PS 300

Volume 1

901194-200

READER'S GUIDE

The PS 300 Document Set contains operation, programming, and system-management information. The information is organized into five volumes and is designed and sequenced to be helpful to the novice, the experienced programmer, and the system manager. Information in the set can be classified as general guide, user tutorial, user reference, user program examples, and system management topics. The document set contents are described by volume in the following sections. More detailed descriptions of contents and how to use each volume are provided in the introductory section of the particular volume.

VOLUME 1-GENERAL INFORMATION

Volume 1 provides general information about the PS 300 product line and its use. Volume 1 should be read by all users. In addition to this Reader's Guide, Volume 1 contains the following sections.

PS 300 Systems Overview

This is an introduction to the PS 300 series of graphics systems. It highlights outstanding features and advantages of each member of the PS 300 family. Read this section for a quick summary of system capabilities and an introduction to PS 300 terminology.

User Operation and Communication Guide

Step-by-step instructions for starting up and operating the PS 300 using a variety of host interfaces are presented in this section.

Read this section before attempting to start up the machine, boot Graphics Firmware, operate the keyboard, or enter the tutorial commands found in Volume 2.

Note that detailed operation and communication information for the system manager is included in Volume 5.

Demonstration Package

This guide accompanies a set of interactive programs on diskettes supplied with your system. The programs are designed to demonstrate ways in which the PS 300 can be used for modeling and analysis. Instructions are included for loading the demonstration programs from diskette. Step-by-step descriptions of how each program runs and how you interact with it are provided. After your system is installed and has passed the Customer Acceptance Test, read this guide and load and run the Demonstration Package.

Maintenance and Services

Software and Documentation Hotline numbers are provided, along with descriptions of E&S maintenance plans and training programs geared to your specific needs.

Software Referral Catalog

The *Software Referral Catalog* contains information about software packages available to PS 300 users. It includes information on the primary application of each package, package capabilities, price, distribution source, hardware/software configuration specifications, and support for the package.

Users Group Information

Information is provided about the E&S Users Group. This section is of interest to anyone who would like to become involved in an exchange of ideas, feedback, and user-written software.

Product Data Sheets

Marketing fact sheets for the PS 300 family members and options are included in this final section of Volume 1.

VOLUME 2-GRAPHICS PROGRAMMING

Volume 2 is a self-paced tutorial which teaches graphics programming for the PS 300. It is organized into individual modules, and is designed as an introduction to users who have no experience in programming the PS 300. Programmers experienced with other graphics systems should read those modules which explain concepts and operations that are specific to the PS 300. The modules can also be used as a review of programming procedures where needed.

All modules assume a knowledge of the basic graphics concepts and introduction to the PS 300 which are presented in the *Graphics Principles-High Performance PS 300 Distributed Graphics* in this volume.

Volume 2 is organized into two binders (Volume 2A and 2B). The concepts presented in Volume 2A are prerequisite to the material in Volume 2B.

Hands-On Experience--Introduction to PS 300 Graphics

The "Hands-On" module provides inexperienced graphics programmers with an initial PS 300 programming experience. It steps through some simple operations to introduce you to several basic PS 300 programming concepts.

Graphics Principles--High Performance PS 300 Distributed Graphics

This section discusses basic graphics operations and principles, and how these operations are performed using the PS 300.

Graphics Principles should be read by all graphics programmers. For novices, it introduces essential concepts taught in the tutorial modules. Each module builds on the concepts and terms introduced in "Graphics Principles". For the advanced programmer who does not plan to study the tutorial modules, it serves as a "fast lane" to the reference material in Volume 3.

Tutorial Demonstration Package

This package accompanies the tutorial modules and contains demonstration programs on tape. These demonstrations are selected to illustrate and clarify concepts taught in the modules. The package should be used as a supplemental learning tool with the modules.

Tutorial Modules

The tutorial is organized into modules that each teach an aspect of PS 300 programming. The modules in Volume 2A teach central concepts, basic to programming a PS 300. Modules in Volume 2B teach specialized applications of these basic concepts to make use of other PS 300 capabilities.

Examples and practice exercises are provided, and many modules use sample programs (from the *Tutorial Demonstration Package*) to illustrate specific concepts and operations.

Sample Programs

These are examples of various PS 300 programs accompanied by code on the distribution tape and descriptions in the *Sample Programs* section of Volume 2B. These programs provide examples of PS 300 programming techniques and applications.

Glossary

Volume 2B contains a glossary of terms used in all five volumes of the documentation set. This is a valuable reference tool for users unfamiliar with graphics terminology and programming techniques.

Appendix

An Introduction to Data-Driven Programming Methodology for PS 300 Users. This paper discusses theoretical information concerning function networks. It is primarily of interest to the advanced user; however, it contains information applicable to all function network programming.

VOLUME 3A-PROGRAMMER REFERENCE

Volume 3A is a reference manual for the PS 300 graphics programmer. It contains concise information for all PS 300 commands and functions.

PS 300 Command Summary

This is an alphabetically organized summary of the ASCII form of every PS 300 command. It contains the full command and the acceptable abbreviated form of the command as well as a diagram of command syntax. It also lists parameters, default values, and, where appropriate, notes and comments. If a command creates a node in a display tree, the inputs and acceptable data types for that node are shown.

PS 300 Function Summary

The *Function Summary* presents information about PS 300 functions in a concise, alphabetical form. A diagram is given for each function showing its input queues, its outputs, and the data types for all inputs and outputs. Notes and comments are included where appropriate.

Release Notes

The *Release Notes* describe the most recent firmware release. These notes provide concise information about new and changed capabilities. The release notes provide references to full descriptions of new capabilities in various sections of the document set.

It is suggested that, as you receive new release information in the future, you keep that information in this section along with the notes from previous releases.

User Error Messages

This is a compendium of all user error messages (informational, recoverable, fatal, and warning) that a graphics programmer might encounter. Error messages are listed in numerical order. The text of the message is given with an indication of common causes of the error and, where appropriate, ways to correct it.

Other Reference

Presently, this section describes how to use the PS 340 Raster System to display images created in the host computer.

In the future, this section can be used to keep additional reference material as it becomes available.

VOLUME 3B-PROGRAMMER REFERENCE

Volume 3B contains reference material for using the PS 300 Graphics Support Routines (GSRs) and PS 300 Host-Resident I/O Subroutines (PSIOs).

PS 300 Graphics Support Routines

The Graphics Support Routines guides are included in this volume. These routines provide an alternate method of communicating graphics data to the PS 300. References to ASCII command forms described in Volume 3A are provided as an ease to understanding GSR functionality. The GSRs can be used with FORTRAN or Pascal programming languages.

PS 300 Host-Resident I/O Subroutines

The PS 300 Host-Resident I/O Subroutines (PSIOs) are a set of callable FORTRAN subroutines distributed on magnetic tape that provide users with a standard method of communicating between the host system and the PS 300. The subroutines were written to provide maximum throughput to the PS 300.

VOLUME 4-PROGRAM DEVELOPMENT TOOLS

Volume 4 provides information for the experienced user to program and debug the PS 300.

The ***Application Notes*** is a collection of useful samples and applications for PS 300 users. Contributions to the Notes come from PS 300 users inside and outside Evans & Sutherland.

The ***Character Font Editor*** is a program that allows you to edit an existing character font or create a new one. It is an interactive, menu-driven program that displays characters in a 128- or 256-character font. Each character can be edited to create a new shape. Different fonts can be combined into a new font, and original fonts can be created from scratch.

There are four tools that help you work with PS 300 Function Networks:

- *Function Network Editor*

  The Function Network Editor lets you create a function network using a diagram on the PS 300 display rather than directly inputting commands to a file. Editing menus are used to build a network of "black boxes" which may contain more detailed representations of parts of the network. When the diagram is complete, an ASCII code file can be generated which contains the PS 300 commands needed to build the network.

- *Function Network Debugger*

  The Function Network Debugger describes NETPROBE, a utility developed at Evans & Sutherland to be used as a guide in writing your own network debugging program.

- *User-Written Functions*

  The User-Written Function facility gives sophisticated PS 300 programmers the ability to write their own customized functions.

- *Updates Function*

  Updates Function provides a method of rapidly updating viewing transformations and characters. It is intended for use in applications such as robotics and animation.

VOLUME 5-SYSTEM MANAGER REFERENCE

Volume 5 contains information on system-level functions, utilities, and communication protocols for all PS 300 systems. A "system manager" is defined as any PS 300 programmer who works directly with the PS 300 and is responsible for system configuration, maintenance, and software or firmware installation. This volume contains information on the following topics.

- *Firmware and Host-Resident Software*

  Includes descriptions of the runtime software, the CONFIG.DAT file, and how to create and download the SITE.DAT file.

- *System Power Up*

  Describes the power-up procedures and definitions of the power-up confidence tests.

- *PS 300/Host Communications*

  Includes RS-232 and RS-449 specifications and pin connector definitions, PS 300 transmission protocol, port values and defaults, and the PS 300 system data reception functions.

- *Local Data Flow*

  Includes illustrations of the PS 300 system network, and the routing functions and routing byte definitions.

- *System Functions*

  Gives a brief overview of system functions, a list of acceptable data types, a definition of Constant and Trigger queues, and a description of each documented system function.

- *Initial Data Structures and System Commands*

  Describes initial data structures created at power-up and system commands. Configuration mode is discussed and a "runtime" system is defined.

- *Terminal Emulator Modes*

  Gives instructions for changing the modes and features of the terminal emulator by either sending escape sequences from the host, entering PS 300 commands in the SITE.DAT file, or sending the appropriate ASCII characters to terminal emulator functions.

- *System Error Messages*

  Provides a description of the system error messages that a programmer might encounter during operation of the PS 300 Graphics System.

- *Utility Commands*

  Provides a reference for the Utility Commands that are on the PS 300 Diagnostic Diskettes.

- *Software Installation*

  Contains the installation instructions for the PSIOs and the GSRs.

- *Interactive Devices*

  Describes PS 300 keyboards, data tablet, functions buttons, control dials, and light pen.

- *Data Formatting*

  This sections provides data formats expected by the PS 300 command interpreter.

PS 300 SYSTEMS OVERVIEW

CONTENTS

ILLUSTRATIONS

Computer graphics is for some the science and for others the art of using a computer to convey information as pictures on a screen. Interactive graphics systems allow the user to create three-dimensional objects, display views of those objects, and interact with the picture. *Interactive devices* such as buttons, dials, and keys are used to move images around on the screen, rotate them, zoom in on them, back away from them, and make design changes to them. Systems such as these have become invaluable tools for many industries, including Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM), molecular modeling, and animation. They simulate real-world situations in which a designer can design and build a complex three-dimensional model, examine its structure from any angle, animate the model, determine how its parts interact, and modify the design as needed.

The PS 300 series of high-performance graphics systems is designed to revolutionize interactive computer graphics. Before the PS 300, sophisticated graphics used for the interactive design and analysis of computer models was exclusively the realm of the highly experienced graphics programmer. Programmers of traditional graphics machines need a knowledge of matrix arithmetic to program the manipulation of objects. A familiarity with at least one conventional language such as FORTRAN was essential for programming the machine to perform transformation and display processing and to handle data from the interactive devices. A powerful host computer was needed not only to run the analysis programs, but also to perform the graphics processing. Graphical information was accessed and manipulated as addresses in memory.

The PS 300 was developed to put the power of sophisticated computer graphics in the hands of users who are primarily designers involved in complex design and analysis tasks. The machine takes much of the burden of graphics processing and interactive device handling away from the host computer and, more importantly, the user. The user is free to concentrate on the application task for which the PS 300 is being used. The PS 300's own high-level ASCII command language was designed to let the user program in a way that is closer to how a designer thinks. Memory is treated not as a set of addresses where data are stored, but as a collection of structured objects created and accessed by name. Minimum knowledge of matrix arithmetic is needed to manipulate graphical data since the system automatically performs all transformation processing and the necessary matrix concatenations. The result is a system which is several steps removed from traditional graphics machines, much as a high-level programming language such as Pascal differs from assembly languages.

FEATURES OF A HIGH-PERFORMANCE MACHINE

The PS 300 graphics systems are high-performance machines with advanced programming features which greatly simplify the task of the graphics programmer. The most important of these features are listed below.

- Hierarchically Structured Models

  The PS 300 systems allow the user to create three-dimensional (3D) objects, as lines, polygons, and solids and to store them in the system's own mass memory. Models are created as hierarchical groupings of graphical data (points and lines or planes), mathematical operations (***transformations***) which are applied to the data, and ***attributes*** of the model such as color and intensity. Hierarchical structuring allows complex objects to be created from simpler parts. Individual components of a model can be used again and again. Changes can be made to individual parts of the structure without the need to recreate the whole structure.

- Control of 3D Models

  Using commands or interactive devices, the user can manipulate 3D images of models, ***translating*** (moving), scaling, and rotating the images by any amount in any direction.

- Local Manipulation of Models

  The PS 300 controls the interactive manipulation of models locally. Values which are input from the various interactive devices (dials, keys, tablet, and buttons) are sent through user-designed ***function networks*** to interaction points in the model's structure. The host computer never has to participate in handling the interactive devices.

- Real-Time Interaction

  Real time interaction refers to the ability of an image to respond instantly to input from an interactive device. The PS 300 lets the user interact in real-time with displayed images of complex 3D models.

- Perspective Views

  The system is capable of displaying objects in ***perspective*** to enhance the illusion of three dimensions. In perspective views, lines which recede from the eye appear to converge. When an object viewed in perspective is manipulated on the screen (translated, rotated, or scaled) the system maintains a true perspective view of the object.

- Depth-Cueing

  To further enhance the illusion of depth, the system performs ***depth cueing.*** This is a visual effect to make the viewer perceive three dimensions on a two-dimensional screen. A line in a picture which represents the depth dimension (into the screen) grows dimmer the "farther away" it is from the viewer.

- Text as a Graphical Item

  The system treats text as any other graphical item, allowing interactive translation, rotation, and scaling of characters and text strings. The PS 300 has a standard character font. Commands are available to create, modify, and use any other style or size of character font.

- Optional Use of Color

  In graphical renditions of complex three-dimensional structures, color can be an important asset in analyzing the design. The system gives the programmer the option of displaying parts of a model in different colors on a Color Shadow Mask (CSM) Calligraphic Display.

- Optional Hardcopy of Screen Displays

  In computer-aided design and analysis, it is often useful to obtain hard copies of objects displayed on the screen. The PS 300 offers an optional hardcopy interface to a plotter and the software to plot screen displays under local control.

- Optional Advanced 3D Visualization of Solid Objects

  One of the PS 300 series of systems, the PS 340, allows users to create objects as polygons or solids and to display hidden-line-removed and sectioned views of polygonally-defined wire-frame objects. An optional color Raster Display is available with the PS 340 for displaying smooth-shaded raster images of objects generated on the host.

- Distributed Processing

  PS 300 systems allow high-performance interactive graphics in a distributed graphics environment. The high degree of local intelligence of the systems allows the PS 300 to store the graphical data base, perform all transformation and display processing, and handle data from the interactive devices without intervention from the host.

- Host-independence

  No specific size or make of host computer is dictated for any member of the PS 300 series. The PS 300 communicates over a low-bandwidth interface to virtually any host that can accept RS-232-C and RS-449 asynchronous serial communications using START/STOP protocol. Other PS 300-Host Computer interfaces are available for high-speed data transfers to several models of DEC and IBM computers.

A FAMILY OF GRAPHICS SYSTEMS

The name PS 300 is applied to any member of the PS 300 family of high-performance, interactive graphics machines. There are three PS 300 systems, each designed to meet the needs of users in education, industry and research: the PS 320, PS 330, and PS 340.

PS 330

The PS 330 is a powerful single-user system. This is the cornerstone of the product line, and most closely resembles the "basic system" referred to as the PS 300. The PS 330 has a wide range of interactive devices and optional enhancements. These include: high-resolution monochrome and Color Shadow Mask (CSM) calligraphic displays; keyboard with function keys and optional LED labels; control dials with optional LED labels; data tablet and stylus; lighted function buttons; hardcopy interface; and up to four megabytes of memory.

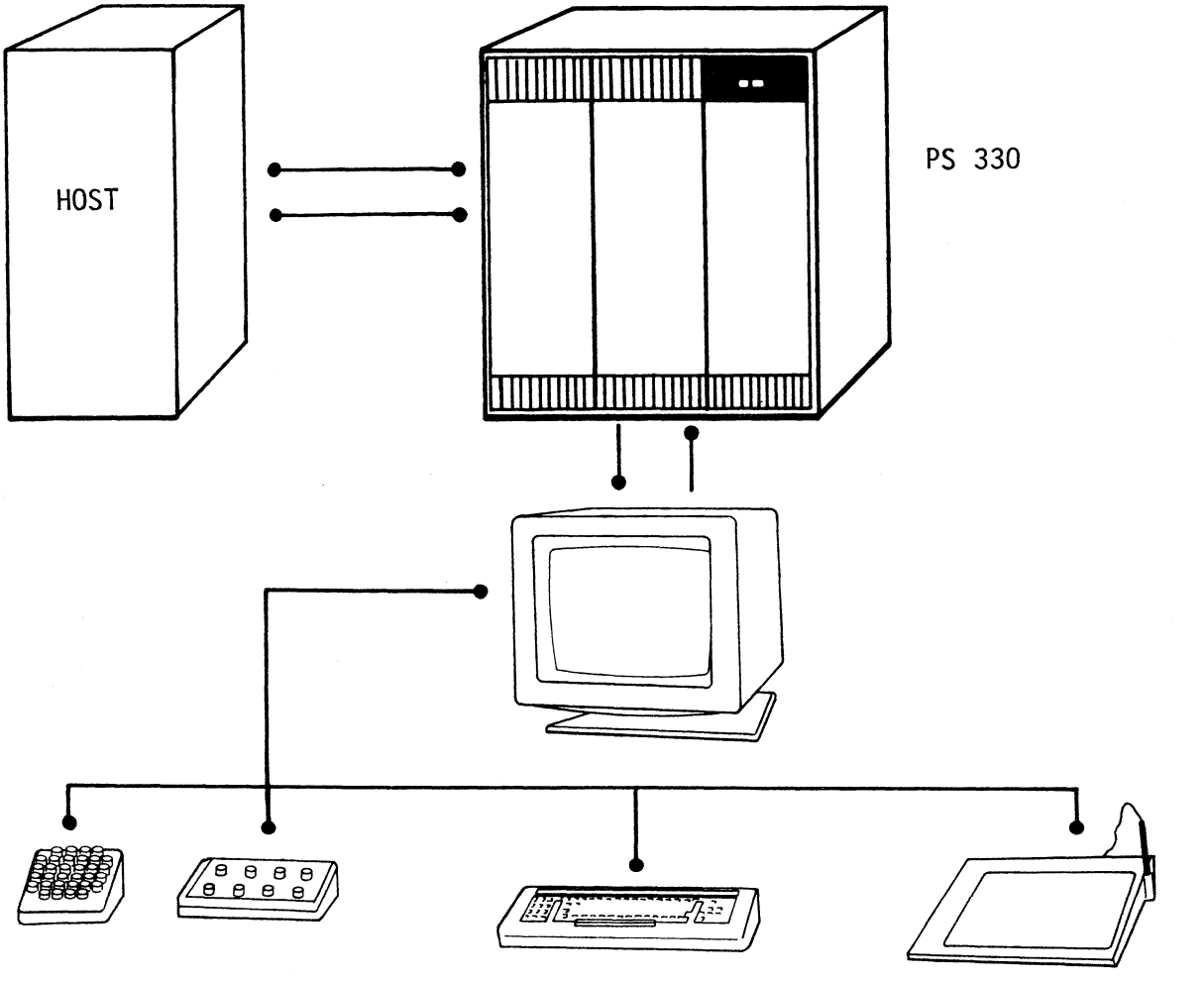


Figure 1. The PS 330

PS 320

The PS 320 is a system that allows two users to share the capacity of one control unit. Two independent stations are supported, each with a monochrome display and a full set of the optional interactive devices.

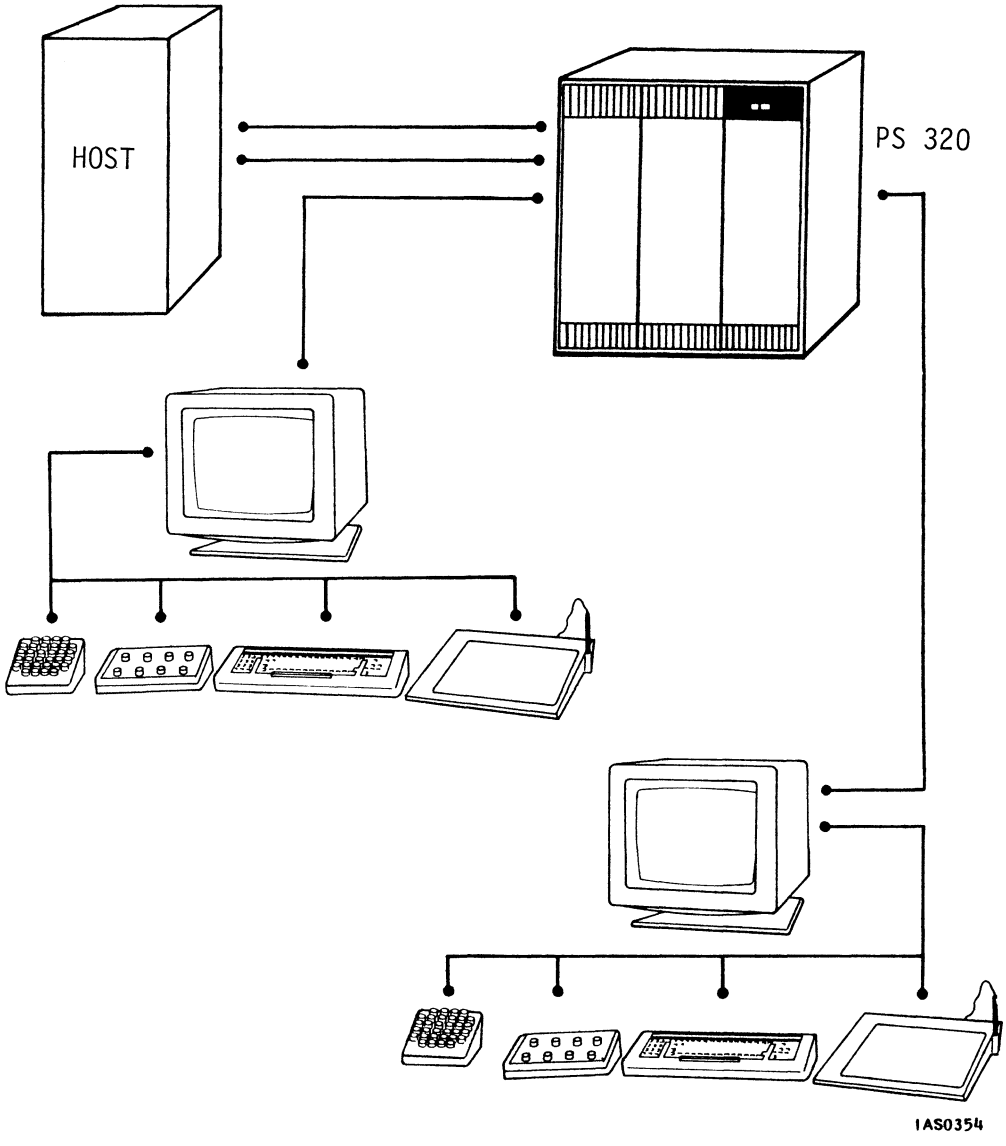


Figure 2. The PS 320

PS 340

The PS 340 is a single-user system with the full capability of the PS 330, and additional features for three-dimensional displays of objects defined as polygons. The monochrome and color calligraphic displays can be used to show hidden-line-removed and sectioned views of polygonal objects. An optional color raster display allows the system to display smooth-shaded static images of three dimensional surfaces and solid objects computed locally or generated by the host computer.

