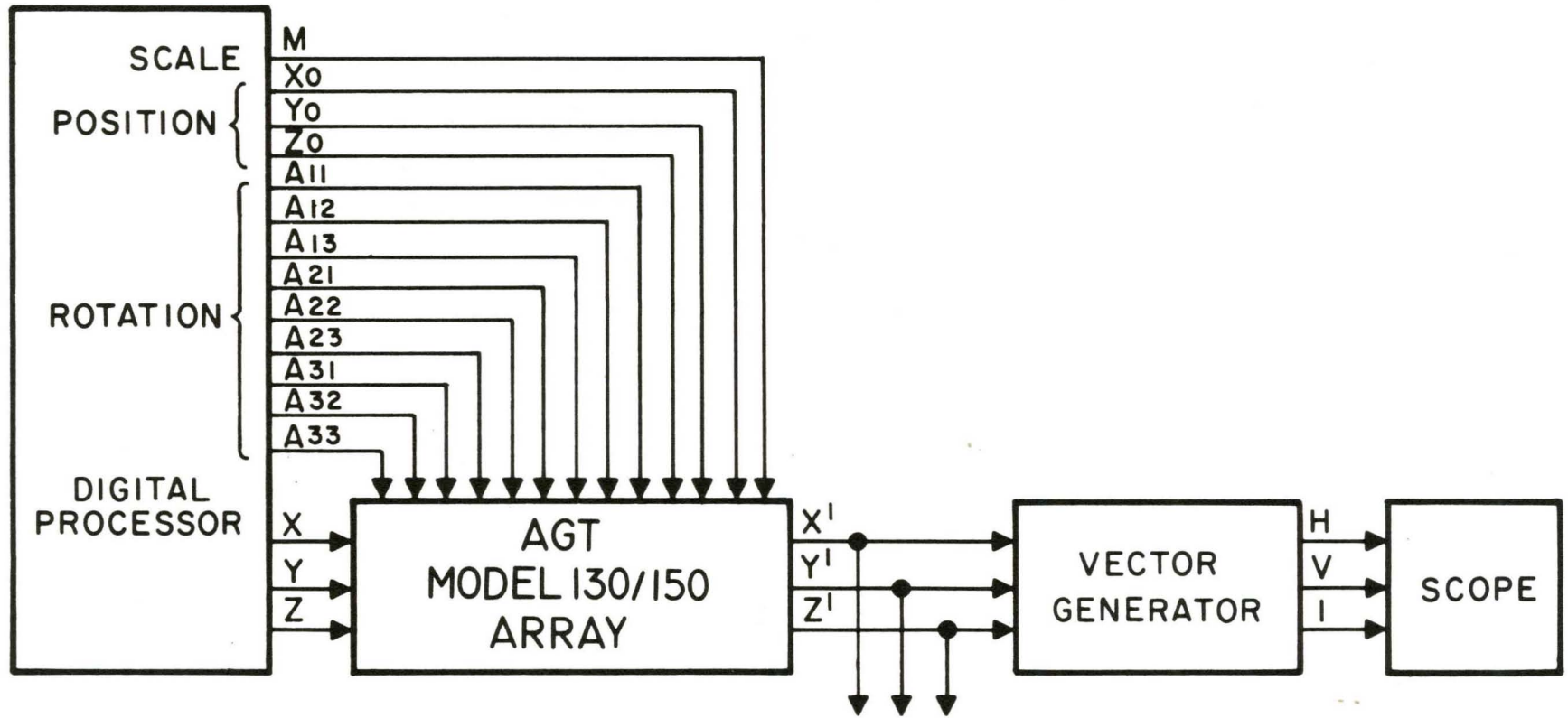


Figure 8. AGT/110 Array



$$\begin{aligned}
 X' &= X_0 + M [A_{11}X + A_{12}Y + A_{13}Z] \\
 Y' &= Y_0 + M [A_{21}X + A_{22}Y + A_{23}Z] \\
 Z' &= Z_0 + M [A_{31}X + A_{32}Y + A_{33}Z]
 \end{aligned}$$