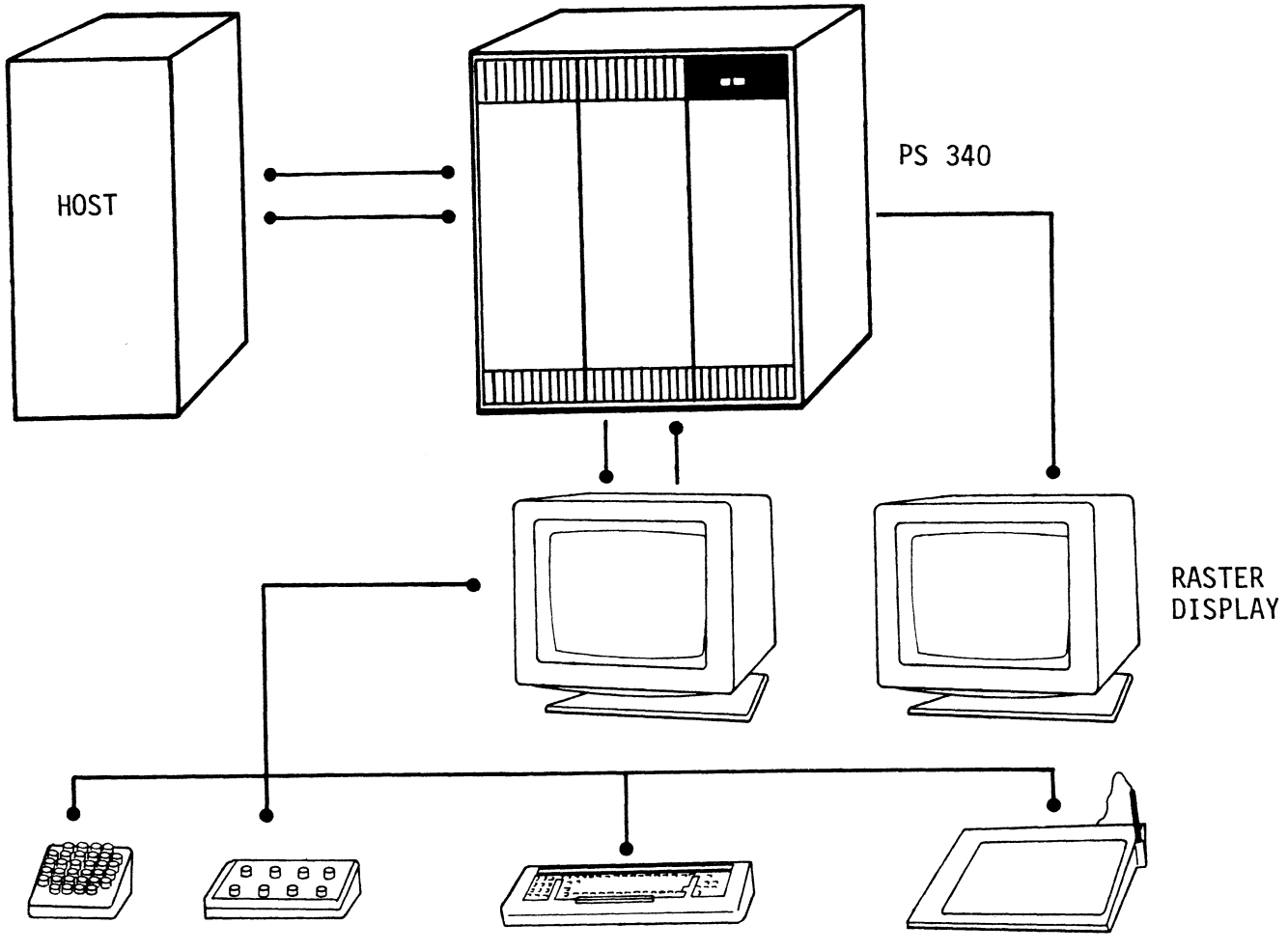


Figure 3. The PS 340

SYSTEM ARCHITECTURE

The basic system configuration for any member of the PS 300 family is the control unit and display(s), various interactive devices, and a host computer.

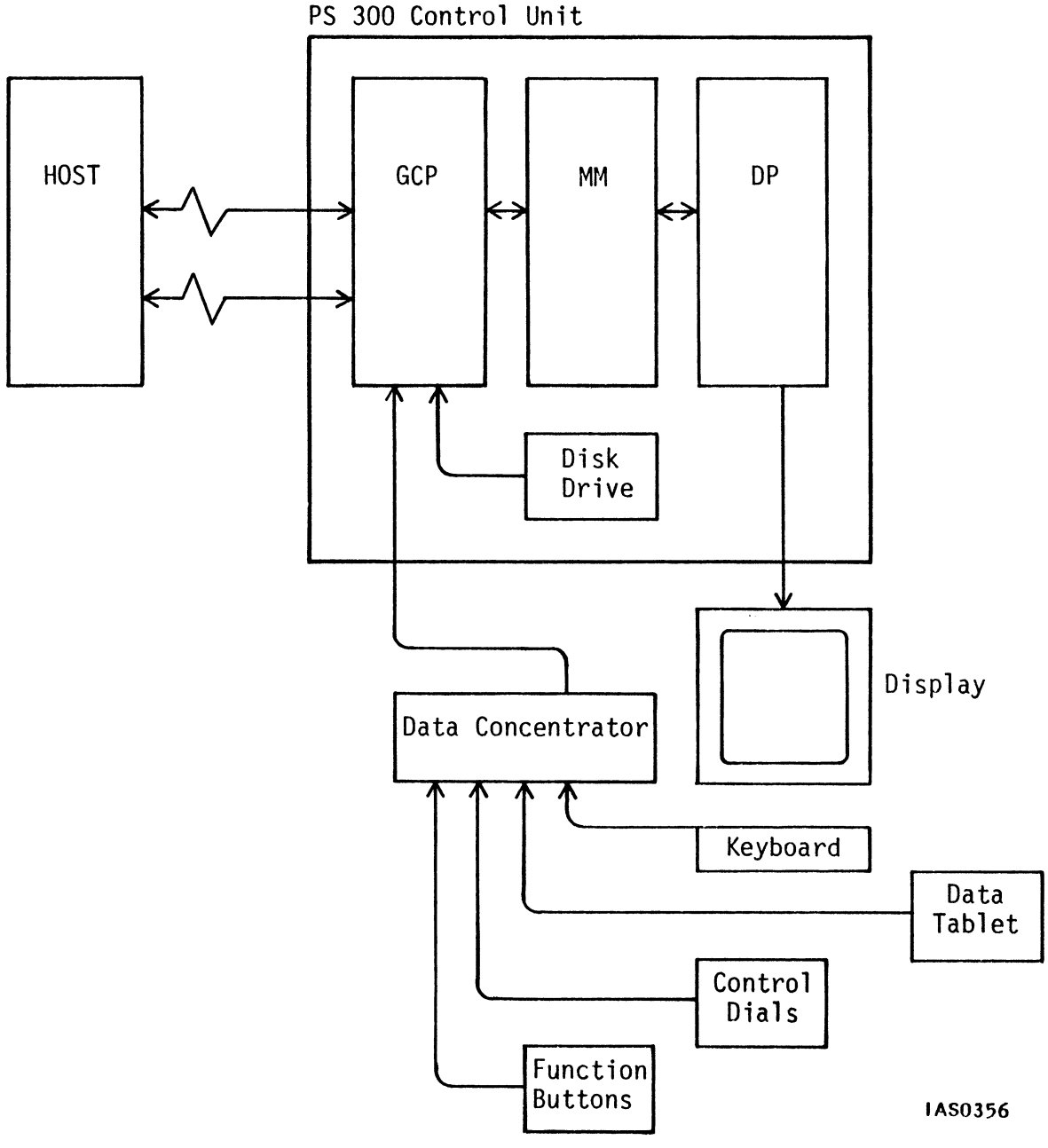


Figure 4. Basic System Configuration

The Control Unit

The Control Unit is the cabinet which contains the power supplies, standard and optional circuit cards for the system, and floppy diskette drive(s) for loading the PS 300 firmware and data files. The main functional components of the PS 300 are: the Graphics Control Processor, Mass Memory, and the Display Processor.

The Graphics Control Processor

The Graphics Control Processor (GCP) uses a Motorola 68000 microprocessor with a 24-bit address space. It contains 256K bytes of local memory which is loaded with graphics firmware when the system is powered on. It also contains communications controllers for host and interactive device handling, and bus interface circuitry. The GCP performs the following tasks:

- Controls communications with the host.
- Provides the Terminal Emulator capability (DEC VT100 or IBM 3278).
- Processes commands and creates data structures in Mass Memory -- display trees for models, and function networks for interactive device handling.
- Performs memory management.
- Handles interactive devices by executing user-designed function networks.
- Synchronizes updates so that complex interacting motion does not appear disjointed.

The GCP can be enhanced with a General Purpose Interface (GPIO) board. This handles high-speed communications with DEC and IBM hosts.

Mass Memory

One megabyte of Mass Memory is standard with any member of the PS 300 series. This can be expanded to four megabytes. Part of memory is taken up with system networks and structures. These are loaded from the firmware diskette when the system is booted. The rest of memory is available for storing data bases of models and function networks.

The GCP communicates with Mass Memory across a 16-bit path, creating structures in memory or sending data to function networks or interaction points in a model's structure. The Display Processor communicates with Mass Memory over a 32-bit path to traverse the structures of models. This broad path ensures fast display access time.

The GCP manages memory automatically. The user does not have to worry about buffering schemes, addresses, or garbage collection.

The user accesses memory by the names of the structures that are created.

The Display Processor

The Display Processor (DP) accesses Mass Memory and generates a picture for display on the screen. It traverses the structures of objects to be displayed, performs the transformations indicated, and generates the lines to be drawn on the display screen. The bit-slice architecture of the Display Processor and pipeline processing of the data allow the update rate (number of new pictures drawn per second) to happen as fast as the refresh rate (number of times a picture is drawn per second). Consequently, the PS 300 does not use an intermediary display file or refresh buffer.

The Display Processor can be enhanced by a hardcopy option, a color calligraphic display option, and a raster display option.

The Display Processor performs the following tasks:

- Reads and traverses structures in Mass Memory.
- Performs character generation - the change from ASCII character code to lines drawn on the screen. This is done early in the process so the characters can be transformed along with the data.

- Does geometric character matrix concatenations. These only affect text, not three-dimensional data.
- Does 3x3 matrix concatenation affecting text and data.
- Performs 3D translation concatenations.
- Does 4x4 windowing concatenation, including perspective.
- Performs all data transformation through matrices.
- Performs clipping.
- Performs viewport mapping.
- Does blinking.
- Handles picking.
- Governs access to the hardcopy interface.
- Performs digital-to-analog line conversion, including color, for circuitry in the PS 300 Display.
- Automatically controls the refresh rate.

The Display

Four different displays are available with the PS 300: a monochrome calligraphic display, a 26-inch and a 19-inch color calligraphic display (CSM), and a static raster display.

The PS 320 dual-user system supports two independent monochrome displays. The PS 330 and PS 340 can generate pictures on the monochrome display and either of the optional CSM displays. The PS 340 has the special ability to produce shaded static raster images of three-dimensional surfaces and solid objects on the static color raster display.

The Monochrome Display

The resolution of the monochrome display is among the finest available in the graphics industry. The display area has a resolution of 8192 X 8192 and 64 levels of intensity. The usable display area is 10.5 by 10.5 inches. The monochrome display can generate black-and-white wire-frame images. A fast-decaying P4 phosphor is used to ensure that ghosting does not occur as images are moved around the screen.

26-inch Color Shadow Mask Calligraphic Display

The PS 300 26-inch Color Shadow Mask Calligraphic Display has a 13-inch by 13-inch usable screen area. The CSM offers a programmable selection of 120 hues and 15 saturation values, plus white for drawing colored wire-frame images. The CSM receives analog signals from the CSM color card (an optional part of the Display Processor).

19-inch Color Shadow Mask Calligraphic Display

The PS 300 19-inch Color Shadow Mask Calligraphic Display has a usable screen area of 10.5 by 10.5 inches. Like the 26-inch model, the 19-inch CSM display receives analog signals from the CSM color card.

PS 340 Static Raster Display

The PS 340 Static Raster Display is a 640 x 480 x 24 pixel, high-resolution static raster display. The Raster Display has a 9-inch by 12-inch usable screen area. It is capable of displaying solid images of objects defined as polygons. The display receives signals from the optional PS 340 Raster card. These signals are generated from an image buffer memory on the Raster card. The Raster Display can display 2^{24} colors simultaneously out of 2^{30} possible different colors. This allows the user an almost unlimited choice of tones which can be blended imperceptibly in a picture to simulate smooth surfaces.

Interactive Devices

Several optional interactive devices are available with the PS 300 systems. These are programmable, easy-to-use devices which allow a PS 300 user to interact with the images displayed on the screen. The devices connect to the Data Concentrator at the back of a PS 300 interactive Display. The Data Concentrator accepts data from the interactive devices and routes them to the GCP. The GCP, in turn, uses the data to trigger execution of function networks. All devices have local intelligence provided by a microprocessor.

Alphanumeric Keyboards

The basic PS 300 keyboard includes all standard alphanumeric keys, a separate numeric keyblock, typical typewriter control keys, symbols, and a set of 12 function keys which can be programmed to perform interactive graphics functions.

The keyboard may include a set of optional Light Emitting Diodes (LEDs) on which letters, numerals, and symbols may be displayed. The LEDs are usually programmed to display prompts to aid the operator or labels that describe the operations being performed (e.g., ROTATE IN X).

An optional IBM Keyboard is available for the PS 300. This is an enhancement to the PS 300/IBM 3278 Interface. The keyboard has both PS 300-specific and IBM-specific keys. Some keys are dual function in which the SHIFTed IBM key performs a PS 300 function.

Data Tablet

The data tablet for the PS 300 consists of an 11-inch by 11-inch tablet, a stylus, and an internal controller. The data tablet is normally used as an interactive pointing and positioning device to control the cursor that is displayed on the CRT. When the stylus touches the tablet, the coordinate position on the tablet is converted to its digital equivalent for use by the system.

Control Dials

A set of eight programmable control dials can be used to control size, position, and orientation of displayed objects, and for other programmed functions. The dials are mounted in two rows of four dials. Above each control dial is an 8-digit LED display which can be programmed to display the function of the dial or other information associated with the use of the dial.

Function Buttons

A unit containing 32 programmable function buttons is available with the PS 300. The function buttons are arranged with one row of four buttons, four rows of six buttons, and a final row of four buttons. Pressing a function button results in a user-specified action. The buttons are usually programmed to display different views of the same object or to switch between views of different objects.

HOST-INDEPENDENCE

The PS 300 systems were designed to provide high-performance interactive graphics in a distributed processing environment. For this reason, all members of the PS 300 family are ***host independent.*** This means that no specific size or make of host computer is dictated for use with the system. Virtually any host which can communicate over RS-232-C and RS-449 asynchronous serial communication lines using START/STOP protocol can be used with any PS 300 system.

The PS 300 does not rely on a host to perform any of the graphics processing or handling of data from the interactive devices. In most applications, the host is used for analysis programs and for file storage. Since the PS 300 does not store commands or save files which create objects and function networks, most users create files on the host and transfer them to the PS 300.

Host Interfaces

The PS 300 was designed to communicate with a host over a low-bandwidth interface. This interface is best suited for infrequent communication of small amounts of data. The ideal application for the PS 300, then, is one in which all graphics processing is performed by the PS 300 and communication with the host only occurs when the result of the graphics processing has an impact on programs being run on the host. The PS 300 programmer must therefore make an intelligent division of the graphics application into graphics processing and analysis to take full advantage of the PS 300's capabilities.

RS-232-C and RS-449 Interfaces

The standard data communication interfaces to the PS 300 are asynchronous serial line RS-232-C or RS-449 using START/STOP protocol. These two interfaces are ideal for interfacing to most host computers in applications requiring a maximum data transfer rate of 19.2K baud. RS-232-C is recommended for distances up to 50 feet between the PS 300 and the host. For runs longer than 50 feet, RS-449 is recommended. A maximum cable length of 3,000 feet is available for 19.2K baud transfers.

In addition to the standard interfaces, two high-speed data transfer interfaces are available for selected IBM and DEC computers. These offer faster transfer rates and allow greater distances between the PS 300 and the host.

IBM 3278 Interface

The PS 300/IBM 3278 interface allows a PS 300 to operate on IBM hosts via a 3274 control unit for the high-speed transmission of data. The PS 300 provides high-performance interactive graphics while emulating an IBM 3278 terminal. A PS 300/IBM keyboard is available which has the same layout as an IBM 3278 keyboard. The interface is designed so that the PS 300 will operate either in Graphics Mode (local mode) or in IBM 3278 Terminal Emulation mode. Data transfer rates depend on the type of 3274 control unit (remote or direct-connect) to which the PS 300 is attached.

DEC DMR-11AE Interface

The PS 300/DEC DMR11-AE interface is designed to operate on a DEC PDP-11 running RSX-11M, or VAX computer running VMS for high-speed transmission of data.

PS 300/UNIBUS Parallel Interface

The PS 300/UNIBUS Parallel Interface offers 16-bit parallel Direct Memory Access (DMA) communication between the PS 300 and a DEC VAX host. The interface is a bi-directional differential-driven data path. It can transfer data at a rate of one megabyte per second.

Communication Lines

Communication between the PS 300 and the host can take place over one or two lines.

In single-line communications, graphics commands and the Terminal Emulator for the host are multiplexed over one line. Control characters preceding and following the data are used to route information to the Terminal Emulator software or to the the PS 300's Command Interpreter.

In dual-line communications, one line is used to communicate graphics commands, and the other is used for terminal emulation. No multiplexing occurs with dual-line communication.

THE PS 300 COMMAND LANGUAGE

The PS 300 has its own command language which has two equivalent representations: ASCII and binary. Both forms can be used over most communications lines.

The ASCII form of the language consists of English-like commands which closely reflect typical operations that are performed in computer graphics applications. The VECTOR_LIST command creates an object as a list of vectors, a set of points and the lines which connect them. The ROTATE command rotates an object through any angle around any axis. The WINDOW command specifies a volume of coordinate space to be displayed on the screen. The DISPLAY command produces an image of an object on the screen, and so on. The ASCII commands were designed to simplify graphics programming for users who are primarily structural designers and analysts, not experienced graphics programmers.

Using PS 300 commands, the user builds structures which represent the objects and models he or she wants to display and interact with. Because of the PS 300 "naming convention", however, the user never has to treat the data which define an object as addresses in memory. Instead, memory is treated as a collection of objects, each created with a name and accessed by that name using the system's commands.

Objects are named groupings of graphical data, mathematical operations called transformations which are applied to the data, and attributes such as color and level-of-detail. Once created, a single named definition of a graphical object can be used again and again like a template to build an endless number of other objects. It can be included in other structures by a simple reference to its name.

For example, a scientist modeling a molecule of water could first create a sphere as a primitive object from which the hydrogen and oxygen atoms can be built. By scaling the sphere, objects named Hydrogen_Atom and Oxygen_Atom can be created. These objects are created as named entities and worked with as named entities. An object named Water_Molecule can then be created. Its structure uses one instance of Oxygen_Atom and two of Hydrogen_Atom, each correctly positioned to simulate the structure of the molecule. Whenever the scientist accesses Water_Molecule to change its definition, to display it on the screen, or rotate it using a dial it is accessed by name.

Both the form of the PS 300 Command Language and the treatment of graphical data as named entities in memory reflect the design of the PS 300 as a tool for designers and analysts, not just graphics programmers.

Commands fall into the following categories:

- Data Structuring

  Data structuring commands are used for creating the structure of objects, naming objects, explicitly and implicitly referencing objects, and conditionally referencing other objects. They create ***display trees*** which are the structured grouping of graphical data, transformations, and attributes which define an object.

- Modeling

  Modeling commands create primitive objects as vector lists, curves, and polygons. They also perform three-dimensional modeling transformations (rotate, translate, scale) on objects and two-dimensional transformations on characters.

- Viewing

  Viewing commands create different views of objects by letting you specify a line of sight, orthographic views, perspective views, and ***viewports*** (the area of the screen in which objects are displayed).

- Attribute Setting

  Attribute setting commands set and change aspects of a model. ***Appearance attributes*** determine such aspects as the color of the model or the intensity of the lines displayed. ***Structure attributes*** allow conditional display of only part of a model's structure. ***Picking attributes*** determine parts of a model that may be ***picked*** from the screen using the stylus and cursor. In picking, the system is capable of recognizing any vector in an arbitrarily-oriented 3D image on the screen.

- Immediate Action

  Immediate action commands display and remove objects from the screen. They also alter the structures of objects by including, prefixing or following named objects with other named objects. Immediate action commands also build ***function networks*** which allow the user to interact with the picture by connecting interactive devices to places in an object's structure.

Each command directs the machine to perform a graphical operation which would require several statements in a conventional programming language such as FORTRAN or Pascal. Once a command is entered, the command itself no longer exists. Instead, the command is interpreted and an action is taken or an entity is created in Mass Memory.

PS 300 commands can be entered in ***Command Mode*** or downloaded in a file from the host system. Commands entered in Command Mode are immediately interpreted by the PS 300. As the PS 300 does not store data entities between power-up cycles, when the system is turned off memory is cleared and existing entities are lost.

The ***Terminal Emulator*** (TE) mode is provided to allow the PS 300 to log on to the host system. In TE mode, the PS 300 keyboard and display can emulate either a DEC VT100 terminal or an IBM 3278 terminal. Commands can be entered into a file on the host system and then downloaded to the PS 300. This method uses the host as a storage device for data files.

PS 300 commands are transmitted in ASCII or in binary format. The PS 300 has its own Command Interpreter which checks the syntax of commands and puts them into effect. When commands are sent in ASCII, they pass through a system function that parses and packages the data into binary data packets that are accepted by the Command Interpreter.

Two software packages allow for efficient communication between the PS 300 and the host system. The PS 300 Host-Resident I/O Subroutines are a set of FORTRAN routines which are run on the host and which are used to write to and read from the PS 300. These subroutines pre-package graphical data into binary packets but transfer all other commands in ASCII format.

The Graphics Support Routines (GSRs) pre-package all commands into binary packets on the host, and provide much faster throughput for downloading PS 300 command files from the host. These routines are available in FORTRAN and Pascal for DEC VAX/VMS and IBM systems with the 3278 interface.

Structures Of Objects

The objects that are created in memory are structured groupings of the graphical data which define shapes and the transformations which are performed on the data. The following example illustrates this.

A cube is defined and given the name Cube with a single PS 300 command that specifies the points and lines (the vector list) that make up the object.

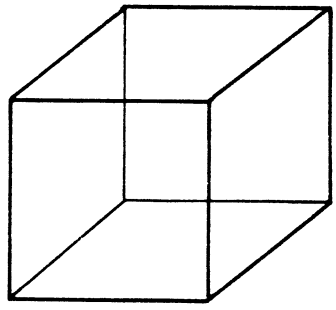


Figure 5. A Cube Primitive

Cube can now be used as a template or *primitive object* from which other objects can be made. Another command is used to create a new object, Brick, by scaling the cube unevenly in height, width, and depth to flatten it and stretch it.

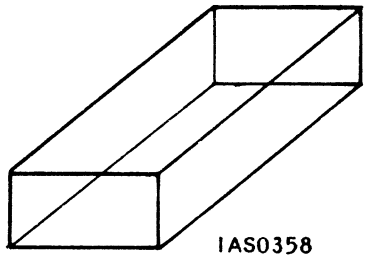


Figure 6. Scaling the Cube

The original object Cube has not been lost. It still exists in memory. The new object Brick merely uses the definition of Cube as part of its own definition. A third object, Upright_Brick can be created by rotating Brick.

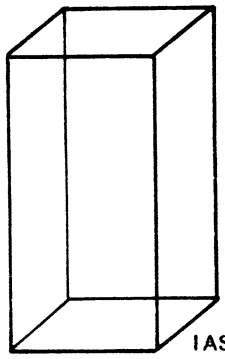


Figure 7. Rotating the Scaled Cube

Again, Brick has not been lost, so now three distinct and separately useable objects have been defined in memory: Cube, Brick, and Upright_Brick.

Another command is used to create an object named All_Shapes which is defined as the group that includes Cube, Brick, and Upright_Brick.

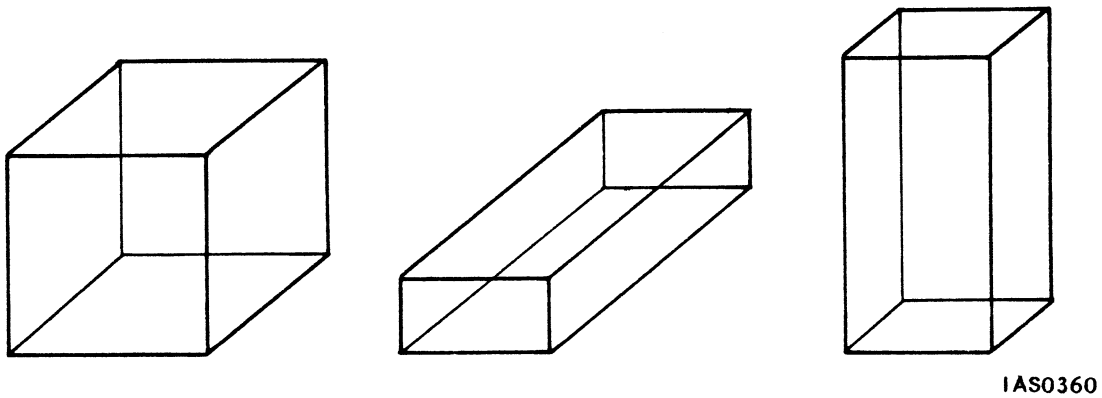


Figure 8. Grouping the Three Objects

Four objects now exist in memory. The simplest is Cube. It consists entirely of the vector list which defines the shape of the cube.