Figure 9. AGT/130 and AGT/150 Array

<u>Character Sizes Selectable (in.)</u>	<u>Character Spacing (in.)</u>	<u>Characters per Line (12 in.)</u>	<u>Lines per Display (12 in.)</u>	<u>Characters per Display (12 in. x 12 in.)</u>	<u>Characters per Display at 40 Frames per Second (12 in. x 12 in.)</u>
.086 x .12	.12	100	50	5000	3333
.172 x .24	.24	50	25	1250	1250
.258 x .36	.36	33	16	528	528
.114 x .16	.16	25	38	2850	2850

Character Set:	64-Character ASCII subset expandable to 96 characters (see Figure 11).
Writing Technique:	Stroke (function generator).
Speed:	7.5 μ s average over 64-character set.
Aspect Ratio (H/W):	Approximately 1.4 : 1
Brightness Control:	Three levels selectable.
Shape Control:	Italic selectable.
Character Position:	Presetable on a grid of 64 rows of 128 characters. Fifty rows of 100 characters fit a 12 in. x 12 in. scope area. The grid can be translated anywhere on the screen.
Other Features:	Carriage return, subscript, superscript, vertical spacing, and 90 ^o rotation of text.

Figure 10. Character Generator Specifications

STANDARD				EXPANDED	
7-bit Code ₈	Character	7-bit Code ₈	Character	7-bit Code ₈	Character
040	Space	100	@	140	
041	!	101	A	141	a
042	"	102	B	142	b
043	#	103	C	143	c
044	\$	104	D	144	d
045	%	105	E	145	e
046	&	106	F	146	f
047	'	107	G	147	g
050	(	110	H	150	h
051	)	111	I	151	i
052	*	112	J	152	j
053	+	113	K	153	k
054	,	114	L	154	l
055	-	115	M	155	m
056	.	116	N	156	n
057	/	117	O	157	o
060	0	120	P	160	p
061	1	121	Q	161	q
062	2	122	R	162	r
063	3	123	S	163	s
064	4	124	T	164	t
065	5	125	U	165	u
066	6	126	V	166	v
067	7	127	W	167	w
070	8	130	X	170	x
071	9	131	Y	171	y
072	:	132	Z	172	z
073	;	133	[	173	{
074	<	134	\	174	|
075	=	135	]	175	}
076	>	136	^	176	~
077	?	137	_	177	Delete
			(underscore)		(Space)

Figure 11. Character Generator Character Set

where he wishes to initiate an action. Each of the function switches and the foot pedals allows the user to specify a specific programmed action which he wants initiated. Typical actions which may be initiated in this way are rotation about an axis, scaling up, or scaling down of the image displayed. The characteristics of the display are as follows:

Minimum Resolution (lines per inch)	50
Maximum Line Width (inches)	.02
Maximum Brightness (foot Lamberts)	50
Maximum End Matching Error (inches)	.032
Time per Vector (μ s)	4-21
Length of Vectors (inches per component)	up to 12
Usable Viewing Area (inches)	13 x 14
Quality Viewing Area (inches)	10 x 10
Dynamic Range Area (inches)	20 x 20

Several optional facilities for interaction are available, and can be selected according to the applications to be performed.

Additional Graphics Consoles and Light Pen

Up to three additional Graphics Consoles (BGC1-P2) with light pen (but without function switches or foot pedals) may be ordered per system. Each console may be programmed to display the same or different images from those displayed on the other Graphics Consoles.

Auxiliary Scope

Auxiliary scopes (AVS1-P1) may be added to an AGT up to a total of four logical scopes. The display scope is the same as that in the Graphics Console. No work area or facilities for interaction are included. Either a low mount or a high mount may be specified. These are slave displays which can be turned on or off by the program to display the same data as is on a Graphics Console.

Light Pen for Auxiliary Scope

An AGT may have up to four light pens associated with it. Light pens are supplied as standard on the Graphics Console. A light pen for an auxiliary scope is available as device LPN2-P2.