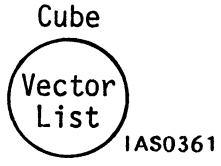


Figure 9. The Structuring Cube

Brick is a more complex object. It consists of a scaling factor applied to the existing definition of Cube.

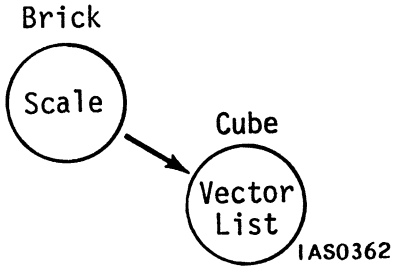


Figure 10. The Structure of Brick

Upright_Brick is more complex still. Its definition consists of a rotation factor applied to Brick. Since Brick itself includes Cube in its definition, Upright_Brick can be diagrammed like this.

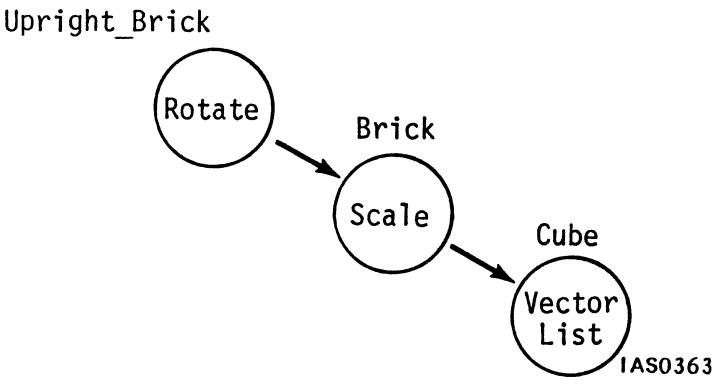


Figure 11. The Structure of Upright_Brick

Finally, All_Shapes is a single named entity that includes Cube, Brick, and Upright_Brick. It can be shown as follows.

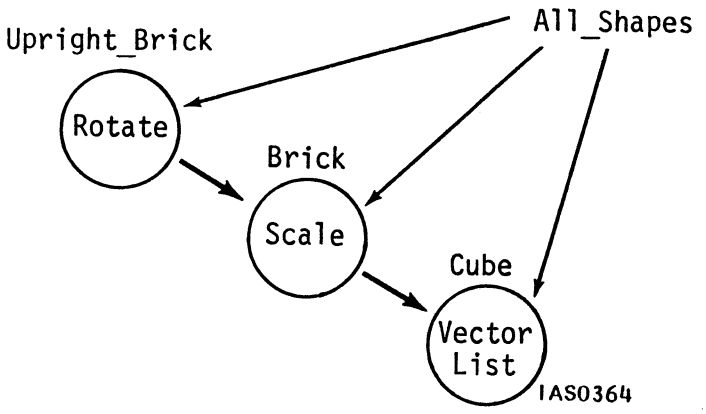


Figure 12. The Structure of All_Shapes

Structures are Hierarchical

The structures that are created in memory form a set of instructions which the display processing hardware performs to generate a picture on the screen. Elements in the structure are organized ***hierarchically.*** Implicit in this hierarchical organization are the operations and transformations that should be applied down any one path.

In a hierarchical structure, each element is used as a reference to all elements below it. So in the structure for All_Shapes:

- Cube references the vector list of points and lines that defines the cube.
- Brick references a scaling operation that is applied to Cube.
- Upright_Brick references a rotate operation that references the scaling operation that references Cube.
- All_Shapes references the vector list, the scale applied to the vector list, and the rotation applied to the scale applied to the vector list.

This type of structure is typical of the structures of objects you create when programming the PS 300. It is referred to as a ***display tree.*** Each element in the structure is called a ***node.*** A node is either a ***data node*** defining points and lines, such as Cube; an ***operation node***, such as Brick (scale) or Upright_Brick (rotate); or an ***instance node***, such as All_Shapes, which groups other elements under a single name. Display trees can be drawn as diagrams which represent the hierarchical structuring of data and operations which define an object. A display tree for All_Shapes is shown in Figure 13.

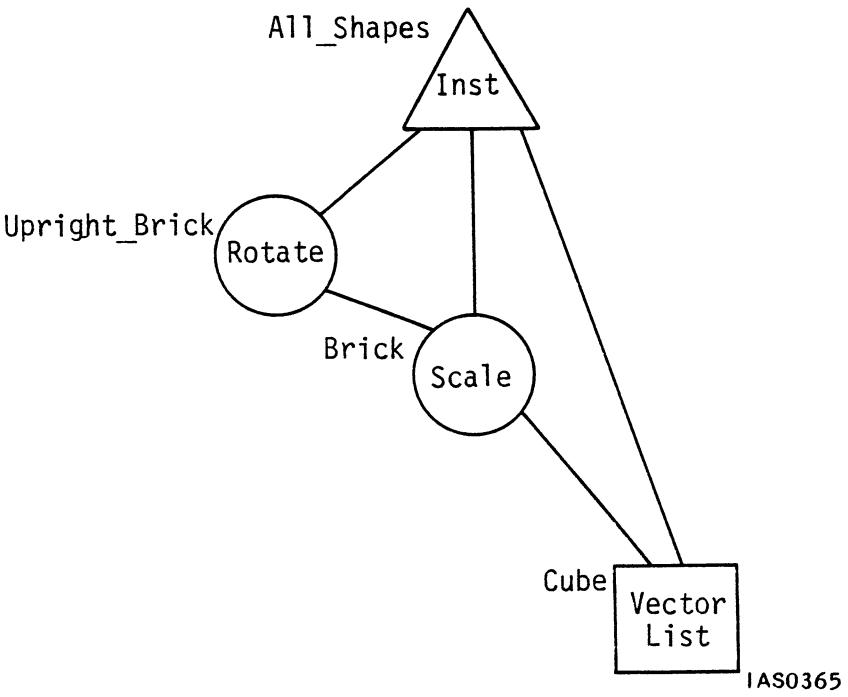


Figure 13. Display Tree for All_Shapes

Data nodes are shown as squares, operation nodes as circles, and instance nodes as triangles. Nodes are connected by ***branches***. The branches in the display tree determine what paths the Display Processor will take when it traverses the object's structure in memory. The content of each node in the tree determines either the operations the display processor will perform as it travels a branch or the data that will be transformed.

PS 300 display trees are more properly described as ***acyclic directed graphs***. In a directed graph, an entity may have more than one ancestor. In PS 300 display trees, a data node may be the terminal node for more than one branch, as is the case for Cube in All_Shapes. An acyclic graph does not allow recursion; that is, an element cannot refer back to itself. In PS 300 display trees, no path out of a node can be a loop back to that node.

THE PS 300 - POWERFUL LOCAL PROCESSING

The PS 300 was designed to perform locally all transformation processing, display processing, and interaction with the picture. Traditionally, the host computer has performed most of these operations.

Transformation and Display Processing

The system performs most of the transformation and display processing involved in modeling and viewing objects without intervention from the user. This greatly reduces the graphics programming task and frees the programmer to concentrate on the design and analysis aspects of the application for which the PS 300 is being used.

The main aspects of the transformation processing which the PS 300 performs are outlined below.

- Traversing Structures in Memory

  The programmer creates objects in memory as display trees with named nodes. The nodes define both the graphical data that determine primitive shapes and the transformations that are applied to the data. The programmer issues a single command to display a picture of the object. Then, during each refresh and update cycle, the system traverses the structure, performs all necessary transformations, and produces an image on the screen. The programmer does not have to issue commands for every step in this process. Note that traversal of the display tree and refresh of the displayed image take place in the same cycle. The PS 300 does not use an intermediary display file or refresh buffer.

- Matrix Concatenation

  All graphical transformations are applied to objects through a matrix called a *transformation matrix.* The display tree indicates the type of transformations in which they are to be performed. The PS 300 performs the concatenation of matrices that this involves, so the programmer does not have to do this explicitly.

- Transformation and Clipping of the Data

  When the programmer manipulates an image on the screen using interactive devices, the system itself performs all the calculations needed to draw the image at each new position on the screen. The system traverses the display tree which defines the object, updating the image as new data is received from the interactive devices. If parts of the image move out of screen boundaries, the image is ***clipped*** automatically without any intervention from the programmer.

- Perspective Viewing

  Much of the "realism" of computer graphics is imparted by displaying views of objects in true perspective projection. The PS 300 produces perspective views of objects and maintains a true perspective view as the objects are in motion. The programmer creates a perspective view with a sequence of viewing commands. The processing which maintains the perspective view while the object is interactively manipulated is performed without intervention from the programmer.

- Viewport Mapping

  The PS 300 automatically performs viewport mapping. A viewport is an area of the screen in which pictures are displayed. The programmer defines a ***window***, an area of coordinate space to be viewed on the screen. No matter what size of viewport the programmer specifies, the system maps the contents of the window to the viewport, ensuring that the view which the programmer wants will fit in the specified area of the screen.

- Generating Characters

  The PS 300 supplies a standard character font of the characters, numerals, and marks and symbols that are usually found on typewriter keyboards. The programmer does not have to generate the vectors that compose a character in the standard font, although the PS 300 does allow the programmer to create, modify, and use other character fonts.

The main aspects of display processing (line generation) which the PS 300 performs are outlined below.

- Digital to Analog Data Conversion

  Part of the display processing functions of virtually all CRT graphics devices is the conversion of digital data defining the vectors that need to be drawn to analog signals that drive the CRT. With the PS 300, this process is performed in the display processing hardware and requires no intervention from the programmer. The conversion of data from digital to analog happens very late in the processing cycle. The system keeps data in digital form through most of the display processing to enhance the processing speed and to allow the update rate to equal the refresh rate.

- Color Specification

  The PS 300 offers an optional CSM Color Calligraphic Display and a Raster Display for displaying images in color. To generate colors, the programmer simply creates "color" nodes in the display tree, indicating the desired colors. The hardware itself does all the processing needed to display those colors.

- Hardcopy

  The PS 300 has an optional interface to a plotter so that hardcopies of the displayed image can be obtained. The programmer merely presses a key on the keyboard to obtain a plot.

- Blinking

  The PS 300 performs blinking as an integral part of display processing. The programmer enters a command with values for the number of frames to display the image and the number of frames to blank the display. The machine itself determines which lines to draw and which not to draw at any time.

- Picking

  Picking allows a graphics system user to select any portion of a randomly-positioned three-dimensional image and get back information about the part of an object's structure it represents. The PS 300 performs this non-trivial task with a minimum of intervention from the programmer.

Interactive Device Handling

The PS 300 lets users manipulate views of objects with a variety of "interactive devices". These include

- keyboard
- function keys
- function buttons
- data tablet
- control dials

The devices are programmed through user-defined software known as function networks. These networks accept data from devices, manipulate the data as programmed in the network, and send new values to interaction points in an object's display tree.

The user programs the interactive devices by designing networks which manipulate the image as desired. The devices themselves convert analog data (such as the amount a dial is turned) into digital form.

Interacting with the Picture

Interaction with an object means changing the image on the screen. Typically, objects can be rotated or translated in any direction, and scaled by any amount along any axis. The PS 300 allows real-time interaction through the interactive devices. Real-time means that when the programmer turns a dial that has been programmed to rotate an object, the delay between the dial turning and the object rotating is imperceptible.

Interaction is achieved by changing the values in an operation node or data node in the display tree. If new values are sent to a scale operation node, for example, the object will appear to grow smaller or larger on the screen. Interaction points in the tree accept new values from function networks connected to interactive devices.

The interaction points in the display tree for All_Shapes can be shown as follows.

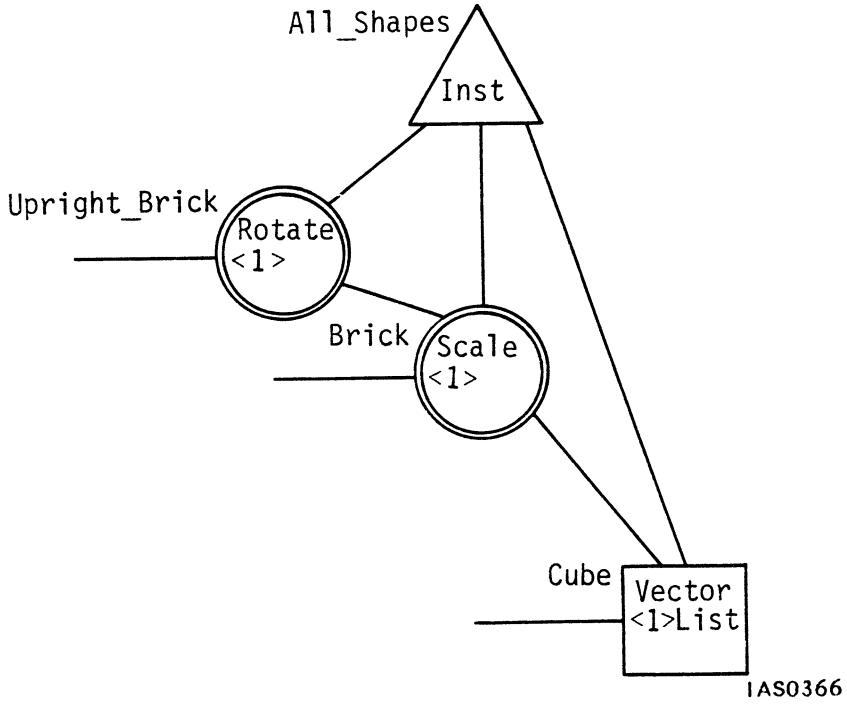


Figure 14. Display Tree with Interaction Nodes

Interaction points are operation nodes and certain data nodes such as vector lists. By convention, operation nodes which are also used as interaction points in a display tree are shown as double circles. The values contained in these nodes can be updated with new values from the interactive devices. The function network through which the data passes ensures that they are converted to the correct data type. For example, a dial can be connected to the rotation node to supply a new rotation matrix. Another dial can be connected to the scale node to supply a new scale matrix. New 3D coordinate values can be sent from the keyboard to the data node to add to or to change the points and lines that define Cube.

Functions and Function Networks

The path between a device and an interaction node in a tree is a function network, created by the user to customize input from the interactive devices. A network is composed of individual functions, each function being thought of as a "black box" with inputs and outputs, as shown below.

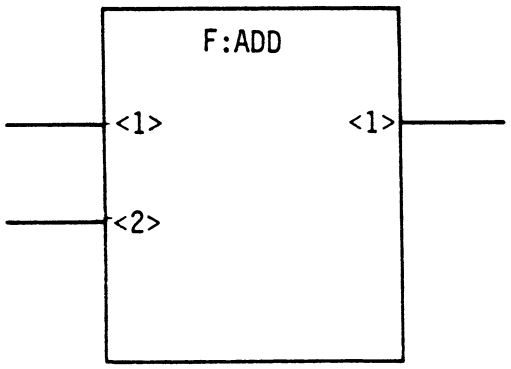


Figure 15. Representation of a Function

Each function performs a mathematical, logical, routing, or selecting operation, such as add, multiply, and, or, route, or choose. The programmer combines functions into networks which manipulate the data from interactive devices usually to produce an effect on a displayed image.

Function identifiers are of the form "F:name" and have numbered inputs and outputs which accept only certain data types. There are nine categories of functions available with the PS 300. These are as follows.

- Data Conversion

  Data conversion functions change matrices into rows, rows into scalar elements, and real numbers to integers or vectors. Data can be output in decimal or exponential format.

- Arithmetic and Logical

  These functions perform all arithmetic operations (add, divide, subtract, multiply, square root, sine, and cosine) and logical operations (and, or, exclusive-or, and complement).

- Comparison

  Comparison functions test whether values are greater than, less than, equal to, not equal to, greater than or equal to, and less than or equal to other values.

- Data Selection and Manipulation

  These functions are used to selectively switch functions, choose outputs, and route data.

- Viewing Transformation

  Viewing transformation functions connect to viewing operation nodes in display trees to change line-of-sight, window size, and viewing angle, interactively.

- Object Transformation

  Object transformation functions connect to modeling operation nodes in display trees to interactively rotate, translate, and scale objects.

- Character Transformation

  These functions are used to interactively position, rotate, and scale text.

- Data Input and Output

  These functions set up and control the interactive devices dials, function keys, function buttons, data tablet, and keyboard and output values to the optional LED labels which several of the devices have.

- Miscellaneous

  Other functions set up and control picking, clocking, timing, and synchronizing operations.

Most functions are general-purpose but have been designed specifically for graphics operations. For example, an arithmetic function such as "multiply" not only accepts two scalar numbers as inputs and outputs their product, it also performs matrix multiplication, accepting two matrices and outputting a concatenated matrix.

Using the set of "master" functions as templates, the programmer creates uniquely named instances of functions and connects them to form a network using PS 300 commands. A function in the network accepts data from an interactive device or another function, performs its specific operation, and outputs the result to another function in a network or to an interaction point in a display tree. The flow of data through a function network is shown in Figure 16.

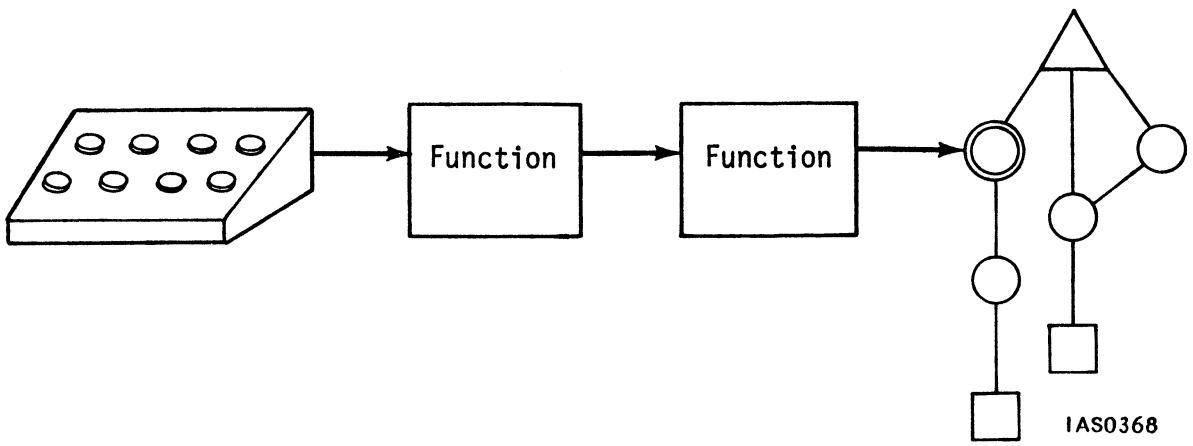


Figure 16. The Flow of Data Through a Network

Function networks differ from programs written in conventional programming languages to handle data from interactive devices. Function networks are ***data-driven.*** That is, networks are dormant until a function receives data at its input queues. The function becomes active, processes the data, passes on the output, and becomes dormant again. In this way, the computer does not have to spend time polling the interactive devices to see if any activity has occurred.

THE PS 300 - A MACHINE FOR DESIGN

The combination of a powerful Graphics Control Processor, large Mass Memory, extremely fast Display Processor, efficiently structured data, versatile Interactive Devices, and the ability to operate in a distributed graphics environment puts the PS 300 at the forefront of interactive computer graphics systems.

The greatest innovation of the PS 300, however, is that it puts the power of computer graphics at the finger-tips of people who are primarily designers. It is a well designed machine for complex tasks. With a minimum of training and background reading in computer graphics concepts, a novice to computer graphics programming can soon create and manipulate three-dimensional structures on the screen. Once learned, the principles involved in structuring simple primitive objects apply to models of any complexity. In the same way, the basic methods learned to construct a function network for simple interactions such as a rotation are easily expanded to apply to larger, more complex networks. Little knowledge is needed of the mathematics involved in transforming graphical data to create moving pictures on the screen. The user is free to concentrate on the application task for which the PS 300 is being used. The PS 300 takes care of the graphics.

USER OPERATION AND COMMUNICATION GUIDE

Supports DEC and DEC compatible operating systems

Supports DEC VAX/VMS and DEC PDP11-RSX-11M
DEC DMR11-AE Driver Interface
DEC Parallel Interface

CONTENTS

ILLUSTRATIONS & TABLES

INTRODUCTION

This manual is directed to users with a DEC/VAX or PDP-11 host system or systems that are functionally similar to the DEC systems. It instructs a PS 300 user in how to operate the PS 300 Graphics System. It describes the control features of the PS 300 Display, Keyboard, and interactive devices and also describes the features of the PS 300 Terminal Emulator package.

The manual provides information necessary to transport data locally in the PS 300 and techniques that can be used for data communication between the host system and the PS 300.

The subjects to be covered are arranged in as chronological an order as possible, chronological implying what a user would first be required to know to efficiently operate the PS 300 Graphics System.

The first section gives instructions for powering up the PS 300.

The second section, Operation, deals with the general operation of the PS 300 Display and Keyboard, and the features available with the PS 300 Terminal Emulator package. It also includes a brief description of the other interactive devices that can be used with the PS 300 Systems: Control Dials, Data Tablet, and Function Buttons.

The third section, Communication, discusses PS 300/host and PS 300 local communication, including the two E&S supported software packages that use host-resident routines to prepare data prior to sending it to the PS 300.

Any reader requiring more information on the topics discussed in the following sections should refer to Volume 5, **System Manager Reference.**

1. BOOTING THE PS 300 GRAPHICS SYSTEMS

Please read the following information carefully before installing any diskette in the floppy diskette drive or turning on the PS 300 Control Unit and Display. PS 300 firmware for some systems requires two floppy diskettes. These diskettes can be booted from one or two drives. Instructions are given for booting systems from a single floppy diskette, and for booting systems requiring two diskettes from either one or two drives.

Booting the PS 300 is a simple procedure. Before starting the booting process, please check the following.

1. Make sure that the the Control Unit and the Display Station are turned off. The "ON-OFF" power switch for the Control Unit is located on the front panel of the Control Unit on the upper-right side. This is a toggle switch and is labeled "ON" and "OFF". The "ON-OFF" power control for the Display Station is the knob located on the lower edge of the Display. Turning the knob to the right will turn the Display on. Both the Control Unit and the Display Station have red power-on indicators.

2. Check that both the Control Unit and Display Station power cords are plugged into active wall outlets of adequate capacity.

3. There must be either a PS 300 Keyboard with Light Emitting Diode (LED) or an auxiliary ASCII terminal available to monitor the progress of the PS 300 confidence tests during the power-up sequence, and to allow commands to be entered once the PS 300 is booted.

4. The cable running from the Display Station to the Control Unit should be connected to the jack labeled "Display 0" at the rear of the Control Unit. (For the PS 320, there should also be a second cable connected to the jack labeled "Display 1" at the rear of the Control Unit.)

5. The interactive devices should be connected to the proper ports at the rear of the Display Station. (Refer to Volume 5.)

1.1 BOOTING WITH ONE DISKETTE

The first step in booting the PS 300 is to install the appropriate PS 300 system diskette in the disk drive. The system diskette used will vary depending on your application. For basic PS 300 graphics operations, use the current version of the PS 300 Graphics Firmware diskette. If the Demonstration Package is going to be run, first load the current version of the firmware, then the demonstration disk "A" should be installed and the loading instructions followed in the "Demonstration Package" chapter in this volume.

The floppy diskette drive is located on the front of the PS 300 Control Unit in the lower-right corner. To install the diskette, remove the bay cover, lift up the latch on the drive, and insert the diskette with the write-protect slot (usually covered with foil) facing to the left and the manufacturer's or E&S label facing up. Push the latch back down when the diskette is in place.

On some drives there is a switch in the upper-right corner of the drive that is used to lock the drive latch. A red dot is visible when the switch is moved to the left, signifying that the latch is locked. The drive door must be closed to activate the drive.

CAUTION

WHILE THE SYSTEM IS BOOTING, DO NOT TRANSMIT FROM THE HOST TO THE PS 300, PRESS ANY KEYS ON THE KEYBOARD OR AUXILIARY TERMINAL, OR USE ANY INTERACTIVE DEVICE.

The second step in the booting process is to turn on the PS 300 Control Unit and the Display.

The PS 300 begins a series of power-up confidence tests as soon as the Control Unit is turned on. These tests are monitored by the LED displays on the PS 300 Keyboard (or on the auxiliary terminal) and appear as alphanumeric sequences beginning with

A B C D E F G H I J K L M N O P 0 1 2 3 4 5 Q R S T

The letters appear at varying times and a beep sounds after the successful completion of several of the tests (before "J" and at "O"). When the confidence tests are complete and the files on the Firmware (or other) diskette have been loaded, the LEDs will display the following:

PS 300: System VXXX A: (date) I: (date)

The version number (XXX) and (dates) will vary.

The LEDs will now clear and the name of the diskette and version number will appear in the middle of the PS 300 Display Screen. You may now log onto the host following directions given in sections 2 and 3, or follow the directions given for the system diskette(s) that has been booted.

More detailed information on powering up the PS 300, system diskettes, and monitoring the power-up confidence tests is in Volume 5, **System Manager Reference.**

1.2 BOOTING WITH TWO DISKETTES

The first step in booting the PS 300 is to install the appropriate PS 300 system diskettes in the disk drives. For basic PS 300 graphics operations, use the current version of the PS 300 Graphics Firmware diskette.

1.2.1 Systems With Two Diskette Drives

The floppy diskette drives are located on the front of the PS 300 Control Unit in the lower-right corner. To install the diskettes, remove the bay cover, lift up the latch on Drive 0, and install the firmware labeled "A" in that drive. The second drive is labeled Drive 1. The diskette labeled "B" should be installed in Drive 1. Insert the diskettes with the write-protect slot (usually covered with foil) facing to the left and the manufacturer's or E&S label facing up. Push the latch back down when the diskette is in place.

On some drives there is a switch in the upper-right corner of the drive that is used to lock the drive latch. A red dot is visible when the switch is moved to the left, signifying that the latch is locked. The drive door must be closed to activate the drive.

CAUTION

WHILE THE SYSTEM IS BOOTING, DO NOT TRANSMIT FROM THE HOST TO THE PS 300, PRESS ANY KEYS ON THE KEYBOARD OR AUXILIARY TERMINAL, OR USE ANY INTERACTIVE DEVICE.

The second step in the booting process is to turn on the PS 300 Control Unit and the Display.

The PS 300 begins a series of power-up confidence tests as soon as the Control Unit is turned on. These tests are monitored by the LED displays on the PS 300 Keyboard (or on the auxiliary terminal) and appear as alphanumeric sequences beginning with

A B C D E F G H I J K L M N O P 0 1 2 3 4 5 Q R S T

The letters appear at varying times and a beep sounds after the successful completion of several of the tests (before "J" and at "O"). When the confidence tests are complete and the files on the Firmware (or other) diskettes have been loaded, the LEDs will display the following:

PS 300: System VXXX A: (date) I: (date)

The version number (XXX) and (dates) will vary.

The LEDs will now clear and the name of the diskette and version number will appear in the middle of the PS 300 Display Screen. You may now log onto the host following directions given in sections 2 and 3, or follow the directions given for the system diskette(s) that has been booted.

More detailed information on powering up the PS 300, system diskettes, and monitoring the power-up confidence tests is in Volume 5, **System Manager Reference.**

1.2.2 Systems With One Diskette Drive

To load two diskettes from one drive, load Diskette "A" following the steps given in section 1.1. The following message will appear on the PS 300 keyboard LEDs after the first diskette has finished loading. (If the keyboard has no LEDs, pause a few minutes.)

‹INSERT ANOTHER DISK AND HIT RETURN

1. Remove Diskette "A" from Drive 0.
2. Insert Diskette "B" into Drive 0. Close the latch.
3. Press the RETURN key on the PS 300 Keyboard.

The second diskette will now load from Drive 0, and the confidence tests should complete normally. The LEDs will clear, and the system name will appear in the middle of the display screen.

1.3 TROUBLE-SHOOTING TIPS

If the booting process is not complete after three to five minutes, something is wrong. There are several things that should be checked before trying to boot the system again.

1. If, after installing the diskette and turning on the Control Unit and Display, the system goes longer than 30 seconds without beeping, a confidence test has failed and the booting process should be repeated. Start over by turning off the Control Unit and taking out the diskette. Then reinsert the diskette, close the drive, and turn the Control Unit back on.

2. Make sure the display is turned on.

3. Check to make sure that the diskette is properly inserted and that the latch is closed.

4. Check all power and cabling connections to make sure that host line(s) and debug terminal line(s) are in correct ports for the firmware being booted.

5. Check to make sure that you have the proper diskette in the drive.

6. If the confidence tests run successfully through "0", but the LEDs do not clear and the diskette name and version number do not appear on the display, the problem is related to trouble in reading the diskette files. If you have another copy of the diskette, attempt to reboot using that diskette.

7. If the confidence tests do not run successfully, contact the System Manager and/or refer to Volume 5 of this set for failure definitions.

2. OPERATION

The operational instructions for the PS 300 begin with the very basic features of the PS 300 Display and Keyboard. It is important to read the information to get an idea of the design and implementation of the system.

2.1 OPERATION - THE STANDARD PS 300 DISPLAY

The standard 19-inch monochrome display screen for the PS 300 has no particular operating instructions other than turning it on and off, adjusting the intensity of the screen, and adjusting the position of the display screen 'head'. The display should be turned on before powering up the PS 300 Control Unit. The display is turned on using the ON/OFF knob located on the lower right-hand side of the display. The ON/OFF knob is the knob on the right. The knob on the left controls intensity. With the varying degrees of possible ambient lighting, it is sometimes necessary to adjust the intensity until a comfortable setting is found.

The display screen 'head' may be rotated by pushing it into the desired position. To adjust the tilt angle of the screen head, reach under the bottom center of the screen and grasp the 'tilt release' handle. Squeezing the handle releases the lock on the head of the Display, allowing it to be repositioned. When the handle is released, the screen head is 'locked' into place.

The main area of the screen is used for viewing text or graphics. The Terminal Emulator viewing area is 80 columns wide and 24 lines high. The screen space used for viewing is dependent on the application. (Refer to 2.4, TE SETUP, for information on adjusting the viewing area of the screen). The graphics viewing area is a 10.5 inch square in the center of the screen.

The bottom line on the PS 300 Screen is the "message display" area. This line will display a memory-alert warning message when the user is running out of mass memory space and can be used to display messages generated by a user application program. The line can be "blanked" by the user. When memory usage drops below the "alert" status, the message display area will automatically blank.

2.2 OPERATION - THE STANDARD PS 300 KEYBOARD

The PS 300 Keyboard operates as a standard ASCII keyboard and has an optional LED array located on the top of the keyboard panel that can display a full line of text or text segments. The LEDs can be used to label the action performed when a Function Key is selected. They also display error messages generated by a fatal error and provide visual feedback during the power-on confidence tests.

The keyboard is activated when the system is booted. The keyboard connector cable should be plugged into Port A of the Data Concentrator (located on the back of the display) prior to a power-up sequence (Figure 2-1).

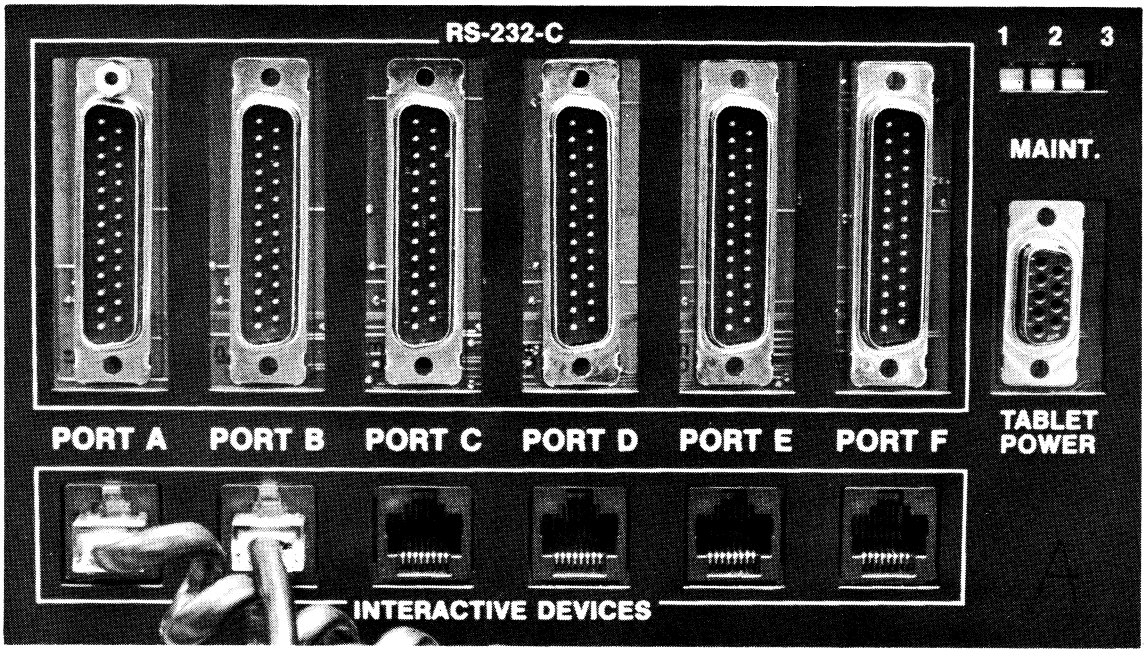


Figure 2-1. Port A of the Data Concentrator

The controls on the keyboard are the 95 keys. These keys fall into eight categories.

- Keyboard Function Control Keys

  These keys are the CONTROL, SHIFT, CAPS LOCK, and REPT keys. They are local control keys that modify the signal generated by other keys when struck in combination with them.

- Alphabetic Keys, Standard Numeric, and Special Character Keys

  These keys all generate standard ASCII character codes and are used to display uppercase and lowercase characters. The keys may be struck alone, or in combination with the Keyboard Function Control keys.

- Terminal Function Keys

  These keys produce codes used by a standard terminal. They are ESC, TAB, BACK SPACE, DEL, RETURN, LINE FEED, and the Space Bar.

- Numeric Keypad Keys

  The function of these keys is determined by the host system and the mode in which they are used.

- PS 300 Device Control Keys

  These keys are PS 300 system keys and are used to activate certain applications of the PS 300 in the various modes of the Terminal Emulator.

- PS 300 Function Keys

  These keys are interactive device keys that are set up by user network functions. They can be used for internal control or for communication back to the application program in the host.

The location of the keys is shown in Figure 2-2.

Figure 2-2. The Standard PS 300 Keyboard

2.3 KEYBOARD MODES OF OPERATION

The keyboard initiates actions that are defined by the 'mode' of operation. These modes are entered by pressing one or more keys on the keyboard. The following table lists the three modes, a brief description of each mode, and the key(s) used to access them.

Table 2-1. Keyboard Modes of Operation

MODE	USE	KEY(S)TO ACCESS	KEYBOARD APPLICATION
Terminal Emulator	Access line to host	LINE LOCAL	Keyboard input sent to host and characters displayed on PS 300 screen.
Command	Enter local PS 300 commands	CONTROL/ LINE LOCAL	Text commands are displayed on the screen and executed by the CI.
Inter-active	Keyboard as graphics device	SHIFT/ LINE LOCAL	Fkeys and Keyboard are activated as input devices for function networks. Text does not appear on screen.

There are two host-specific terminal emulators: the Digital Equipment Corporation VT-100 terminal emulator and the IBM 3278 terminal emulator. (Literature on the IBM 3278 Terminal Emulator is found in the PS 300 Operation and Communication User's Guide for IBM 3278 Interface Systems.) Both the Command (CI) mode and the Interactive mode are local to the PS 300 and require no host system interaction.

The PS 300 Terminal Emulator (TE) package provides the user with the ability to use the PS 300 display and keyboard as interactive graphics devices and allows for DEC VT-100 emulation on the PS 300. The following sections describe the three keyboard modes available on the PS 300 and how to access them.

2.3.1 Terminal Emulator Mode

In the Terminal Emulator Mode, often referred to as TE mode, the PS 300 terminal functions as a standard terminal on the host. The user can log on to the host, access and edit host resident files, and use the available host system utility commands.

To enter the Terminal Emulator Mode and access a line to the host, press the LINE LOCAL key on the left-hand keypad. Next, the RETURN key on the keyboard must be pressed at least once to generate a host 'prompt' character on the screen. The cursor, a blinking square character, will appear on the active line in the active column.

The PS 300 powers up in the Terminal Emulator Mode.

2.3.2 Command Mode

In Command Mode, commands entered on the PS 300 keyboard are displayed as text on the screen. While in Command Mode, valid commands with the proper ";" terminator are immediately interpreted by the PS 300 and are not stored by the system or host in a file. Error messages received from the Parser and the Command Interpreter are displayed on the screen.

To enter PS 300 Command Mode, press and hold down the CONTROL key and then press the LINE LOCAL key. Next, the RETURN key should be pressed to generate the PS 300 Command prompt '@@' and the cursor.

2.3.3 Interactive Mode

In Interactive Mode, the Function Keys on the keyboard (and any other programmed keys) act as local input or selection devices for user-constructed PS 300 function networks. There is no cursor or screen 'prompt' in the Interactive Mode, and the keyboard does not send any information to the host.

To enter the Interactive Mode, press and hold down the SHIFT key and then press the LINE LOCAL key.

2.3.4 PS 300 Keys of Interest

The following keys and their functions are active in all three keyboard modes. These keys are all located on the left-hand keypad of the the PS 300 Keyboard.

- HARDCOPY

  The HARDCOPY key is used to signal the hardcopy plotter device attached to the PS 300. When the HARDCOPY Key is used alone, a hardcopy plot of the screen is generated by the plotter. When HARDCOPY is used with the SHIFT key, it triggers a form feed on the plotter. HARDCOPY used with the CONTROL key triggers a hardcopy initialization. If there is no hardcopy device attached to the PS 300, the key has no function, and an error message will be displayed on the screen if the key is pressed.

- GRAPH and TERM keys

  Pressing the TERM key blanks the text associated with either the TE or the Command Mode. Pressing the key a second time will restore the text. Pressing the GRAPH key blanks any graphics being displayed. Pressing the key a second time will restore the graphics display. These keys may be used at any time, and allow the user to view both the text and the graphics display simultaneously, or to clear one or both from the screen.

- CLEAR HOME

  When used alone, this key erases the Terminal Emulator text from the screen and places the cursor in the top left corner of the screen. When used with the SHIFT key, the cursor is moved to home, but the screen is not cleared. When used with the CONTROL key, the screen is cleared, but the cursor is not moved to home.

2.3.5 General Information

Keyboard activities are dependent on the mode used. The following list is an easy reference for keyboard use in various modes.

1. In the TE mode, movement of the text on the screen is host-dependent. Refer to 2.5 for more information.

2. In Command Mode, text appears on the first available line and moves down the screen. Text scrolls up when the last line is filled. By default, there is no automatic line wrap-around; text terminates at 80 columns. This can be changed, and is dependent on host system configuration (refer to Volume 5).

3. The Function Keys generate certain escape sequences when used in modes other than Interactive Mode. Refer to 2.5 for more information about the Function Keys.

2.4 TE SETUP

TE SETUP facility allows users to change some features of the display and keyboard. SETUP also gives the user access to a menu display of the current keyboard configuration.

The SETUP facility is accessed by pressing the SETUP Key on the PS 300 Keyboard. While in SETUP, the SETUP menu is displayed on the PS 300 screen. All keyboard input is sent to the SETUP facility, and the only active keys are the PS 300 device keys and the keys that the SETUP facility uses. SETUP may be entered from any of the three keyboard modes.

The status of features that have been changed using SETUP are in effect until changed by the user or when the system is rebooted. When the system is rebooted, the default values of SETUP are reinstated.

The default values of the features in SETUP may be changed by entering the new values into the SITE.DAT file on the PS 300 Graphics Firmware. Refer to Volume 5 for information on creating and using the SITE.DAT.

2.4.1 SETUP Menu Display

The following menu is displayed when the SETUP key is pressed.

```
------------------------------------------------------------
SETUP

F2=SRM:T  F3=AWRP:F  F4=ANSI:T  F5=VT52:F
F6=KPM:F  F7=CKM :F  F8:Cnum:T  F9=Knum:T

F10= Define break key :↑V
F11: Move TE viewport, lower left corner
F12= Move TE viewport, upper right corner
Mode: KB  Term: On  Graph : On
------------------------------------------------------------
```

Pressing F11 or F12 causes the following prompt to appear:

"Move corner with cursor keys, F1 to exit."

Pressing F10 causes the following prompt:

"Press special key to be break key, F1 to exit."

The status of the features (T or F) is displayed on the screen when the SETUP menu is displayed. With the exception of defining the BREAK key and setting the screen viewport for text, all the features are set or reset by pressing the indicated Function Key. The status of the feature changes (from T to F, or F to T) on the screen menu when the key is pressed. When additional keystrokes are required, as in setting the viewport location and size, additional prompts are displayed after the Function Key that accesses that feature has been pressed. Table 2-2 gives a breakdown of the Function Keys, their purpose, and the default values assigned to the features by the system.

A full description of the SETUP options appears in section 2.4.2.

Table 2-2. TE SETUP Features

FUNCTION KEY	FEATURE	DEFAULT VALUE
FKey F2	SRM Mode	TRUE
Fkey F3	Autowrap	FALSE
Fkey F4	ANSI Mode	TRUE
Fkey F5	VT52 Mode	FALSE
Fkey F6	Keypad Mode	FALSE
Fkey F7	Cursor Keys	FALSE
Fkey F8	Numeric Keys-Command Mode	TRUE
Fkey F9	Numeric Keys-Keyboard Mode	TRUE
Fkey F10	Define BREAK key	User defined
Fkey F11	Viewport lower-left corner	User defined
Fkey F12	Viewport upper-right corner	User defined

2.4.2 SETUP Feature Definitions

The following features may be set to ON or OFF by toggling the appropriate Function Key in the SETUP Mode. To exit SETUP, toggle the SETUP key.

Function Key F2 sets or resets the Send-Receive mode of the PS 300 terminal. This mode determines whether the input to the screen from the keyboard is sent via the host or a PS 300 system function. (Refer to Section 2.5.1 for more information on this feature.) The Send-Receive mode is set to TRUE by the system and may be changed by the user at any time.

Function Key F3 (AWRP) lets you set or reset (on or off) automatic line wrap-around at 80 characters.

Function Key F4 (ANSI) sets the ANSI (VT-100) mode of the PS 300 terminal. When set (or TRUE) the PS 300 will generate and respond to VT-100 (ANSI) control sequences. This mode defaults to TRUE and should only be changed when the user wants the PS 300 to respond like a teletype-style terminal and not respond to VT-100 control sequences.

Function Key F5 (VT52) allows the PS 300 to respond VT52 coded sequences. This defaults to FALSE.

Function Key F6 (KPM) determines the function of the right-hand keypad on the PS 300 Keyboard. If set to TRUE, the right-hand keypad will generate the control sequences used in the keypad application mode (i.e. host editing utilities such as DEC's EDT and KED). When set to FALSE, the right-hand keypad generates its numeric keycap values.

Function Key F7 (CKM) sets the cursor keys mode. When this mode is TRUE, the cursor keys are operational in all keyboard modes. The ANSI/VT52 feature must be set to TRUE for this to be effective.

Function Key F8 (Cnum) determines whether the right-hand numeric keyboard will generate keycap values or escape sequences in Command Mode. When set to TRUE, the keypad will generate the numeric keycap values in Command Mode.

Function Key F9 (Knum) determines whether the right-hand numeric keyboard will generate keycap values or escape sequences in Interactive Mode. When set to TRUE, the keypad will generate the numeric keycap values in Interactive Mode.

Function Key F10 (BREAK) is used to send a break sequence to the host system. It is up to the user to decide which PS 300 key will be interpreted as a 'break' key by the host. To designate the BREAK key, first press Function Key F10, and then press the key that is to be used at the BREAK key. After pressing the designated BREAK key, press Function Key F1 to indicate the BREAK key has been selected and to return to SETUP Mode.

Any key may be used as a BREAK key, with the exception of those listed below.

SETUP
Function Key F1
GRAPH Key
TERM Key
LINE/LOCAL Key

Any other Function Key, HARDCOPY, CLEAR/HOME, and any key on the entire right-hand keypad can be designated as the BREAK key. The BREAK key can be designated as a key, the shifted value of a key, or the control value of a key. This allows for keys with an ordinary use to be designated as the BREAK key using their shifted value or using them in conjunction with the CONTROL Key.

Instead of a key, users may designate a CTRL-V <single character> escape sequence that will cause the Terminal Emulator to send a break to the host. A restriction on this sequence is that it must not be one that is generated by the E&S Keyboard. The **System Manager Reference**, Volume 5, contains the escape sequences generated by the Keyboard.

The BREAK key is only functional in the TE mode of operation.

Function Keys F11 & F12 (Viewport). When the PS 300 System is booted, the display screen is initialized with a Terminal Emulator screen area that is 24 lines high and 80 columns wide. When the size and location of the viewport is changed, the viewport still contains the 24 horizontal lines and the 80 vertical columns, but the size of the rows and columns can be changed. For example, if the upper-right corner is moved from its original position to the top right-hand corner of the PS 300 screen, this does not add more available lines for text or display, but rather transforms the text appearing on the 24 lines. This text will appear to have twice the height. The viewport can be made any size and any rectangular shape and can be placed anywhere on the PS 300 Screen. To remove any previous text from the screen, toggle the TERM Key on the left-hand keypad. The SETUP menu is then visible.

There are two steps needed to change the viewport size and/or location:

1. To move the upper-right corner, first press Function Key F12, then the cursor key or keys that move the corner in the desired direction. As there is no cursor in SETUP, toggle the TERM Key again to get some text on the screen. As the cursor key is pressed, the text on the screen conforms to the corner position. When the appropriate position is reached, press Function Key F1.

2. To move the lower-left corner, first press Function Key F11, then the appropriate cursor key or keys. Again, have some text on the screen so that the movement of the corner is visible. When the lower-left corner reaches the desired position, press Function Key F1.

   When the right corner of the text display area meets the left corner, or the bottom edge meets the top edge, the sizing action stops until cursor keys are pressed that move the corners in an appropriate direction. The movement of the corners also stops when they reach the edge of the display area of the screen.

2.5 USING THE TERMINAL EMULATOR - DEC VT100 Emulation

TE mode operation, under DEC-compatible firmware, closely emulates the DEC VT100 terminal features. Typed lines of text appear at the top of the PS 300 Display Screen and move down to the bottom. When the bottom of the screen is reached, text scrolls up.

Movement of text on the screen and the function of many of the keys are host-dependent. The Terminal Emulator performs no automatic line-wrap, but various terminal features may be set from the host, including automatic line wrap-around at the end of 80 columns. Without automatic line-wrap, the lines of text terminate at 80 columns and any subsequent text is lost. With the carriage return, the completed 80 characters are scrolled up. The LINE FEED Key scrolls the line down, but does not generate a carriage return.

The terminal function keys include BACK SPACE, DEL, RETURN, LINE FEED, ESC, TAB, and the space bar. The TE has tab stops permanently set in positions 9, 17, 25, and every subsequent 8 columns across the screen.

The DEL key is used to delete characters on the bottom, or active, line of the TE display area. Pressing the DEL key causes the system to backspace, deleting the characters on the active line.

2.5.1 TE in Local/No Local Echo (SRM)

The Send-Receive Mode determines whether the input from the PS 300 keyboard is echoed back to the screen from a PS 300 function or from the host system. This mode can be set to TRUE or FALSE using the SETUP Mode of the Terminal Emulator (section 2.4). The way that the text moves on the screen and the actions certain keys perform depend on whether the text is displayed as characters returned on the host communication line, or as characters being sent to the screen from the keyboard by a PS 300 function.

The PS 300 communication protocol requires a full duplex line. As keys are pressed on the keyboard, keycodes are sent to the host, which in turn sends them to the screen where they appear as text. There is also a PS 300 system function that receives keyboard transmission and returns it to the screen.

Because of the various communication lines available from the keyboard and to the display, two abnormal situations may occur.

1. No characters appear on the screen when keys are pressed on the keyboard. This may occur because neither the host nor the PS 300 function are transmitting the data received from the keyboard to the screen.

2. Two characters appear on the screen when only one was entered on the keyboard. This may occur because both the host and the PS 300 function are transmitting the characters to the screen.

Local echo, which is toggled on or off by the TE SETUP facility, allows transmission of the characters to the screen by the PS 300 function. Toggling it on (TRUE) sets the PS 300 to no local echo and stops the transmission of characters from the PS 300 function to the PS 300 Screen. This is the default at bootup.

The communication line from the host may be set to echo back characters or not echo back characters using host setup features.

2.5.2 Editing Utilities

The PS 300 Terminal Emulator package allows the operator to use the editing program utilities (EDT and KED on DEC operating systems VMS and RSX-11M, respectively). Users with DEC operating systems should refer to their utility manuals for information concerning the operation of particular editing programs. The following paragraphs describe the features available on the Terminal Emulator that correspond to similar features on the DEC VT100 and DEC VT52 terminals.