Electrostatic Printer/Plotter

An Electrostatic Printer/Plotter provides capability to produce hard copy of the image displayed on the scope. Both alphanumeric text and complex graphic data can be output to the printer/plotter. Models with both 8-1/2 inch paper width (PPL1-NP1) and 11-inch paper width (PPL1-NP2) are available. Resolution on both is 80 dots per inch in both directions. A printout is made in 3 - 15 seconds depending on the complexity of the image on the scope. Programmable paper cutting options are available in both models.

Alphanumeric Keyboard

Up to four ANK2 Alphanumeric Keyboards may be connected to an AGT system. These are used to enter character symbols onto the display scope and into the processor.

Lights for Function Switches

A light is provided for each function switch, controlled by the program, usually to indicate which function key has been depressed and has caused an action to be initiated.

Analog Tablet

The Analog Data Tablet (ADT1-P1) is a device for entering two-dimensional graphics into the processor. The position of a stylus, similar to an ordinary pen, is tracked as it moves over a tablet of transparent glass. A drawing or tracing is usually displayed on the scope for visual feedback as it is entered into the processor via the data tablet. The position of the stylus, used with an appropriate overlay, may also be used like a function switch to initiate a preprogrammed action. Accuracy of the tablet over its 10 in. x 10 in. working area is 5%. Resolution is better than 7 bits.

Joystick

The JSB1 Joystick is a device for moving a spot, visible to the user on the scope, either vertically or horizontally, according to the motion of the joystick. This is a means of entering two-dimensional information into the system.

Track Ball

The TRB2-P1 Track Ball allows the user, by spinning the track ball, to move a spot, visible on the scope, in three dimensions, and thus to enter three-dimensional information into the system.

Variable Control Dials

The Variable Control Dial option (VCD2-P2) affords a means for continuously changing program variables. The position of six potentiometers, varied by the operator's dial motion, are converted to digital values and can be sampled by the processor.

ADAGE GRAPHICS SYSTEMS SOFTWARE

Hardware provides capability. To accomplish his objectives, the user must also have a program that tailors the capability of the hardware to his particular application. In computer graphics, software has been a particular problem. Manipulating images is considerably more complex than manipulating numbers, which is the more familiar use of computers. Computer graphics has also been a more specialized field with fewer programmers working in it. The cost and time required to develop user programs depends to a large degree on the range and depth of the software supplied with the hardware system. Adage Graphics Systems Software, supplied with each Adage Graphics System, allows the user to concentrate on his own problem, using high-level languages to describe it, rather than to become mired down with considerations related to the functioning of the hardware. Adage Graphics System Software is the result of more than six years of effort in conjunction with the users of Adage Graphics Systems.

MONITOR AND OPERATING SYSTEM

AMOS/2, the Adage Disk Monitor and Operating System for the Adage Graphics Terminal (AGT), consists of an extensive set of computer programs and the standards for their use and interrelation. The software contained in the AMOS/2 system provides the user with ready access to and control over all available facilities of the AGT.

AMOS/2 programs are designed for on-line, interactive execution under control of a core-resident monitor program. By initially entering "statements" to the monitor, a user may cause programs, source texts, or graphics-image-descriptions to be loaded into core from library files on system disk mass storage, and to be operated upon. Other available monitor statements permit the on-line user to examine, modify, or otherwise process core contents in flexible, symbolic, user-oriented notations. Modified texts, images, or program dumps may again be filed for later use. Finally, statements to the monitor are available for executing programs (or portions thereof), displaying images, and assembling or compiling source texts into loadable, linkable, relocatable object files.

THE RESIDENT MONITOR

The AMOS/2 Resident Monitor, AMRMX, is a program which is stored in core-image form on the system disk mass storage. The monitor is initially loaded into AGT core memory by a short bootstrap loader program, AMLDX. Once loaded, the monitor remains in core and controls all subsequent AMOS/2 system operation.

The monitor provides facilities for accepting and processing user control statements from the system input device (teletype or alphanumeric keyboard). Available control statements allow the user to invoke the loader program to load object programs, to execute loaded programs, to control partial execution of any loaded code, to monitor immediate results of any running programs, and to modify loaded programs.