Keypad Modes

There are two keypad modes available in the VT100 simulation. These modes correspond to the DEC modes of DECCKM, that determines when the cursor keys are active, and DECKPAM/DECKPNM that allows the right-hand keypad to operate in an editor program.

These keypads may be set in a permanent mode by using the TE SETUP facility described in 2.4.

Cursor Keypad Mode (DECCKM)

All DEC cursor movement commands are implemented. These are editor program functions, enabling cursor movement on the available screen area. The cursor keys are located on the left-hand keypad of the PS 300 Keyboard.

DEC's private commands DECSC (save cursor) and DECRC (restore cursor) have not been implemented.

Keypad Application Mode (DECKPAM)

This mode allows the operator to access command sequences corresponding to the EDT or KED editor programs. Using the right-hand keypad of the PS 300 Keyboard, the right four PS 300 Function Keys (F9 to F12) duplicate the action of the top four keys, (PF1 to PF4), on the right-hand keyboard of the standard DEC VT100 terminal. (See Figure 2-2, PS 300 Standard Keyboard.) Refer to the Editor Reference manuals for DEC operating systems for information on the functions available in the DECKPAM mode.

"Select" Graphic Rendition

The PS 300 Terminal Emulator uses an underscore character to highlight portions of the text in the file that have been 'selected'when the SELECT key function is used on the right-hand keypad during an editing session.

DEC's private codes for line size and double width characters and alternate characters sets, G0 and G1, have not been implemented.

Special Keys of Interest

Pressing the CLEAR HOME key, while editing a host-resident file, causes the screen to erase and the cursor to move to the home position. This is a local function and is separate from host editing utilities. The screen text can be repainted by entering a <CTRL>W, which causes the host to refresh the screen.

NOTE

Entering the SETUP mode and changing features does not result in the loss of data displayed on the screen.

2.6 INTERACTIVE DEVICES

This section contains descriptions and typical uses of interactive devices that can be configured with the PS 300. With each device description there are operational instructions.

Setup procedures, brief maintenance information, and a description of the control codes generated by the interactive devices are provided in Volume 5, **System Manager Reference**, for site or system managers and for users who build their own function networks and wish to program the devices.

The interactive devices that can be configured with the PS 300 Graphics System include the following peripherals.

- PS 300 Keyboard with or without LED display
- Control Dials Unit with or without LED display
- Data Tablet
- 32-Function Buttons Unit

The acceptable inputs and programmable outputs from these devices are found in the "Function Summary" section of Volume 3.

The interactive devices are sensitive and should be handled and stored in an appropriate manner. Normal considerations should be taken in use; any liquids or foreign objects spilled or dropped into or on any of the devices may cause damage or cause the devices to malfunction.

2.6.1 Keyboard and Control Dials LED Display Operation

Both the PS 300 Standard Keyboard and the PS 300 Control Dials Unit have optional LED displays. These are used to display character strings that serve the following purposes:

- During a power-up sequence, the keyboard LEDs display system information and are used to identify hardware or firmware failures.
- Fatal Error messages are displayed on the keyboard LEDs.
- The LEDs can be programmed by the user to name or display information about the use of the Function Key or Control Dial located directly below each LED display segment.

Most users will use PS 300 function networks to set up and send character strings to the LED display. Information for sending characters and text to the Keyboard LEDs is found in the **Function Summary** section of Volume 3.

2.6.2 PS 300 Keyboard Function Keys

The PS 300 Keyboard Function Keys are the top row of 12 keys on the Keyboard. These keys typically act as graphics input devices to user function networks. They can be used for internal control of or communication back to an application program in the host. The mode of the Keyboard also determines the function of the keys. In Interactive Mode, the Functions Keys supply values to user designed Function Networks; in TE mode the Function Keys are configured to act as input keys that send data to the host system. The keys can be set to act as graphics input devices (like in interactive mode) in all modes by using the TE SETUP feature. (Refer to 2.4.)

These keys can be used to do such things as:

- Switch the input of the Control Dials between function networks
- Send specific information back to an application program
- Determine the function of other interactive devices (e.g. Control Dials, Data Tablet).

2.6.3 Control Dials Unit

The PS 300 Control Dials Unit (Figure 2-3) has eight dials with optional LED displays. The dials are used to communicate dynamic, incrementing, and decrementing data to the PS 300. The Control Dials Unit connects to Port B of the Data Concentrator.

In typical applications, the Control Dials can be used to perform the following operations.

- Rotate objects about the X, Y, or Z axis, each type of rotation typically using a different dial.
- Zoom in or out.

- Translate objects in X, Y, and Z, each translation typically using a different dial.

Like the PS 300 Keyboard, the Control Dials Unit has optional LED displays. These displays function as 8-character labels for each of the dials.

Refer to the "Function Networks I" module in Volume 2 and to **Function Summary** in Volume 3 for information on using the Control Dials as an input device to user-created function networks.

The information that describes system-level data formats and codes exchanged in dial and LED display operation is found in Volume 5 of this document set.

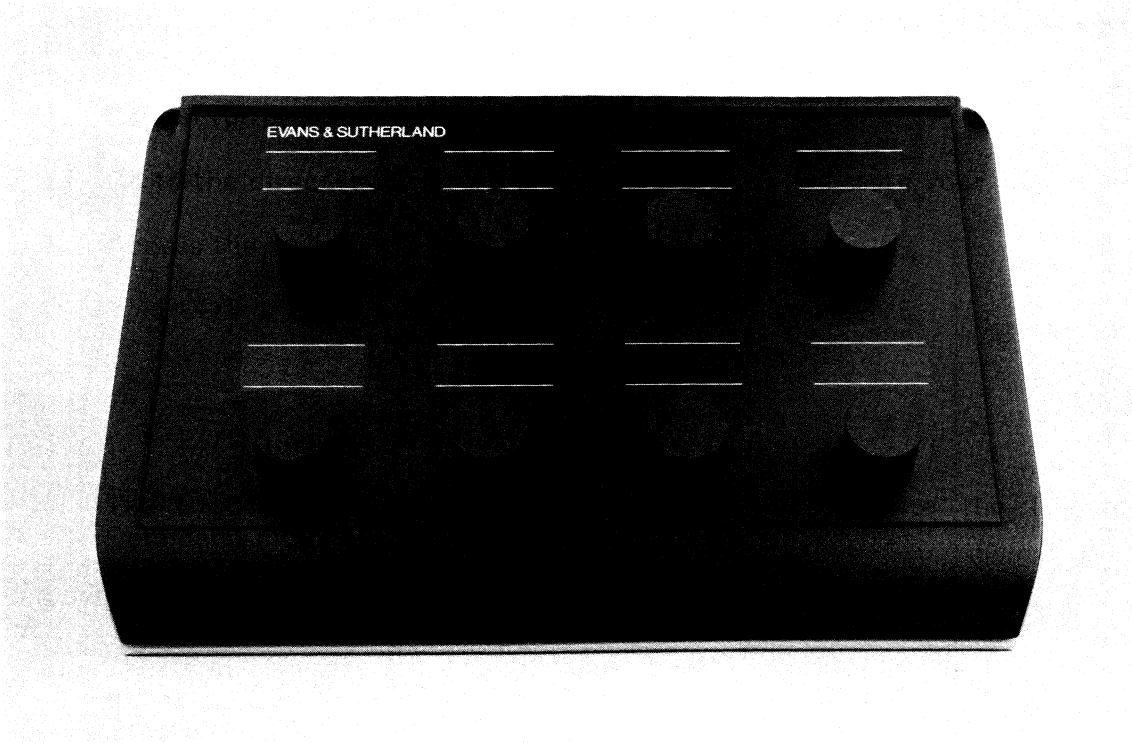


Figure 2-3. Control Dials

2.6.4 Data Tablet

The PS 300 Data Tablet (Figure 2-4) consists of a tablet and a stylus or a four-button cursor called a "puck." Stylus or puck position information is sent to the PS 300 in digital form that expresses a two-dimensional coordinate value (x,y). The Data Tablet connects to Port F of the Data Concentrator and to the power supply connector on the Data Concentrator. The Data Concentrator is on the back of the PS 300 Display.

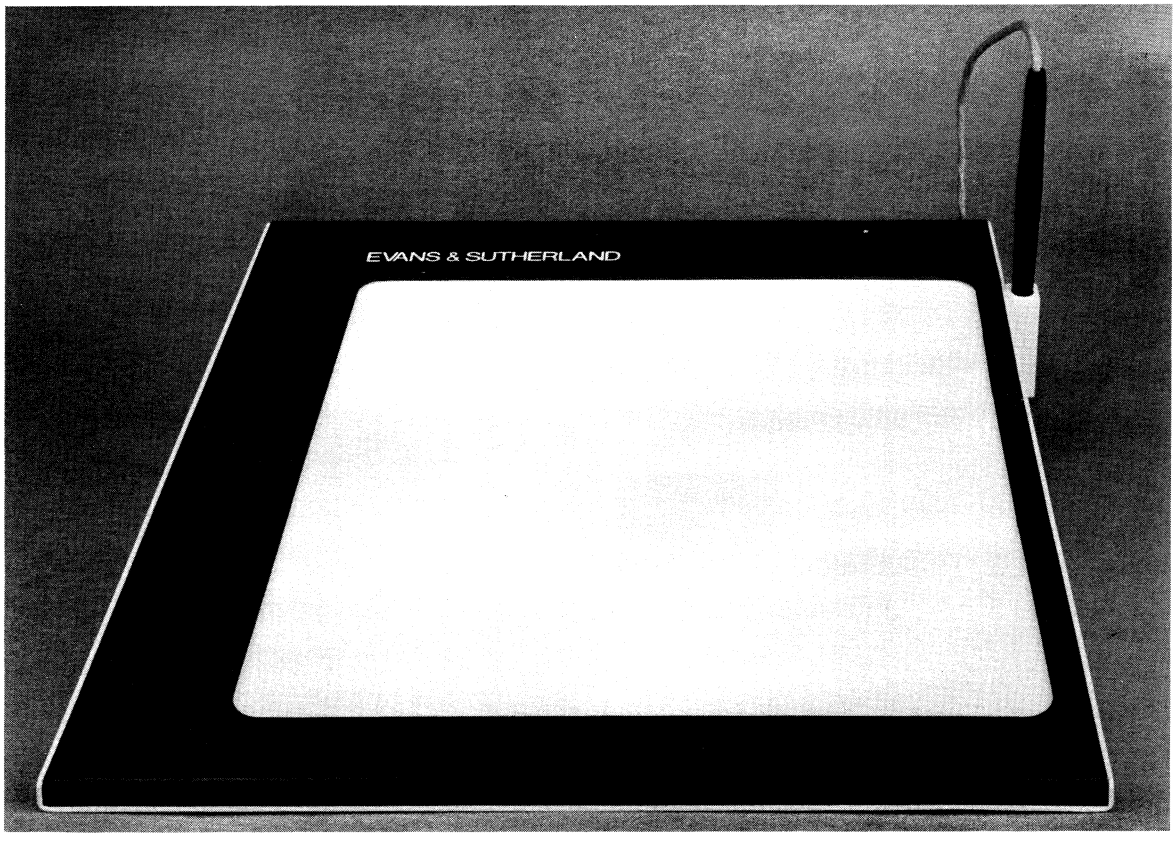


Figure 2-4. Data Tablet

Maps, diagrams, and drawings may be used as overlays on the surface of the tablet.

The movement of the stylus across the surface of the Data Tablet is shown by the position of a cursor on the PS 300 Screen. The shape of the cursor is programmable. (Refer to **Function Summary** in Volume 3.)

The PS 300 Data Tablet's operating mode and sampling rate are both controlled by the Graphics Control Processor (GCP). The following modes are available.

- Point Mode

  Depressing the stylus or puck button at a given tablet location causes one X,Y coordinate pair (sample) to be transmitted.

- Stream Mode

  X,Y coordinate pairs (samples) are generated continuously at the selected sampling rate when the stylus or puck near the tablet surface. Pressing the stylus on the tablet surface or pressing the puck button puts the flag character (F) in the output stream.

- Switched Stream Mode

  Pressing the stylus on the tablet surface, or the button on the puck, causes causes X,Y coordinate pairs (samples) to be output continuously at the selected sampling rate until the stylus is lifted or the puck button is released. The cursor will not track in this mode unless the stylus or button is depressed.

These modes are selected by sending inputs to the TABLETOUT function. For programming information refer to **Function Summary** in Volume 3.

2.6.5 32-Function Buttons Unit

The 32-Function Buttons Unit (Figure 2-5) is a set of 32 programmable buttons. Each button is backed by a light that can be used to indicate the button setting. The Function Buttons Unit is connected to Port C of the Data Concentrator.

The only controls on the Function Buttons Unit are the 32 buttons. They are arranged with one row of four buttons, four rows of six buttons, and a final row of four buttons. The buttons are not numbered but are usually counted from left to right, beginning at the top row of four buttons. A button is triggered by pressing it down and releasing it. The lights backing the buttons are programmable and can be set to on or off.

As with the Function Keys on the PS 300 Keyboard, the Function Buttons are used to send inputs to user-created function networks. Typical applications are selecting menus and selecting data structures for display.

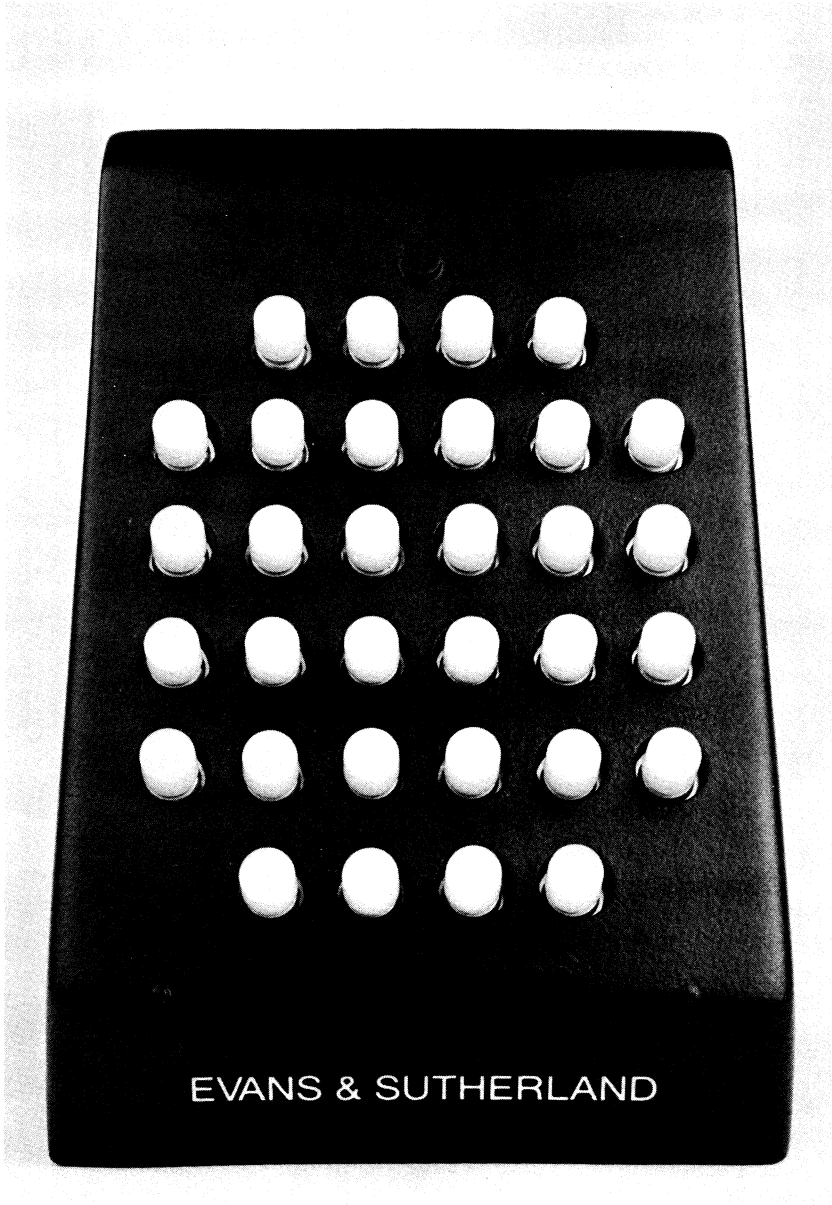


Figure 2-5. Function Buttons

3. COMMUNICATION

The PS 300 was developed as a "host-independent" computer graphics system. The PS 300 does not rely on the host to perform any graphical manipulations, nor the mathematical calculations behind the manipulations. Also, the PS 300 is host-independent in the sense that it can be interfaced to a variety of host systems. These interfaces use different communication protocols, and require varied means of access to the PS 300 system.

Even as a host-independent system, communication between the host and the PS 300 is very important. This section discusses what different options are available for communicating with the host, and when that communication is important. These communication options include:

- Standard host/PS 300 data transfer.

  ASCII files are downloaded to the PS 300 just as they would be sent to any physical device. In this scheme, the PS 300 system functions perform the parsing of data, and then "package" that data in a format that is acceptable by the PS 300 Command Interpreter. "Standard" communication implies that the host can transmit data that is immediately acceptable by the PS 300 Chopper/Parser, including routing bytes to multiplex graphics commands and terminal emulator information (ASCII ESCAPE and CONTROL sequences).

- Communication using the PS 300 Host-Resident I/O Subroutines (PSIOs).

  These host-resident FORTRAN subroutines perform a certain amount of pre-packaging of PS 300 commands the host. The PS 300 commands are called from a FORTRAN program using the PSIOs. The PSIOs provide a standard method of communication between the host system and the PS 300. The routing bytes that are used by PS 300 system functions for system communication are incorporated into the FORTRAN subroutines. These subroutines also provide a way for the host to read from the PS 300.

  The PSIOs are recommended for systems that cannot support the Graphics Support Routines.

- Communication using the PS 300 Graphics Support Routines (GSRs).

  The GSRs perform all pre-packaging on the host PS 300 commands are invoked by Pascal or FORTRAN calls and are sent directly to the PS 300 Command Interpreter. The GSRs utilize the host CPU to pre-package data before downloading to the PS 300. This allows for substantially faster throughput, as the PS 300 Command Interpreter can immediately accept the data from the host and initiate the appropriate actions without having to parse the incoming commands. The GSRs also contain the routing bytes within the routines. This is the recommended communication scheme for finished user applications.

Two-way communication between the host and the PS 300 allows for the utilization of various components and facilities of each system.

3.1 USING THE HOST SYSTEM

The cable between the PS 300 and the host provides a way to utilize different components and facilities of each system. The host is used as a storage device by the PS 300 and, optionally, is used as a data processing device by the host-resident software packages provided by Evans & Sutherland, the PSIOs and the GSRs.

3.1.1 Using the Host as a Storage Device

The PS 300 has no local storage capability beyond what is loaded into memory during a graphics session. Once the system is powered down, or an INITIALIZATION is performed, memory is cleared and the loaded data are lost. To retain information, the host system must be used as a storage device.

Initially, the best way to visualize this is to think of the PS 300 as a physical device attached to the host, like a line printer or a terminal. They both have local memory, but that memory is temporary. Therefore, the host system is used to store data that will be used repeatedly.

Conventionally, the storage is accomplished by building files, or loading files that will be used by the PS 300 into the host system. The host names the files and stores them in an appropriate manner. Files can be built on the host (using the PS 300 TE facility) and then downloaded to the PS 300, using the host system facilities. The content of these files depends on the method of communication that is going to be used. The first communication method that will be to be covered here is standard ASCII communication with the host, where the host recognizes the PS 300 to be a physical device attached to the host, and the PS 300 can be assigned a logical name.

3.1.2 Using the Host as a Processor

Since the host is used as a storage device for the PS 300, it is also appropriate to consider what other host facilities might be used by the PS 300. The PS 300 Host Resident I/O Subroutines (PSIOs) were developed by E&S to provide a standard method of communication between the host and the PS 300.

These FORTRAN subroutines provide a two-way communication between the host and the PS 300. But, they also use the host to package vector lists into binary data packets before they are sent to the PS 300. This allows for substantially faster downloading of vector information.

The second software package provided by E&S, the Graphics Support Routines (GSRs), uses the host to package all data before it is sent to the PS 300. The GSRs provide an alternative method of invoking almost all the PS 300 standard commands as either FORTRAN subroutines or Pascal procedures. The pre-packaging that is performed on the host gives a much faster throughput for any data being transferred.

The GSRs, as with the PSIOs, incorporate the appropriate routing bytes into each routine or, in the case with some of the utility routines, allow the user to select the routing byte in a parameter of the call.

3.2 PS 300 LOCAL COMMUNICATION

When entering the PS 300 Command Mode, (CONTROL/LINE LOCAL, see Modes of Operation in section 2 of this guide), all commands sent after the '@@' prompt and terminated with the ';' command delimiter character are routed directly through the keyboard system function to the PS 300 Parser, and then passed to the Command Interpreter after being processed. Local communication implies that nothing is sent down from the host, nor sent back to the host.

3.3 DIRECT COMMUNICATION USING HOST FACILITIES

Under DEC VAX/VMS and DEC PDP/RSX-11 files built on the host using the standard ASCII PS 300 command language can be routed through CIROUTE to the appropriate PS 300 system function network using standard host utilities such as the VMS WRITE, TYPE, and COPY commands and the RSX-11 PIP commands. These same methods are also available to other operating systems that have ways of building a file on the host, including the proper routing bytes, and then sending that file to the PS 300 using the logical or physical name given to the PS 300 by the host system.

3.3.1 Routing to the Appropriate Function

In building the host file, one of the first considerations is to determine what system network in the PS 300 the file should be sent to. For the ASCII commands or vector lists in a file to be sent to the PS 300 command interpreter to create displayable data structures or create function networks, the file must contain a Field Separator (FS) and a routing character as the first characters in a file. The FS character is the single CONTROL \ character (made by pressing the CONTROL key and the \ key simultaneously). The routing character is 0 (zero). The characters at the top of the file, then, would be:

```
↑\0
```

The file must terminate with an FS character and another routing character that will send any following data to the terminal emulator, so that messages from the host will appear as text on the screen. The FS character and the routing character for the TE are:

```
↑\>
```

A good illustration of how these bytes work is to send a file containing a small vector list and PS 300 commands from the host to the PS 300. With the '↑\>' characters at the top and bottom of the file, the file will appear as text on the screen. By editing the file and replacing the top '↑\>' characters with the '↑\0' characters, the file will be processed by the command interpreter and the graphics will be displayed on the screen.

3.3.2 Using Operating System Utilities for Downloading

The following example shows how DEC operating utilities can be used to download a file containing a vector list and/or other PS 300 commands to the PS 300.

Example using the EDT editor on VAX/VMS systems or the EDT or KED editor on RSX-11M systems:

1. Log on to the host.
2. Go to the directory in which you wish to create and store your file.
3. Access the VMS or the RSX keypad editor:

   $ EDT or EDIT/EDT filename.extension for VAX/VMS

   or

   > EDT filename.extension for RSX-11M

4. The first characters in the file must be ↑\0 to route the file to the Command Interpreter of the PS 300.
5. Enter in the appropriate vector list and/or other PS 300 commands.
6. The final characters in the file must be ↑\> to route the next data received to the Terminal Emulator.

Under VMS, while in the editor, the file can be written to the physical or logical device name of the PS 300 terminal by using the appropriate system commands. The file MUST contain the routing characters described above to do this.

Example:

where the PS 300 is TTa0:

Press Function Key F9 (emulating the 'gold' key of the VT-100 right-hand keypad) and then the '7' key on the right-hand keypad (emulating the 'Command' key on a VT-100.

The editor will prompt with "Command:" at the bottom of the screen.

Enter in

WR tta0:

to send a copy of the file you are editing to the PS 300.

Or, the file can be 'exited', leaving the editor utility and then copied to the physical or logical device name of the PS 300 by using the COPY command in VMS and the PIP command in RSX-11M.

Example:

where the filename is robot.dat and the physical device name of the PS 300 is tta0: for VMS and tt16: for RSX-11M

$ COPY robot.dat tta0:

or

> PIP tt16:=robot.dat

The file can also be written directly to the PS 300 using the VMS TYPE command, if entered from the PS 300.

$ TYPE robot.dat

These commands will copy or write the file to the PS 300. The routing characters at the top of the file will send the data to the Command Interpreter of the PS 300, where the ASCII characters are processed into graphics data to be sent as a graphics display to the screen.