The monitor also implements secondary facilities needed for the above operations, such as allocating and releasing core memory, maintaining symbol tables for defined mnemonics, handling real-time signals and interrupts for teletype, disk, and tape input/output, etc.

The loader program, which is an integral part of the AMOS/2 monitor, contains many features which are useful for the design of higher-level user programs. These include the ability to load separate relocatable object subprograms and link them together through the use of entry-points and external references. Also provided is a multi-level overlay facility,

which enables the dynamic loading of program segments to permit execution of programs which exceed the available core memory storage, and the ability to load data into a COMMON area of core for reference by multiple program units. These facilities are further extended to allow high-speed core-image overlays and multiple, labeled, COMMON blocks.

The monitor utilizes the AGT display screen for message listing, and output to the user. Other devices which may be used for listing output are the TTY, Electrostatic Printer/Plotter, and High-Speed Paper Tape Punch. The monitor also provides a "macro" facility, which enables the user to specify combinations of multiple system functions by a single control statement. (For example, the facility may be used to provide FORTRAN users with an "edit-compile-load-and-go" command).

Many of the monitor's processes are closely interrelated with the retrieval, modification, and storage of files on the system library.

THE SYSTEM LIBRARY

The system's library consists of a set of files recorded on on-line mass storage (disk or tape). Files may be of several types, including source program texts, relocatable object programs, saved core-image binary "dumps", image descriptions for graphics display, relocatable program symbols for debugging purposes, etc. In addition, the user may define his own file formats for storing data produced by object programs.

Each file has associated with it a 10-character title, version number, a revision letter, and a date. Facilities are provided in the monitor to create, access, update, and list the contents of library files.

All programs available to a terminal reside in the library. Available programs fall into three classes: standard library system-programs, graphics library system-programs, and user library programs.

Standard System Library

This set of library programs comprises the language processors (the FORTRAN IV compiler, ADEPT macro-assembler, and AFLOW flow chart generator), the alphanumeric display text editor (EDIT), the utility programs (text-to-printer, card-to-disk, etc.), the input/output device driver programs (card reader, printer-plotter, etc.), and the FORTRAN subroutine library (object routines: fixed and floating-point decimal arithmetic, formatted input/output, compiler run-time subroutines, and the function library: sin, cos, tan, tanh, exp, atan, log, etc.).

Many other system program functions are included as core-image binary overlay segments in the monitor itself. (For example, tape and printer-plotter utility subroutines.) In addition, the generation of the disk monitor is performed from separate program segments, enabling each installation to produce a unique "tailored" monitor which may include user-written support programs.

FORTRAN IV Compiler and Library

One of the major features of the AMOS/2 software system is the Adage extended FORTRAN language compiler. The Adage FORTRAN language is based on the American National Standards Institute (ANSI) FORTRAN IV language, but contains numerous additions and extensions. Chief among these is the inclusion of a special "IMAGE" sub-language, which may be used to compile images for display on the AGT using FORTRAN-like statements.

Facilities are also provided for controlling all aspects of the AGT-AMOS/2 interactive environment from FORTRAN routines.

The arithmetic, input/output, and compiler support routines in the FORTRAN object-time library are designed for minimum core storage and program execution timing overhead. The display support routines in the FORTRAN library enable truly high-level programming of graphics images.

Graphics Library

This set of systems programs comprises a powerful display processor (GRAFX) for creating dynamic CRT output from core-resident image descriptions, the display utility programs (image freeze, image save, printer-plotter output, etc.), the interactive input/output device handlers (function switches, light pen, variable control dials, joystick, track ball, analog data tablet, etc.), and the FORTRAN object-time display support subroutines.

User Library

Any user-written subroutines, in either ADEPT assembly language or FORTRAN IV, may be added to the on-line library and called into execution by other programs or directly by monitor statements which activate any of their defined entry-points.