If the routing characters are not compatible with the host system, or need to be changed, refer to the Communication section in Volume 5, **System Manager Reference.**

3.4 PS 300 HOST RESIDENT I/O SUBROUTINES

The PS 300 Host Resident I/O Subroutines (PSIOs) are callable FORTRAN subroutines that provide users with a standard method of communicating between the host system and the PS 300. The subroutines were written to provide maximum throughput to the PS 300. Any file containing PS 300 commands can be downloaded from the host using the PSIOs. A subroutine, PSVECS, sends all vector lists to the PS 300 in compact, binary form, which provides faster downloading time.

The PSIOs are distributed on magnetic tape. It is the responsibility of the user to load, compile, and link these subroutines with application programs. Installation instructions are provided in Volume 5, **System Manager Reference.**

The PSIOs require a FORTRAN-77 compiler and are supported in the following environments:

- DEC VAX/VMS (standard RS-232, or DMR11-AE interface)
- DEC PDP-11/RSX-11 (standard RS-232, or DMR11-AE interface)

The definitions and parameters for the PSIOs are in Volume 3 of this document set.

3.4.1 Application and Description of the PSIOs

Typical application of the PSIOs might include the following:

1. Create a file(s) on the host containing the appropriate PS 300 commands.
2. Initialize and set up the PS 300, using the PSETUP subroutine.
3. Create the vector list for the PS 300 using the PSVECS subroutine.
4. Create the PS 300 structuring and function network commands for the PS 300 using the PSSEND or PSCHAR subroutines.
5. Exit the subroutines using the PSEXIT subroutine.

This section contains a short definition of the subroutines. A detailed description of the top level PSIOs is found in Volume 3 of this document set. These subroutines support most host/PS 300 interfaces.

The top level subroutines and their parameters are:

- PSETUP (IN, IOUT, INIT, LEN, IARRAY): sets up the communication link
- PSEXIT (LEN, IARRAY): disconnects the communication link
- PSREAD (INLEN, INBUF, NUMBYT): reads a character buffer from the PS 300
- PSPOLL (INLEN, INBUF, NUMBYT): requests a character buffer from the PS 300
- PSVECS (IVT, IVC, VECS, IPS, DELIM, IOSTAT): sends a vector list to the PS 300
- PSSEND (LEN, IOUTBF): sends a character buffer to the PS 300 immediately
- PSCHAR (LEN, IOUTBF, FLUSH): If FLUSH=TRUE, a character buffer is sent to the PS 300 immediately. If FLUSH=FALSE a character buffer is sent when the internal buffer is full
- PSFIXI (DFTINI): changes the default vector intensity

3.4.2 A Short Sample Program

In the following FORTRAN example, FILCPY, the file name containing the PS 300 function networking commands and the vector list is robot.300. This example demonstrates the simplest way to use the I/O subroutines.

Any file containing PS 300 commands can be downloaded from the host to the PS 300 using a very similar program. Please read through the descriptions of the PSIOs in Volume 3 of this documentation set before using these subroutines.

```
 PROGRAM FILCPY

C
   LOGICAL*1, BUFFER(132)
C
   INTEGER BYTCNT, ISTAT(2)
C
C  setup for serial line
C
   ISTAT(2)=0
   CALL PSETUP(7,7,.FALSE.,2,ISTAT)
C
C  open the file
C
   OPEN(UNIT= 5, NAME='robot.300', STATUS='OLD', READONLY,
   ERR=100)
C
30 READ(5,40,END=90,ERR=200) BYTCNT,BUFFER
   IF( BYTCNT .GT. 0 ) CALL PSSEND(BYCNT,BUFFER )
   GOTO 30
C
40 FORMAT(Q,132A1)
100     TYPE 101
101     FORMAT ('OPEN ERROR')
   GOTO 90
C
200     TYPE 201
201     FORMAT(' READ ERROR WHILE TRANSFERRING FILE DATA ')
C
90 CALL PSEXIT( 1,ISTAT)
   STOP
C
   END
```

All software packages distributed by E&S are the latest released versions. As the PSIOs need to be relinked with user application programs at the time of a new, or updated release, a strong attempt has been made to make them as upwardly compatible.

Modifications that might be made to the low-level routines that set up the communication line between the host and the PS 300 should not affect the routines and/or parameters that are used by the programmer.

3.4.3 Availability of Top-Level PSIOs

A special version of the top-level PSIOs is available for host systems that cannot generate or accept the data transfer format used by the standard PSIOs. It should be used by hosts that are unable to send 8-bit binary format untouched to the PS 300.

The special version is written in FORTRAN-77 with no lower-level assembly code. It uses a 6-bit binary encoded format for data transfer rather than the 8-bit unencoded binary format used by the standard PSIOs.

The special PSIOs require a SITE.DAT file on the PS 300 Graphics Firmware diskette that alters a data-reception system function in the PS 300. Attributes on the communication line between the host (such as no_echo, no_wrap) must also be set to allow the data transfer.

The special version of the PSIOs includes:

- PSETUP
- PSEXIT
- PSRCHR (replacing PSREAD and PSPOLL)
- PSXCHR (replacing PSCHAR
- PSVECS
- PSFIXI

The code for the special version of the PSIOs and the PS 300 commands that must be included in the SITE.DAT are available, by request, from Customer Engineering Software Support.

3.5 THE GRAPHICS SUPPORT ROUTINES

The Graphics Support Routines (GSRs) were developed to provide an alternative method of invoking the standard PS 300 command language to provide for faster through-put rates between the host system and the PS 300. The GSRs are distributed on magnetic tape as source code in both FORTRAN and Pascal programming languages.

It is the responsibility of the user to load, compile, and link the routines with their application program. Installation instructions for the GSRs are provided in Volume 5, **System Manager Reference.**

The documentation for the GSRs is provided in Volume 3 of this documentation set. For easy user reference, documentation has been provided for each language; there is a GSR DEC/VAX Pascal section, and a DEC/VAX FORTRAN section.

3.5.1 Software Product Description

The GSRs provide the following capabilities:

1. Reduce local PS 300 processing time by bypassing the PS 300 parsing function. The GSRs allow the host to 'pre-package' PS 300 graphics commands, and send the packaged data directly to the PS 300 Command Interpreter.

2. Allows PS 300 commands to be called by an application program. The PS 300 programmer is supplied with an alternative method of invoking the PS 300 command language. With the GSRs the programmer invokes the appropriate PS 300 command and defines the command parameters in either FORTRAN or Pascal.

3. Supports most standard PS 300 commands. There is almost a one-to-one correlation between each PS 300 command and each GSR routine. Most of the commands that are not supported by the GSRs are commands that have to do with system configuration rather than graphics applications.

4. Maintains PS 300 command language syntax and naming conventions. The GSRs maintain the naming conventions and command syntax established by the PS 300 command language as much as possible. Most commands have simply been prefixed with a 'P' and shortened to conform to FORTRAN or Pascal name limitations. Syntax follows command language syntax, when appropriate.

5. Error-handling utilities. Each GSR routine has an error handling parameter that can be used by the programmer to call an error-handling subroutine or procedure.

6. Supports new products and options. The Graphics Support Routines will continue to support new PS 300 commands as they are added to the PS 300 command list.

All software distributed by E&S are the latest released versions. As the GSRs would need to be relinked with user application programs at the time of a new or updated release, a strong attempt has been made to make the GSRs as 'fixed' as possible. Modifications made to the low-level routines that set up the communication line between the host and the PS 300 that might be made should not affect the routines and/or parameters that are used by the programmer.

3.5.2 Minimum PS 300 System Requirements

- Standard system configuration with 2K ACP
- PS 300 Graphics Firmware P5.V03 or higher

3.5.3 Minimum DEC VAX/VMS Requirements

- Standard RS-232-C, DMR11-AE, or Parallel Interface
- VMS Version 3.2 or higher
- FORTRAN-77 compiler and/or Pascal V.2 compiler

PS 300 DEMONSTRATION PACKAGE

LIMITED SUPPORT DISCLAIMER

The PS 300 Demonstration Package is distributed by Evans & Sutherland as a convenience to customers and as an aid to understanding the capabilities of the PS 300 graphics systems. Evans & Sutherland Customer Engineering supports the Demonstration Package to the extent of answering questions concerning the installation and operation of the Demonstration Programs, as well as receiving reports on any bugs encountered while the programs are running. However, Evans & Sutherland makes no commitment to correct any errors which may be found.

PS 300 DEMONSTRATION PACKAGE

CONTENTS

1. INTRODUCTION TO THE DEMONSTRATION PACKAGE

The nine Demonstration Programs show some of the capabilities of the PS 300 graphics systems to process data locally, to display the data as models on the screen, and to allow a user to manipulate this data through the Interactive Devices. One of the programs also demonstrates communication with the host computer. Each program gives a feel for the different capabilities of this highly versatile machine, and suggests ways to use it as a design and analysis tool.

The Data Tablet, Control Dials, and Function Keys allow interaction with the models displayed by the Demonstration Programs on the screen. Control Dials and Function Keys are programmed to perform such operations as translation, rotation, and scaling of the models displayed. Programmed functions are shown in the LED displays above each Control Dial or Function Key.

The Demonstration Programs that form the PS 300 Demonstration Package are provided to PS 320, PS 330, and PS 340 owners as an aid to learning how to use the graphics system in actual design and analysis applications. This manual explains how to install the Demonstration Package and how to run each of the programs. Volume 5 explains how to transfer to the host the PS 300 Host-Resident I/O Subroutines which are needed to run the Modeling Demonstration program.

This section lists the components of the Demonstration Package and explains the Interactive Devices and host computer requirements for running the demonstrations.

Section 2 explains how to install the diskettes and load the Demonstration Programs.

Section 3 gives complete operating instructions for each of the programs.

1.1 THE COMPONENTS OF THE DEMONSTRATION PACKAGE

The PS 300 Demonstration Package consists of two diskettes and a magnetic tape. To boot the system prior to loading the Demonstration Programs, the current version of the Graphics Firmware (P5.V03 or higher) is also required.

Demonstration diskettes A and B contain control networks for loading the programs into memory, the Demonstration Menu from which programs are chosen, the Demonstration Programs themselves, and an Old English character font.

The magnetic tape that accompanies the Demonstration Package contains FORTRAN files required for running the Modeling program (the only program which requires host interaction) and source files for all the Demonstration Programs. When listed out, the source files will provide a useful reference to the programming techniques that were used to create the Demonstration Programs.

1.2 REQUIRED INTERACTIVE DEVICES

The following Interactive Devices are required to run the Demonstration Programs.

- Data Tablet and Stylus
- Keyboard with Function Keys
- Control Dials

The Data Tablet and Stylus are used to pick programs from the Demonstration Menu and to interact with the models displayed by some of the programs.

The Function Keys and Control Dials are programmed by Function Networks to perform various graphical operations such as scale, rotate, and translate on the models displayed. The operation controlled by each Function Key and Control Dial is displayed in its associated LED.

1.3 HOST COMPUTER REQUIREMENTS

Eight of the nine programs that comprise the Demonstration Package are run locally on the PS 300 and require no host interaction at all. The Modeling program, however, requires a host on which a FORTRAN program must be run. The necessary FORTRAN files are distributed with the Demonstration Package on magnetic tape. The FORTRAN files may have to be modified to run under operating systems other than Digital Equipment Corporation's VAX/VMS®.

® Trademark of the Digital Equipment Corporation, Maynard, Massachusetts.

2. LOADING THE DEMONSTRATION PACKAGE

The Demonstration Package may be run on a single-user system (PS 330 and PS 340) or on a dual-user PS 320 system. The procedure for loading the programs differs slightly for the two systems. Separate instructions are given when necessary.

The complete Demonstration Package takes about 25 minutes to load from the two diskettes.

CAUTION

While you are loading the Demonstration Package, be sure that the host is unable to send messages to the PS 300. Any messages sent may corrupt the files that are being loaded. As a general precaution, it is recommended that you do not log on to the host until loading is complete.

2.1 LOADING THE PROGRAMS ON SINGLE-USER SYSTEMS

The current version of the Graphics Firmware (P5.V03 or higher) must be loaded first from diskette to boot the system so that the Demonstration Programs can be loaded. This is described in detail in the "User Operation and Communication" section in Volume 1. Briefly, here is what you need to do.

- Put the PS 300 Graphics Firmware Diskette in the disk drive.
- Boot the system by turning on the power.

After the confidence tests are completed and the system is booted, remove the Graphics Firmware diskette and install Demonstration Diskette A. If your system has two disk drives, use drive 0 to load both diskettes. Put the PS 300 in command mode by holding down the control key (CTRL) and pressing the LINE LOCAL key followed by a return. Enter the following command when the @@ prompt appears:

```
send 'demo' to <1>readascii;
```

The screen will flash as files are loaded from the diskette. Then the following message is displayed.

```
PS 300 Demonstration Package
System Ready
```

The following Loading Menu is displayed in small type at the top left of the screen.

```
Load demos by holding CTRL and pressing F1 through F10
Press CTRL and F12 to disable loading
```

Key	Disk	Program	Size	Key	Disk	Program	Size
F1	A	Control network/Menu	:108K	F6	B	Modeling	:45K
F2	A	Old English Font	: 14K	F7	B	Digitizing	:11K
F3	A	Animation	: 26K	F8	B	B-spline	:17K
F4	A	Programming	:160K	F9	B	Robot Man	:44K
F5	B	Robot Arm	: 73K	F10	B	Suspension	:35K

Demonstration Programs are loaded by holding down the control key (CTRL) and pressing Function Keys F1 through F10 in sequence. The Loading Menu indicates which key loads a program, the diskette on which the program is located, and the amount of memory the program requires.

Before any files can be loaded from the diskette, the PS 300 must be in Interactive Mode. Press the SHIFT key and the LINE LOCAL key at the same time. The Function Keys will now be enabled to allow program loading.

First, load the Control Network and Menu by holding down CTRL and pressing Function Key F1. As the Demonstration Menu file is read in, the menu display will start to appear. This consists of a central viewport with a spinning globe and comet, menu boxes to the left and right of the viewport, and the words "PS 300" and "Evans & Sutherland." (Refer to section 3 for an illustration.) When the file is fully loaded, the globe and comet will spin freely.

NOTE

As files are being loaded from the diskettes, the PS 300 screen will go blank from time to time, or the system will appear idle for a few moments. This is a normal part of the loading procedure. Whenever a file has finished loading, the globe in the Demonstration Menu begins to spin again.

After the Control Network and Demonstration Menu have been loaded, press CTRL F2 to load the Old English character font. When this is loaded, the text on the Demonstration Menu will change to Old English font and the globe will spin.

The remaining files on Diskette A are the Animation and Programming demonstrations. These may be loaded in any order by pressing CTRL F3 and CTRL F4 respectively. When the programs are loaded, their names appear in the Demonstration Menu boxes.

When all files have been loaded from Diskette A, remove it from the diskette drive and insert Diskette B. The Demonstration Programs on this diskette may be loaded in any order. Function Keys F5 through F10 load the individual Demonstration Programs as indicated in the Demonstration Menu. When a program is fully loaded, its name appears in one of the Demonstration Menu boxes and the globe spins freely. When all the programs have been loaded, there will be eight program names in the boxes.

NOTE

If you press a wrong Function Key for the diskette you are loading from, the following message is displayed:

M1086 *** File not found on floppy disk in drive 0

followed by the name of the program associated with the Function Key you pressed. If this occurs, simply press the correct key or change diskettes and continue loading.

2.2 LOADING THE PROGRAMS ON THE PS 320

For the Demonstration Package to operate at each station, the programs must be loaded from both stations.

Note, however, that the number of programs that can reside in Mass Memory at one time is limited by the amount of memory available. A PS 320 system with 1024K of Mass Memory cannot accommodate the entire Demonstration Package for both stations.

If you have only 1024K of Mass Memory available with your system, load the Control Network and Menu at each station, and up to three Demonstration Programs, depending on their size. Use the Loading Menu as a guide to program size.

The programs cannot be loaded simultaneously at the two stations. Loading of a single program must be complete before loading of another program is started. Loading is complete when the program name appears in a menu box.

Once loading is complete, each station will run the Demonstration Package independently.

The current version of the Graphics Firmware (P5.V03 or higher) must be loaded first from diskette to boot the system so that the Demonstration Programs can be loaded. This is described in detail in the "User Operation and Communication" section in Volume 1. Briefly, here is what you need to do.

- Put the PS 300 Graphics Firmware Diskette in the disk drive.
- Boot the system by turning on the power.

Once the system is booted, remove the Graphics Firmware diskette and install Demonstration Diskette A. If your system has two disk drives, use drive 0 to load both diskettes. At the User 1 station, put the PS 320 in command mode by holding down the control key (CTRL) and pressing the LINE LOCAL key followed by a return. Enter the following command when the @@ prompt appears:

```
send 'demo1' to <1>readascii;
```

The screen will flash as control files are read from disk, and the following message will appear:

```
PS 320 Demonstration Package
This is the Workstation for User1
```

At the station for User 2, enter command mode and type the following command:

```
send 'demo2' to <1>readascii;
```

Again, the screen will flash as the control files are read. The following message then appears:

```
PS 320 Demonstration Package
This is the Workstation for User2
```

The loading menu will be displayed at the top left of each station's display screen. You are then ready to start loading the Demonstration Programs as indicated in the Loading Menu. Programs are loaded as explained in Section 2.1 for single-user systems.

2.3 DISABLING THE LOADING PROGRAM

When you have finished loading the files, press CTRL F12 to disable the Function Keys network that is set up for loading the programs.

Disabling loading also causes the Loading Menu which is displayed at the top of the screen to disappear. This is also a good time to clear the screen of any messages that have been displayed by the loading procedure. To do this, press the TERM key on the PS 300 Keyboard. Press this key again at any time to redisplay the messages.

NOTE

It is not necessary to load all of the Programs at one time. You may discontinue loading at any time by holding down CTRL and pressing F12. To continue loading, press CTRL and F12 again any time the system is displaying the Demonstration Menu.

You are now ready to run any of the programs listed in the Demonstration Menu displayed on the screen, with the exception of the Modeling program.

2.4 RUNNING THE MODELING PROGRAM

The Modeling program is the only one which requires host intervention to download the initial model to the PS 300 and to perform calculations for modifying the model. You cannot run this program unless

- you have a host computer
- the PS 300 is able to communicate with that host
- the host has been loaded with the FORTRAN source files distributed on magnetic tape with the Demonstration Package
- the host-resident I/O subroutines (version P5) have been installed on the host.

Refer to Section 3 of this manual for complete information on requirements for running the Modeling Program.

2.5 USING THE PROGRAMS ON A COLOR SYSTEM

The Demonstration Package contains the necessary commands for display on the PS 300 CSM Calligraphic Display System. Note, however, that SET CSM OFF; which is the default display mode, does not produce optimum colors on the CSM. To obtain brighter colors on the CSM, first press the TERM key to display host messages on the terminal. Then press the CTRL and LINE LOCAL keys and enter a RETURN. This puts the PS 300 in Command Mode. Now enter the command

```
SEND TRUE TO <1>DEMOS.CSM;
```

When this command has been entered, press the SHIFT and LINE LOCAL keys again to return the PS 300 to Interactive Mode. Then press the TERM key to remove host messages from the screen.

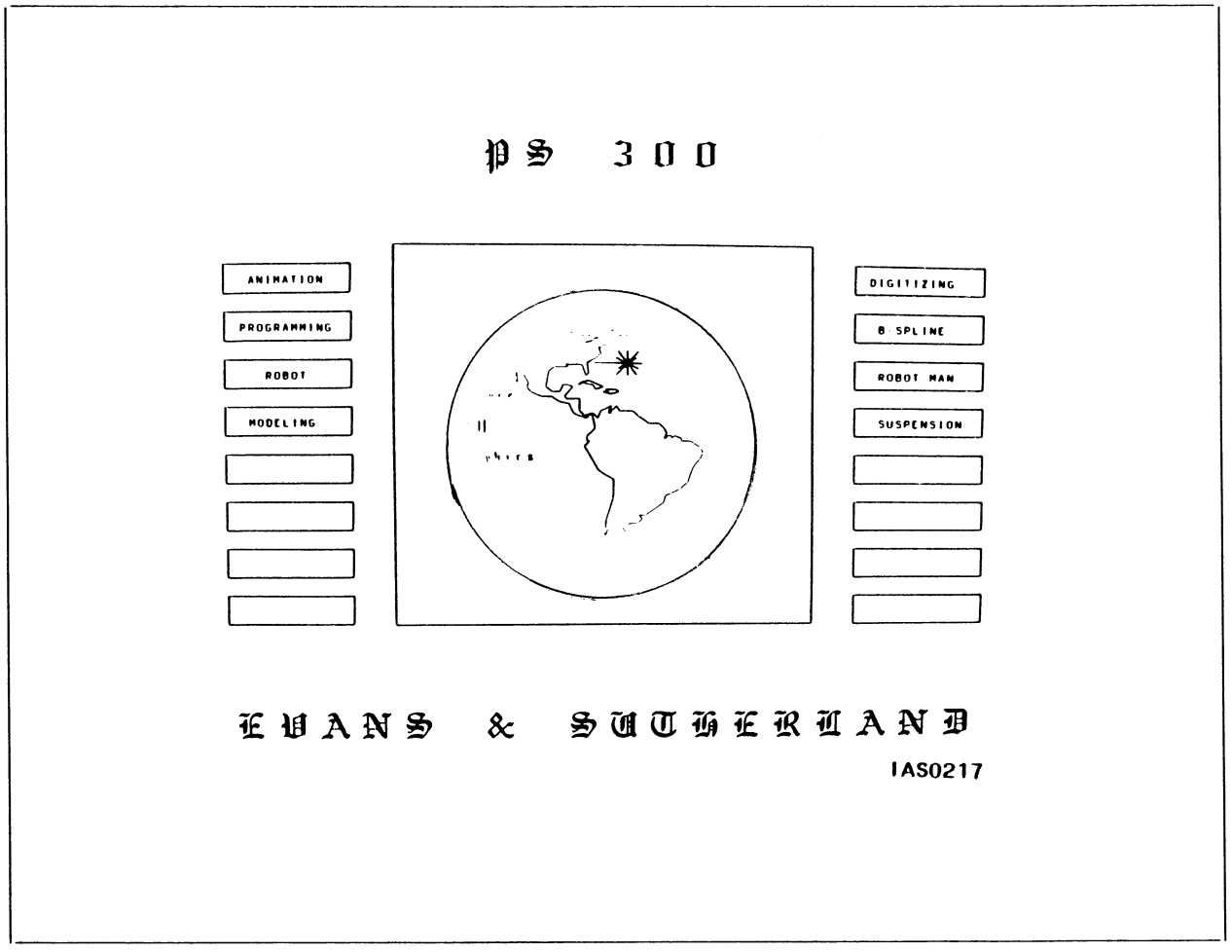
3. RUNNING THE DEMONSTRATION PROGRAMS

This section contains the information needed for running each of the Demonstration Programs.

An illustration is included of a typical screen display when each program is running. An abstract points out some of the features of the PS 300 that are illustrated in the demonstration. The programmed functions and the LED labels that appear on Control Dials and Function Keys are shown. Notes on usage give instructions for running the program.

Program: DEMONSTRATION MENU - GLOBE

Typical Program Display



Abstract

This program serves both as a demonstration in itself and as the menu from which the other Demonstration Programs are picked. Programs are picked using the Data Tablet to position the cursor over the menu boxes to the left and right of the globe. Function Keys and Control Dials allow you to interact with the globe and the orbiting comet together, and with the comet on its own.

Programmed Functions

Control Dials
D1 - SS X ROT (globe and comet)
D2 - SS Y ROT (globe and comet)
D3 - SS Z ROT (globe and comet)
D4 - SCALE (globe and comet)
D5 - DS X ROT (comet only)
D6 - DS Y ROT (comet only)
D7 - DS Z ROT (comet only)

Function Keys
F1 - ORB ROT (start/stop)
F11 - RESET

Notes on Usage

To use this program as a menu, pick the Demonstration Program you want to run by positioning the cursor over the name and pressing the tip switch down on the Data Tablet. Whenever you exit from a program, you will be returned to this display.

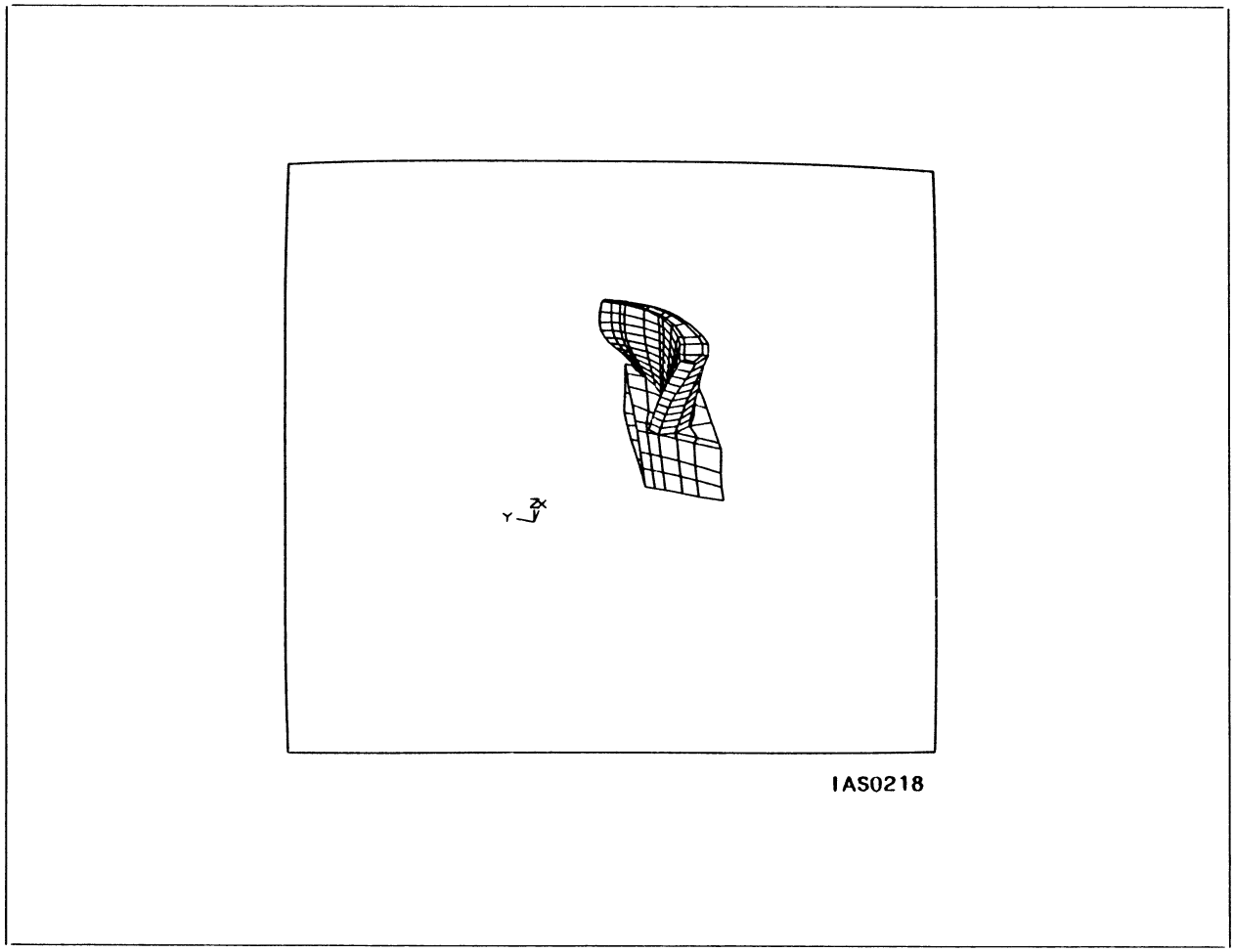
The Function Keys and Dials let you interact with the spinning globe and comet displayed in the viewport in the center of the screen. Dials 1 through 4 affect the globe and comet together in screen space and are labeled SS on the LEDs. Dials 5 through 7 rotate the comet in data space and are labeled DS.

Function Key F1 starts and stops the rotation of the globe and comet.

Function Key F11 resets the orientation of the globe and comet.

Program: ANIMATION

Typical Program Display



Abstract

The Animation program displays and lets you manipulate the animated model shown above. The model is part of a turbine blade, showing stress on the blade. The hidden-line removal sequence is a sequence of ten frames that are cycled through using the SET LEVEL OF DETAIL command. Real-time hidden line removal is not performed. Translational and scale controls are programmed into the Control Dials.

This demonstration was provided by AVCO Lycoming, Stratford, CT.

Programmed Functions

Control Dials	Function Keys
D4 - SCALE	F1 - STRT/STP (start/stop)
D6 - TRANS Y	F11 - RESET
D7 - TRANS Z	F12 - EXIT

Notes on Usage

The model is animated when first displayed. Use the start/stop key (F1) to freeze the motion at any point.

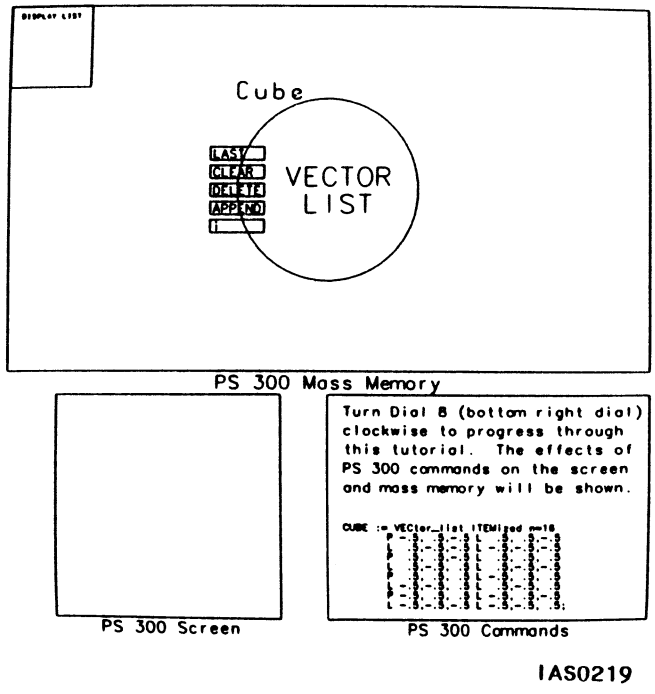
Dials 4, 6, and 7 allow you to scale and translate the model on the screen.

F11 resets the model.

F12 returns you to the Demonstration Menu.

Program: PROGRAMMING

Typical Program Display



Abstract

This program is a tutorial introduction to programming the PS 300. It illustrates various methods of displaying Data Structures and setting up data-driven function networks. After an initial introductory message, the screen is divided into four viewports representing the contents of the Display List, the contents of Mass Memory, the PS 300 screen, and PS 300 Commands. By rotating Control Dial 8, commands illustrated in the tutorial appear in the PS 300 Commands viewport. Each time a complete command is displayed, the display in the other viewports is modified to reflect updates to Mass Memory, the Display List, or the PS 300 screen.

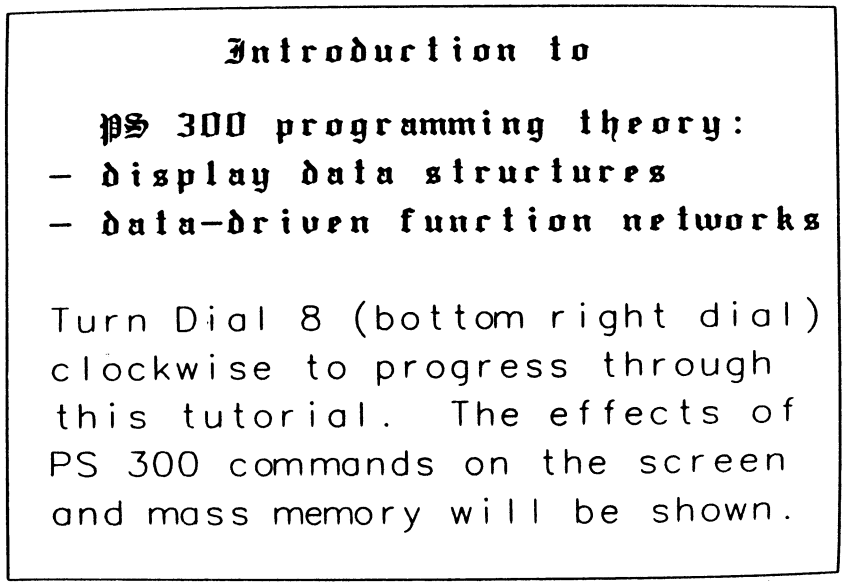
Programmed Functions

Control Dials
D4 – (rotate the object displayed)
D8 – (progress through tutorial)

Function Keys
F1 – (used with conditional
F2 – referencing commands)
F11 – RESET
F12 – EXIT

Notes on Usage

When the Programming Demonstration is chosen, the following message is displayed.



IAS0220

Dial 8 controls your progress through this tutorial. As you turn the dial, the PS 300 commands will scroll in the lower right viewport of the screen. As commands become visible, their effect will be reflected in the other viewports on the screen. Function Keys F1 and F2 and Control Dial 4 become active as the PS 300 commands controlling them become visible.

Initially, the program shows how an entity called CUBE is created in Mass Memory and displayed on the screen. Another entity called CUBE_ROT is created in Mass Memory which points at CUBE. The two entities are displayed simultaneously as one bright cube, because the display processor is traversing both structures. CUBE is then removed and CUBE_ROT is displayed alone.

Notes on Usage (continued)

Next, the local capability of the PS 300 to do graphical manipulations is shown through the use of functions. An instance of a Y rotation (F:DYROTATE) is created and connected to Control Dial 4. Dial 4 can now be turned to rotate the cube displayed in the PS 300 Screen viewport. To see the value of the rotation, an instance of the PRINT function (F:PRINT) is created and connected to Dial label 4. When Dial 4 is turned, the value of the rotation will now be displayed in Dial 4's LED and in the Mass Memory viewport.

A scaling structure named S_CUBE is now created which points to CUBE. This shows how one vector list description can be displayed two different ways, one through CUBE_ROT, and one through S_CUBE. Now an instance of VIEW is created (which is nothing more than CUBE_ROT), the display is initialized, and VIEW is displayed. CUBE_S is then interactively included in VIEW, so both CUBE_ROT and S_CUBE are displayed with the one DISPLAY VIEW command.

CUBE_S is then redefined as CUBE_CHAR, a nul structure which has not yet been defined. CUBE_CHAR is then defined as the character string 'PS 300', which is displayed on the screen. CUBE_S is now redefined to be a special 2x2 matrix to italicize the characters. Using a user-defined character font, the string is displayed in an Old English character set.

The LOOK command is used to view the structure being displayed from an arbitrary point in space. The use of BEGIN_STRUCTURE ... END_STRUCTURE is used as an alternative to naming every command. The four types of PS 300 matrices are also illustrated: 4x4, 4x3, 3x3, and 2x2.

Another structure is created, which shows conditional references to different branches of the display hierarchy. Function Keys are connected to the SET LEVEL_OF_DETAIL node. F1 controls display of one branch of the hierarchy, F2 controls display of the other. A similar operation is performed with the SET CONDITIONAL_BIT node, but now the objects can be displayed independent of each other, depending on the CONDITIONAL_BIT test. The cube is displayed if conditional bit one is set, the text if bit two is set. Another way to conditionally branch is shown, using the SET RATE node. The number of refresh frames on and off are given, and a phase attribute is set so that for 20 frames, the phase attribute is on and for 40 frames it is off. By doing a test of the phase attribute, the cube is displayed for 20 frames and the text for 40 frames.

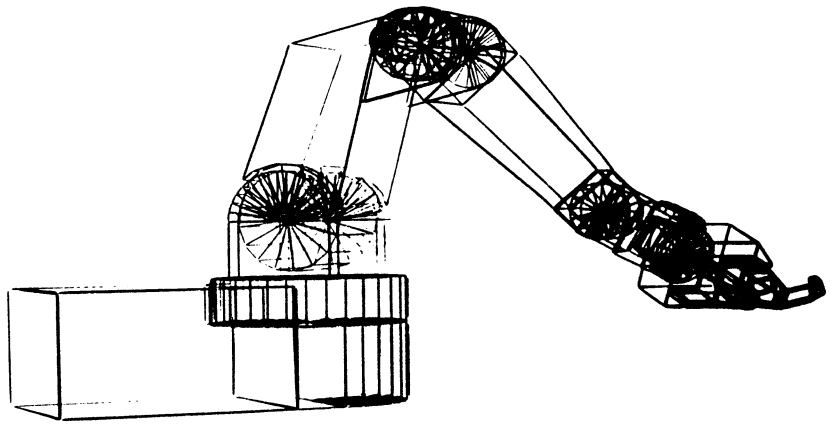
Note that you can go back through the program by turning Dial 8 in the opposite direction.

Function Key F11 lets you reset the screen back to the initial display.

Function Key F12 lets you leave this program and return to the Demonstration Menu.

Program: ROBOT ARM

Typical Program Display



IAS0221

Abstract

The articulated Robot Arm displayed by this program shows how the Control Dials can be programmed to perform different functions within one program. By pressing a single key, the programmed functions of the Control Dials are completely changed. This switching is entirely under function network control: there is no interaction with the host. Function Keys F1 and F2 let you choose whether the dials interact with the whole model of the robot or with the various components of the arm.

The data for this program were provided by General Electric CAE International Inc., Cincinnati, OH.

Programmed Functions

VIEW MANIPULATION

Control Dials	Function Keys
D1 - ROT X	F1 - VIEW
D2 - ROT Y	F2 - ARMS
D3 - ROT Z	F11 - RESET
D4 - SCALE	F12 - EXIT
D5 - TRANS X	
D6 - TRANS Y	
D7 - TRANS Z	
D8 - VIEW (blinks to show active mode)	

ARM MANIPULATION

Control Dials	Function Keys
D1 - ROT BASE	F1 - VIEW
D2 - ROT ARM 1	F2 - ARMS
D3 - ROT ARM 2	F11 - RESET
D4 - ROT ARM 3	F12 - EXIT
D5 - WRIST	
D6 - HAND	
D8 - ARMS (blinks to show active mode)	

Notes on Usage

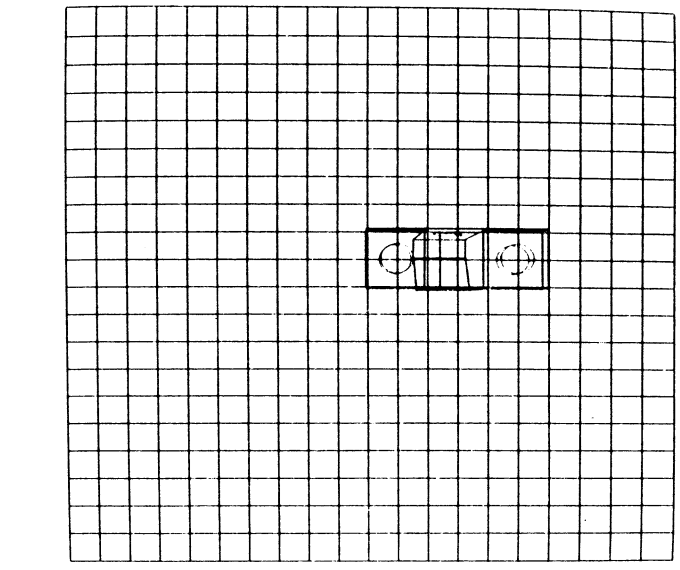
The functions of the Control Dials vary according to your selection of VIEW or ARMS from the Function Keys F1 and F2. Whichever mode you choose is displayed intermittently on Dial 8's LED. VIEW allows you to rotate, translate, and scale the entire model. ARMS lets you rotate the various components of the Robot Arm independently.

Note that the RESET key (F11) only resets the orientation of the model. The arms, wrist, and hand are not reset.

Key F12 lets you leave the program and return to the Demonstration Menu.

Program: MODELING

Typical Program Display



IAS0222

Abstract

The Modeling program is the most complex in the demonstration package, since it uses the host computer extensively for computations. A FORTRAN host-resident program is needed in addition to the PS 300 program supplied on diskette. This Demonstration Program also uses the PS 300 Host-Resident I/O Subroutines.

The display consists of a grid and a model which can be modified using the Data Tablet and programmed Function Keys. The grid may be manipulated in any plane using the Control Dials, to create three-dimensional models.

Abstract (continued)

This demonstration shows a few of the modeling capabilities of the system. You can use the Data Tablet and the input grid as a plane of reference for inputting points, connecting points, creating curves, and moving the model around on the screen.

Programmed Functions

Control Dials
D1 - ROT X
D2 - ROT Y
D3 - ROT Z
D4 - SCALE
D5 - TRANS X
D6 - TRANS Y
D7 - TRANS Z

Function Keys
F1 - ADD PNT
F2 - ADD LINE
F3 - DEL PNT
F4 - DEL LINE
F5 - ROT ALL
F6 - ROT GRID
F7 - BLNK GRD (grid off/on)
F8 - BLNK LNS (lines off/on)
F9 - BLNK PNTS (point off/on)
F10 - ADD CURV
F11 - DEL CURV
F12 - EXIT
SHIFT F1 - center grid on point
SHIFT F2 - specify plane for grid
SHIFT F8 - terminate host program

Notes on Usage

The following steps must be taken before the Modeling program can be run on the PS 300. Users should refer to the "User Operation and Communication" section for instructions on loading and compiling the I/O Subroutines and the MODEL.FOR program.

The following instructions are general. Specific implementation on host systems may vary.

1. Transfer the PS 300 Host-Resident I/O Subroutines (version P5 or higher) to the host.

2. Transfer to the host the files MODEL.FOR, POSTCON.300, and POSTPNT.300 from the PS 300 Demonstration Programs magnetic tape. For IBM systems, the file names are MODEL FOR, POSTCON 300, and POSTPNT 300.

Notes on Usage (continued)

3. Follow the instructions given in the appropriate I/O Subroutine Manual for compiling the I/O Subroutines and the MODEL source file.

4. Link the I/O Subroutines with the MODEL program.

After the files MODEL.FOR, POSTCON.300, and POSTPNT.300 and the I/O Subroutines have been transferred to the host and compiled and linked, the following steps must be taken either before or after Modeling is picked from the Demonstration Menu.

1. Press the TERM key to display the terminal and host messages on the screen.

2. Put the PS 300 in Terminal Emulator mode by pressing the LINE/LOCAL key and then RETURN.

3. Log on to the host into the area that contains the files MODEL.FOR, POSTCON.300, and POSTPNT.300.

4. DEC VAX/VMS users should assign the PS 300 terminal to Logical PS (Assign TTxx: PS).

5. Run (or execute) the program MODEL.

6. Put the PS 300 into Interactive mode by pressing SHIFT and LINE/LOCAL simultaneously.

7. Press the TERM key to clear the screen of host messages.

The Modeling program will now run on the PS 300.

The program uses all of the Function Keys (F1 through F12) and, in addition, shift F1, shift F2, and shift F8. Initially, the Control Dials give control over the whole image, that is the grid and the model displayed, allowing you to rotate, translate, and scale the entire image. Function Key F5 controls this. Key F6 gives the Control Dials control over the grid only.

Positioning the Grid

There are three ways of positioning the grid. F6 allows you to manually rotate, translate and scale the grid about its center using the Control Dials. Alternatively, you can use shift F1, and pick one of the points on the screen. The program will translate the center of the grid to that point. Another option is to use shift F2, and then pick three points which are not coincident. The grid will be established along the plane defined by the three points, with the center at the first point, the positive X axis along the second point, and the positive Y axis along the third point.

Notes on Usage (continued)

Adding and Deleting Points and Lines

Points can be added at grid intersections or along grid lines only. Press F1 and indicate the position you want, using the Data Tablet and Cursor. Lines are added by specifying end points. Press F2 and indicate any two points. To delete a point, press F3 and indicate the point. To delete a line, press F4 and indicate the line.

Creating and Deleting Curves

The program uses the Rational Polynomial command to generate curves. This command is best used to create half-circles. To add a curve, press F10 and indicate three points. The first and third specify the end points of the curve, the second specifies the midpoint of the curve. Those three coordinate numbers are sent to the host, the host determines the parametric equation, creates the Polynomial command and sends this back to the PS 300 to create the curve. To delete a curve, press F11 and indicate the curve.

Terminating the Model and Exiting

Shift F8 clears the model from the grid and terminates the program that is running on the host.

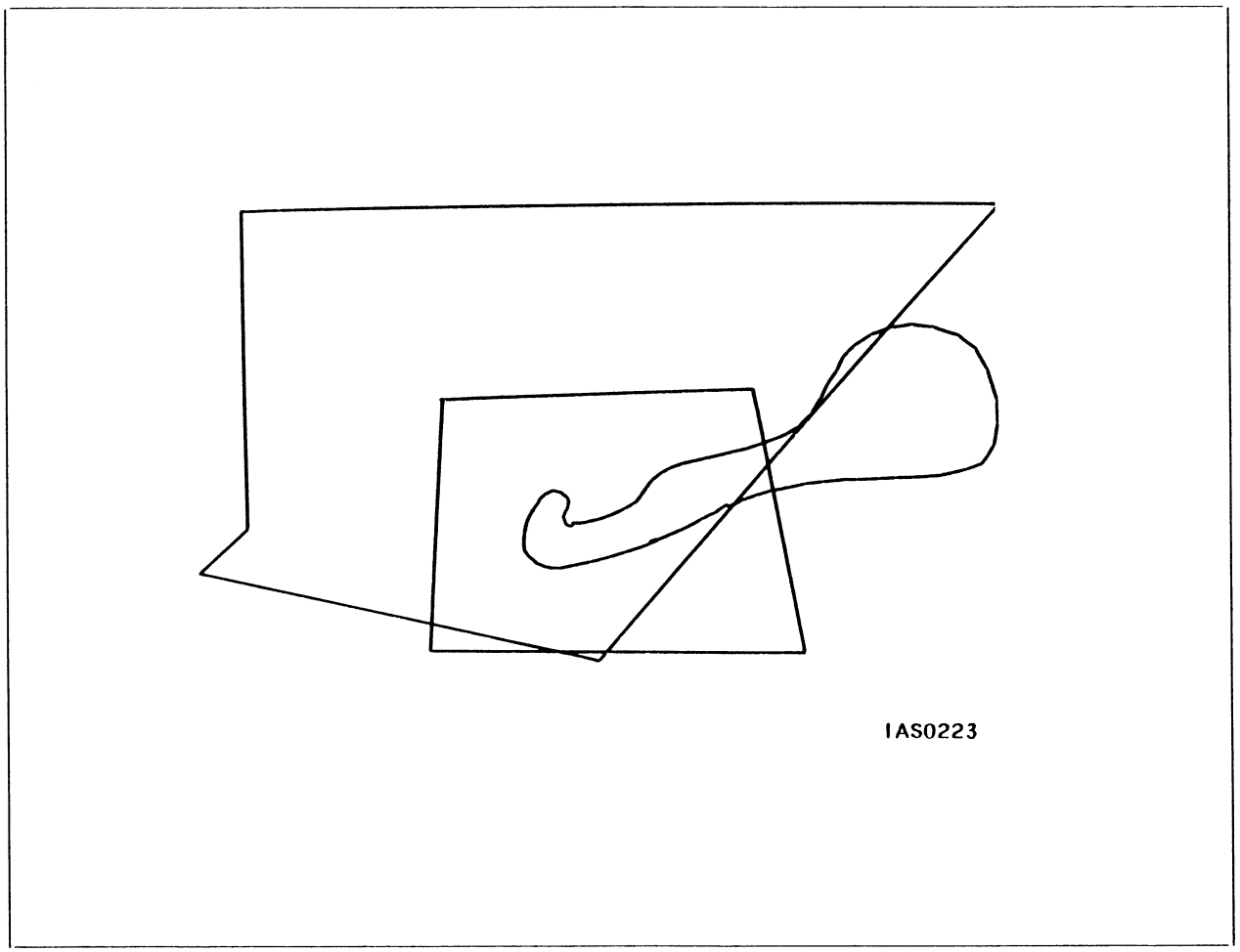
F12 takes you from the program and returns you to the Demonstration Menu.

NOTE

When you are finished with this Demonstration Program, remember to stop the MODEL.FOR program running on the host by pressing SHIFT F8. Then put the PS 300 in Terminal Emulator mode by pressing the LINE LOCAL key then RETURN so that you can log off host. If you do not do this, the process MODEL will continue to run indefinitely on the host after the PS 300 is turned off.

Program: DIGITIZING

Typical Program Display



Abstract

This program shows the ability of the PS 300 to draw pictures on the screen using the Data Tablet in three ways: inking, rubber banding, and grid banding. This is accomplished entirely through function networks local to the PS 300.

Programmed Functions

Control Dials
None

Function Keys
F1 - INKING
F2 - RUBRBAND (rubber band)
F3 - GRDBAND (grid band)
F9 - DELETE (last vector)
F10 - CLEAR (delete all)
F12 - EXIT

Notes on Usage

Use Function Keys F1 through F3 to select the digitizing mode. The default mode when the program is brought up is rubber banding.

In inking mode, as you move the cursor across the screen, end points are established and vectors are drawn at an interval determined by the sample rate of the tablet: the slower you move the cursor, the shorter the vectors drawn.

With rubber banding, you must press the stylus tipswitch to establish a beginning point and start a vector. Press again to establish the end point of the vector and start another.