IBM 360/370 Attachment Support

Three levels of support are available for attaching AGT to IBM 360/370 Systems:

IBM 2250 Emulator. -- This program allows a properly configured AGT to act as a plug-for-plug replacement of the IBM 2250 Model 1 on an IBM 360/370. No modifications to IBM software are required.

Support Processor Graphics System (SPGS). -- A software system implemented with code both on the IBM 360/370 and the AGT. The IBM 360/370 is used for accessing on-line mass storage. SPGS allows user's programs written on the IBM 360/370 to control all AGT facilities and to respond to attention requests generated by the user at the terminal.

Remote Job Entry. -- This package allows the AGT to operate as a remote terminal via RJE or HASP, to an IBM 360/370. The AGT, in batch processing mode, initiates the running of a program on the IBM 360/370 which is part of the total graphics application.

Additional information on Adage Graphics Systems Software may be found in the Programmer's Reference Manual.

ADAGE GRAPHICS TERMINALS

Standard Models

	Digital Processor	Display Generation Hardware	Operator Facilities
AGT/110	DPR4 8K Core Memory	2-D Coordinate Transformation Array Character Generator Vector Generator	Console ASR-33 Teletype CRT with Light Pen Function Switches
AGT/130	DPR4 8K Core Memory	3-D Coordinate Transformation Array Character Generator Vector Generator with Intensity Modulation	Console ASR-33 Teletype CRT with Light Pen Function Switches
AGT/150	DPR4 8K Core Memory	3-D Coordinate Transformation Array Character Generator Vector Generator with Intensity Modulation Extended Image Processor	Console ASR-33 Teletype CRT with Light Pen Function Switches
Standard Options	Core Memory Expansion to 16K or 32K Magnetic Tape Disk Storage Card Reader Data Phone Interface Parallel Computer Interface	Vector Generator with Programmed Intensity Control (Standard with AGT/130 and AGT/150) Windowing Operator (Available with AGT/130 and AGT/150 only) Expanded Character Generator Raster Segment Generator	Data Tablet Joystick Variable Control Dials Up to 3 Auxiliary CRTS Trackball Electrostatic Printer/Plotter

The subsystems listed for each model, grouped by function, define the basic configuration. Standard options are also shown and are available with all models except where noted. Models are upward compatible and can be expanded or converted in the field with a minimum of downtime.

ADAGE GRAPHICS PROGRAMS

Monitor and Operating System:	<u>AMOS/2.</u> A disk monitor and operating system controls all hardware and software facilities of the system.
Resident Monitor:	<u>AMRMX.</u> Processes control statements for loading, executing, and debugging of all programs in the AMOS/2 library.
Program Preparation Aids:	<u>FORTRAN IV.</u> Compiles FORTRAN IV source language programs with extensions allowing a full range of on-line graphic interaction, including IMAGE, a sub-language for describing images. <u>ADEPT.</u> Assembles in object code from machine-oriented source languages. <u>EDIT.</u> Provides for entry and modification of source language programs. <u>AFLOW.</u> Generates program flow charts for documentation.
Graphics Operators:	<u>GRAFEX.</u> Displays pictures from image description generated by FORTRAN, ADEPT, or user programs. Routines for manipulating and storing images.
File Management:	A full complement of system programs for building and maintaining files of text, images, or other data, and bringing selected portions from these files to and from the CRT scope, the disk, the processor, and the printer/plotter.
Utility Routines:	Communications systems interfaces. Peripheral devices. Graphics devices interfaces. Mathematical functions. Test and diagnostics.
IBM 360/370 Attachment Support:	<u>2250 Emulator.</u> Enables a user to replace an IBM 2250 Model 1 with the more powerful Adage Graphics Systems without rewriting the software for his existing applications. <u>SPGS.</u> Support Processor Graphics System. A combination of IBM 360/360 and Adage Graphics Systems programs to allow an IBM 360/370 user full use of Adage Graphics capabilities. <u>RJE.</u> Remote Job Entry. Allow the AGT user to make use of the IBM 360/370 for mass storage retrieval and processing in configurations with graphics applications.

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