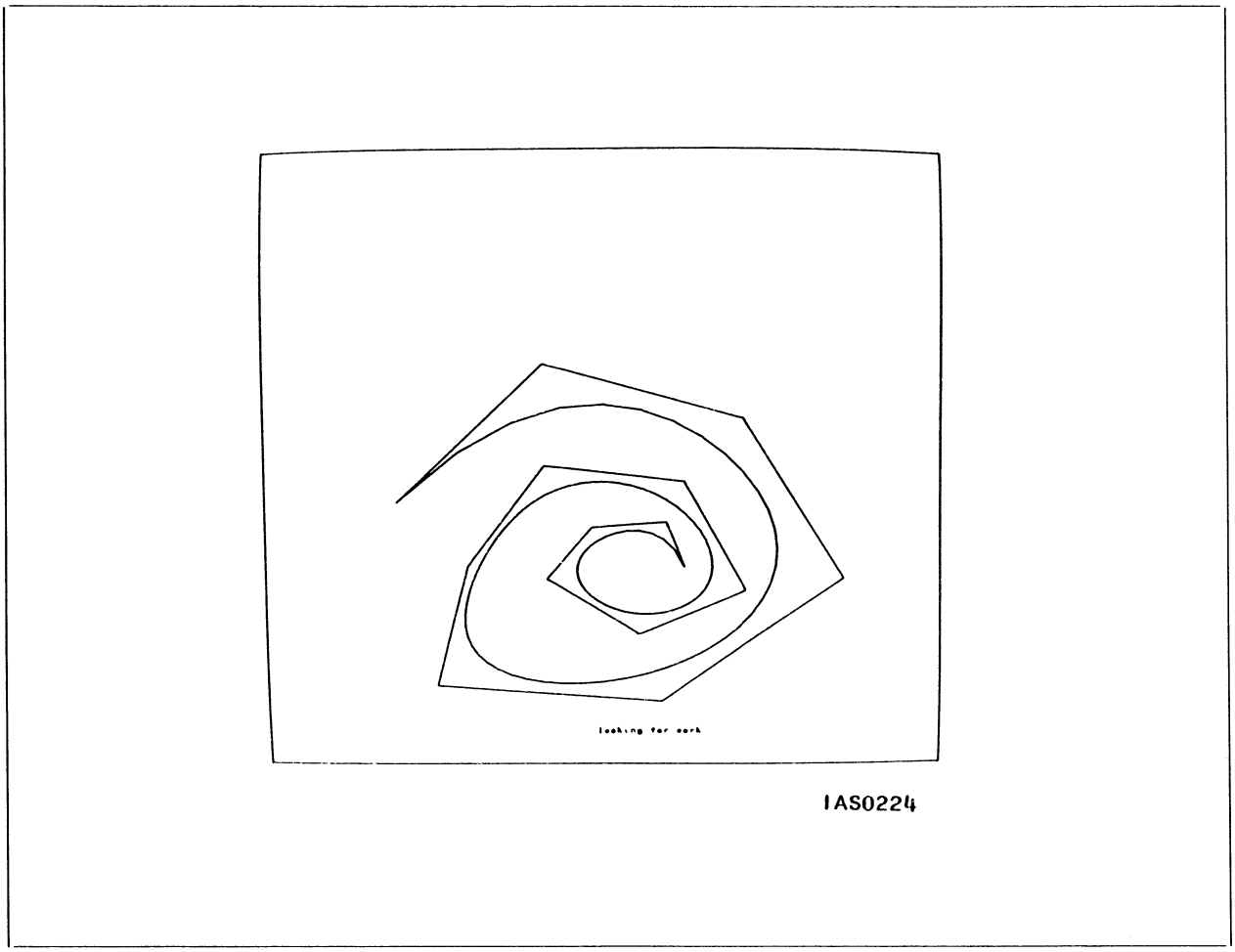
Grid banding is like rubber banding, except the start and end points of the vectors lock to an undisplayed grid intersection.

Key F10 clears the display.

Key F12 takes you from the program and redisplays the Demonstration Menu.

Program: B-SPLINE

Typical Program Display



Abstract

This program shows the ability of the PS 300 itself to create open, non-periodic B-spline curves. Use the cursor to establish control points for the spline, and then use the Function Keys to establish an order of B-spline to fit those control points. All calculations are done locally to the PS 300.

Note on B-splines

Order 1 B-splines are displayed as the control points themselves. Order 2 B-splines are the lines between the control points. Order 3 B-splines are the most used B-spline curve. An "n" order B-spline needs "n+1" control points to calculate the curve. For example, if you request an order 10 B-spline, 11 control points are needed. If you request an order 10 B-spline with only 4 control points defined, the system will give a curve of order 3.

Programmed Functions

Control Dials
None

Function Keys
F1 - ORDER 1
F2 - ORDER 2
F3 - ORDER 3
F4 - ORDER 4
F5 - ORDER 5
F6 - ORDER 6
F7 - ORDER 7
F8 - ORDER 8
F9 - ORDER 9
F10 - ORDER 10
F11 - CLEAR (delete all)
F12 - EXIT

Notes on Usage

Specify the control points for the B-spline by moving the cursor around the screen area and pressing the tipswitch. The system draws straight lines between each point. The message "looking for work" is displayed while you are specifying points. When you have selected all control points, press the Function Key which corresponds to the order of B-spline you want computed and drawn. The message "computing spline" is displayed intermittently while calculations are in progress. The curve is then drawn.

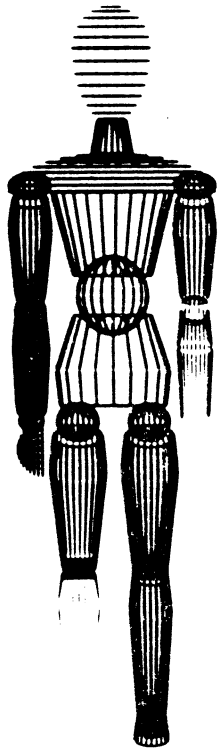
By pressing the stylus tipswitch with the cursor over a control point, the point may be repositioned on the screen. As the two adjoining lines are moved, the message "dragging" is displayed. Press the tipswitch again to reposition the control point. A new spline of the previous order will be computed for the new position.

Use Key F11 to clear the screen for a new drawing.

Use Key F12 to exit and return to the Demonstration Menu.

Program: ROBOT MAN

Typical Program Display



IAS0225

Abstract

The Robot Man displayed in this program shows the use of function networks to manipulate multiple parts of a model simultaneously. A single clock control defines several rotation matrices to provide motion to the Robot Man, which is constructed of spheres, half spheres, elongated half spheres, and cones.

Programmed Functions

Control Dials	Function Keys
D1 - SS X ROT	F1 - STRT/STP (start/stop)
D2 - SS Y ROT	F11 - RESET
D3 - SS Z ROT	F12 - EXIT

Notes on Usage

Note the synchronized simultaneous motion at the shoulder, the elbow, the hips, knees, and feet, as the Robot Man walks the undisplayed treadmill of life. Ten different motions are controlled by the same clock.

Dials 1 through 3 let you rotate the Robot Man in screen space, in any direction.

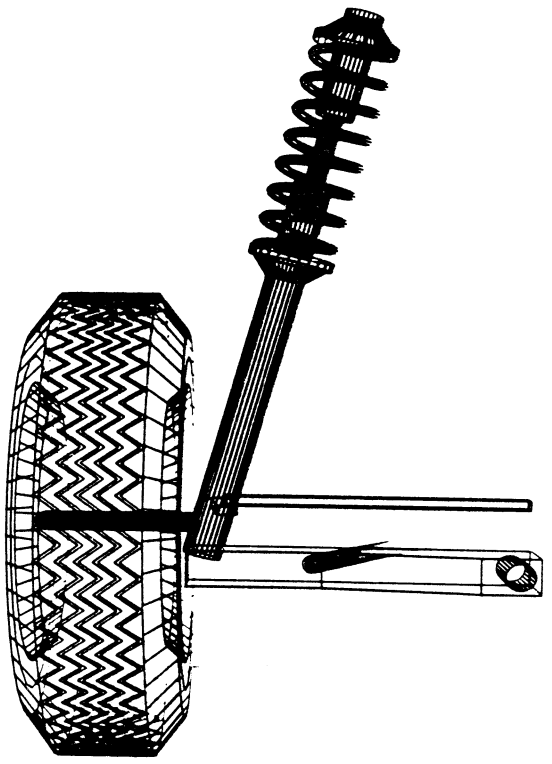
Function Key F1 lets you start and stop the Robot Man's motion, freezing him in any position.

Key F11 resets the program.

Key F12 takes you from the program and returns you to the Demonstration Menu.

Program: SUSPENSION

Typical Program Display



IAS0226

Abstract

The model displayed in this program is the wheel, axle, and suspension of a car. The wheel rotates, can be steered, and can be moved up and down to show the limits of compression and expansion of the suspension spring.

Programmed Functions

Control Dials
D1 - DS X ROT
D2 - DS Y ROT
D3 - DS Z ROT
D4 - STEERING
D5 - TRANS X
D6 - TRANS Y
D7 - TRANS Z
D8 - BOUND

Function Keys
F1 - TIRE ROT (start/stop)
F11 - RESET
F12 - EXIT

Notes on Usage

Dials 1 through 3 let you rotate the model in the data space.

Dial 4 simulates steering. The pivot point of the wheel, the rotation of one of the tie bars and translation of the other are all synchronized in the steering motion.

Dial 8, BOUND, shows spring compression by moving the cylinders up and down and collapsing the spring. Limiting factors have been programmed into the BOUND and STEERING manipulations, so you cannot bounce the tire up through the shock absorber, and you cannot steer the tire completely around.

Key F1 lets you start and stop the rotation of the tire.

Key F11 resets the program.

Key F12 lets you leave the program and returns you to the Demonstration Menu.

MAINTENANCE AND SERVICES

CONTENTS

Evans & Sutherland provides complete hardware and software support of all E&S products. Nationwide coverage of over 200 customer sites is currently provided out of 16 field service locations. Service in Europe is provided by Evans & Sutherland GMBH, operating out of two locations. Field service operations and customer sites receive back-up support from the Software and Technical Support Groups based in Salt Lake City.

In the United States, requests for hardware service are handled through two regional service dispatch centers which provide the customer with a call-back by an E&S Customer Engineer within one hour of the request.

Evans & Sutherland offers two standard maintenance service plans, OEM support, and will contract to provide on-site "high response" service. Evans & Sutherland can also negotiate special service contracts for maintenance programs tailored to fit individual needs.

In addition to providing maintenance service for hardware and software, Evans & Sutherland offers several information services, including training class for programmers and a telephone hotlines for software and documentation questions.

The following sections detail these services. For more information, contact the Evans & Sutherland Customer Engineering Department.

CONTINUOUS MAINTENANCE SERVICE

Continuous Maintenance Service is an on-call contract maintenance service. It is designed to supply the Graphics Systems owner with complete and continuing maintenance of all hardware, software, and firmware supplied by Evans & Sutherland. It features 24 hour response for corrective maintenance, and periodic preventative maintenance. The standard period of service is eight hours per day, 8:00 a.m. to 5:00 p.m. five days per week, excluding holidays. Extended service periods are also available under the CONTINUOUS MAINTENANCE SERVICE plan. The cost of all labor, parts, travel and living are covered by a monthly service fee.

Software maintenance under the CONTINUOUS MAINTENANCE SERVICE plan features software hotline service to the Customer Engineering Software Support Group. Software maintenance covers identification and correction of errors in the software, and consultation on the programming of the graphics system. On site assistance is supplied when necessary.

REQUESTED MAINTENANCE SERVICE

REQUESTED MAINTENANCE SERVICE is a time and material service supplied only upon customer request. Response time is supplied on a time-and-resource availability basis.

Customers will be billed for all labor, replacement parts, travel, and per diem using the published REQUESTED MAINTENANCE SERVICE rates in effect when the service request is received.

MAINTENANCE SUPPORT FOR OEM'S

Various service and support offerings are available for OEM customers. These include maintenance training, card and module repair, first level on-site support, maintenance plan design and an OEM FIELD SERVICE SUPPORT PLAN. In this latter plan, second and third level support is provided to the OEM's first level field service personnel by the Technical Support and Software Support groups of the E&S Customer Engineering Department.

OTHER MAINTENANCE SERVICE

In addition to standard on-call and time and material contracts, E&S designs custom maintenance service plans to meet the needs of its customers. A typical maintenance service designed for a large Continuous Maintenance customer guarantees a 30 minute average response time, 60 minute mean time to repair, and a 99.5% system availability over a 96 hour per week service period. Actual performance on this contract, as measured by the customer over a two year period, exceeded the guaranteed goals. The actual performance levels reported show an average response time of 21 minutes, a mean time to repair of 38 minutes, and a system availability of 99.8%.

SOFTWARE SUPPORT AND DOCUMENTATION HOTLINE

Software Support and Documentation Hotline
800-582-4375

Software Support

Software support is provided to customers by the Customer Engineering Software Support Group at Evans & Sutherland corporate headquarters in Salt Lake City, Utah. During the hours 8:30 a.m. to 4:30 p.m. Mountain Standard Time, customer software problems will be logged into a problem tracking system which insures that all software calls receive the fastest possible resolution.

Once you have logged your problem through the hotline, a Software Support Analyst will call back within one hour to get a detailed description of your problem. Within 48 hours, you will receive by telephone either a solution for your problem or a status report.

There is no charge for this service, provided the following conditions are met:

- You have a Continuous Maintenance Contract
- You are having a problem with an Evans & Sutherland-supported product which fails to perform as specified
- Your system is PS2, MPS, or PS 300
- Your system is being installed or is still under warranty.

Customers who do not hold a Continuous Maintenance Contract, who request special help with unsupported software (and are not covered under installation or warranty) will be billed for the service at prevailing Customer Engineering hourly rates. If you will be billed, your consent will be obtained before the problem is investigated.

The hotline number is intended only for logging problems; it should not be busy for extended periods. However, if the number is continually busy or non-operational, the formal problem logging service may also be reached by calling (801) 582-5847 and asking for Customer Engineering Software Support. Before 8:30 a.m. and after 4:30 p.m., a call recorder will be operational on the hotline number. If you leave your name, phone number, and type of system (for example, PS 300) an Analyst will call you before 10 a.m. MST on the next work day.

Before you call, please check the documentation to be sure your question cannot be answered there. Also, please have the following information at hand when you call.

- PS 300 Graphics Firmware Version Number. This is the E&S part number that appears on the distribution media of the PS 300 Graphics Firmware Package (for example, 904015-001 A1)
- The host computer model, and operating system and its version number under which you are encountering difficulties (for example, DEC VAX 11/780, VMS V3.3.)
- Complete error numbers and messages which were output.
- If possible, the commands issued that caused the problem in question.

Documentation Support

Additional support is provided to customers by the Interactive Systems Publications Group at corporate headquarters in Salt Lake City, Utah. During the hours of 8:30 a.m. to 4:30 p.m. Mountain Standard Time, technical writers will be available for questions or comments regarding documentation. Your corrections and/or suggestions are encouraged regarding existing documentation or needed documentation.

This service is available free of charge to anyone using E&S equipment and its related documentation. No other requirements (such as a Maintenance Contract) are required.

Evans & Sutherland documentation must be ordered through your E&S Marketing Representative. The PS 300 User Document Set is orderable as a complete set, by volume, and by section. Other E&S documentation is orderable by volume only.

TRAINING PROGRAM

Evans & Sutherland offers a comprehensive training course for the PS 300 Programmer. The class is designed to train personnel involved in writing application software for the PS 300. It is recommended that students already have a basic understanding of computer graphics, computer programming, and the basic operating system and editing functions of the host computer that will be used. Upon completion, students should have the knowledge and experience to use the PS 300 in most computer graphics applications.

The PS 300 Programmer Training Class is given at the E&S Corporate Offices in Salt Lake City, Utah, or arranged classes can be taught at customer sites. Class instructors are experienced E&S product specialists and application engineers.

A limited class capacity of no more than six people assures that students are given specialized, individual attention during classroom instruction, as well as hands-on experience at the PS 300.

Training materials are included in the cost of the course. Contact your E&S representative about current costs and scheduling.

EVANS & SUTHERLAND

SOFTWARE REFERRAL CATALOG

CONTENTS

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: ANIMATION & SPECIAL EFFECTS

SOFTWARE PACKAGE: CAMCON/PICTURE

PRICE: APPROX $190,000

PACKAGE CAPABILITIES:

CAMCON provides a fully generalized structure for defining movement. Motion description files of unlimited length can be created and refined as needed to define complex choreography. A complete menu of data generation techniques are available.

PICTURE is a three-dimensional modeling program. A variety of techniques are used to aid the drawing process, including rubber banding, point locking, angle locking and arc generation.

CAMCON and PICTURE can be used separately or in conjunction with each other.

HARDWARE/SOFTWARE CONFIGURATION:

PICTURE SYSTEM II (PS2) with 64K of Memory, Control Dials, 16 Function Switches/Lights, and Data Tablet (36" x 48"). Host computer capable of supporting above graphics system.

DISTRIBUTION SOURCE:

Robert Abel & Associates
953 N. Highland Avenue
Hollywood, CA 90038

(213) 462-8100

SUPPORTED BY:

Same as above

COMMENTS:

Main applications include previewing live action cinematography, production film work, set design, three-dimensional film animation, and vehicle design.

Hardware is included in the purchase price.

9/7/82

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: FACILITY DESIGN and MANAGEMENT

SOFTWARE PACKAGE: DDD (Dynamic Design & Drafting) **PRICE:** $55,000

PACKAGE CAPABILITIES:

DDD is designed for use by corporate facility management groups. The program offers capability to develop two-dimensional interior space plans and to dynamically arrange furnishings and equipment within the plan. There is also a program for viewing these interior spaces as a three-dimensional, dynamic model for further design analysis.

DDD can be integrated with other programs from CORE for specifying equipment, controlling equipment inventories, managing space, determining space requirements, tracking leases, and so forth.

HARDWARE/SOFTWARE CONFIGURATION:

MULTI PICTURE SYSTEM (monochrome or color display)

DEC PDP-11/RSX-11M

DISTRIBUTION SOURCE:

CORE - a division of Herman Miller, Incorporated
2855 44th Street, SW
Grandville, MI 49418

(616) 531-8900

SUPPORTED BY:

Same as above

COMMENTS:

Product literature available from CORE

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: FACILITY DESIGN and MANAGEMENT

SOFTWARE PACKAGE: VIEWPOINT

PRICE: APPROX $70,000

PACKAGE CAPABILITIES:

VIEWPOINT is a facility design and management package capable of:

- Two-dimensional drawing & drafting
- Three-dimensional dynamic modeling
- Image creation for building a graphical data base
- Supports both monochrome and color
- Bridge to data base management program for equipment specification & management

HARDWARE/SOFTWARE CONFIGURATION:

MULTI PICTURE SYSTEM with 256K bytes of Picture Memory, DEC PDP-11 or VAX (emulation mode only) computer, UNIBUS interface, 20MB hard disk, high-speed plotter, hardcopy terminal, VDT, and DDD software

DISTRIBUTION SOURCE:

Core Computer Resources
Herman Miller, Incorporated
8400 Byron Road
Zeeland, MI 49464

(616) 531-8860

SUPPORTED BY:

Same as above

COMMENTS:

The above quoted price DOES NOT include the necessary hardware described above.

Future plans involve having VIEWPOINT being compatible with the PS 300 family of products.

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: FINITE ELEMENT MODELING

SOFTWARE PACKAGE: FEMGEN

PRICE: $4,100
(Base Program Only)

PACKAGE CAPABILITIES:

FEMGEN is a general interactive graphics pre-processor for finite element modeling. Input is via menu, interactive devices or CAD/CAM modellers such as ROMULUS, CADAM, EUCLID, MEDUSA and others. Translators exist which can pass FEMGEN output to analysis programs such as NASTRAN, ANSYS, ADINA, ABAQUS, MARC and others.

The program is command-driven using non-hierarchical commands which can be issued in any sensible sequence. Models can be designed at any level including nodes, elements, points, lines, surfaces, bodies, and analytical shapes such as planes, cylinders, spheres & cones. Mesh generation capabilities exist which allow the user to combine lines, surfaces and solids.

Additional features include model area/volume checking, bandwidth optimization, and element condition checks.

Other options and features available at extra cost.

HARDWARE/SOFTWARE CONFIGURATION:

PS 300 or Multi Picture System

Host computer capable of supporting one of the above graphics systems

DISTRIBUTION SOURCE:

U.S. Only:
Jordan, Apostal, Ritter Associates, Inc.
Administration Building 7
Davisville, Rhode Island 02854

(401) 294-4589

SUPPORTED BY:
Same as above

COMMENTS:
For further information, contact the distributor.

Outside the United States contact:
FEGS International, Ltd.
2 All Saints Passage
Cambridge CB2 3LS ENGLAND

8/16/83

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: FINITE ELEMENT MODELING

SOFTWARE PACKAGE: FEMVIEW

PRICE: $4,400
(Base Program Only)

PACKAGE CAPABILITIES:

FEMVIEW is an independent post-processor for quick and comprehensive graphics evaluation of finite element results. While being complementary to FEMGEN, it is not dependent upon it.

Major features of FEMVIEW include: multiple view modes (e. g. outline only, shrunken elements, full mesh and hidden line removal, sections along element faces in solids, zoom, rotations, etc.); multiple results presentations (iso-contours, displaced shapes, vectors, XY plots, peaks & threshold values, etc.); various output variables (stresses - components & Von Mises, strains, displacements, velocities, accelerations, etc.); and database administration.

Capable of processing results data from programs such as: ADINA, ANSYS, PAFEC, NASTRAN, BERSAFE.

Other options and features available at extra cost.

HARDWARE/SOFTWARE CONFIGURATION:

PS 300 or Multi Picture System

Host computer capable of supporting one of the above graphics systems

DISTRIBUTION SOURCE:

U.S. Only:
Jordan, Apostal, Ritter Associates, Inc.
Administration Building 7
Davisville, Rhode Island 02854

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Cambridge CB2 3LS ENGLAND

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SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: FINITE ELEMENT MODELING

SOFTWARE PACKAGE: PATRAN-G

PRICE: $8,000 BASE/YR

PACKAGE CAPABILITIES:

An interactive color graphics modeling system for the creation of geometry, finite element models and results evaluation. Geometric description using grids, lines, surfaces, and volumes; refined mesh generation; nodal equivalencing; band-width optimization; model verification using boundary edge plotting; surface checking; element shrink display; contouring; automatic titling; interface to NASTRAN, ANSYS, and others.

HARDWARE/SOFTWARE CONFIGURATION:

Standard configuration MPS or PS 300 using Control Dials and Keyboard. Host computer capable of supporting one of the above graphics systems.

DISTRIBUTION SOURCE:

PDA Engineering
1560 Brookhollow Drive
Santa Ana, CA 92705

(714) 556-2800 TELEX: 683392 PDA SNA

SUPPORTED BY:

Same as above

COMMENTS:

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SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: FINITE ELEMENT MODELING

SOFTWARE PACKAGE: SUPERTAB Version 7.1
IDEAS LEVEL PS 300

PRICE: APPROX
$40,000

PACKAGE CAPABILITIES:

Includes modules to display the results of finite element analysis. Model preparation and modification using geometric models or mesh generation. Checks for coincident nodes, free edges, deflected or distorted geometry, displays stress contour plots and criterion plots. Interfaces to a variety of finite element analysis programs including NASTRAN, ANSYS, SUPERB and others.

HARDWARE/SOFTWARE CONFIGURATION:

Standard configuration MPS or PS 300 using data tablet, control dials, and keyboard. Compatible with VAX only.

DISTRIBUTION SOURCE:

General Electric/CAE International
Computer-Aided Engineering
300 TechneCenter Drive
Milford, OH 45150

(513) 576-2400 TELEX: 8104608325 SDRC CIN MILO

SUPPORTED BY:

Same as above

COMMENTS:

Also Distributed by:

General Electric/CAE International
San Diego, CA

(619) 450-1553

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: GENERAL PURPOSE GRAPHICS

SOFTWARE PACKAGE: GRACE (GRAphical Curve Editor) **PRICE:** Unknown

PACKAGE CAPABILITIES:

GRACE was created to provide a highly interactive environment for creating two-dimensional diagrams, scenes and logos. Facilities include the ability to save a scene for later editing, load an existing scene and include an existing scene into the scene being edited. Scenes are created by creating/modifying any number of objects. Object types currently supported are text, vector lists, rectangles, and b-splines.

HARDWARE/SOFTWARE CONFIGURATION:

Standard configuration PS 300 attached to a DEC VAX 11/780 computer running under UNIX and supporting the C programming language.

DISTRIBUTION SOURCE:

Tony DeRose
Berkeley Computer Graphics Laboratory
University of California
Berkeley, CA 94704

SUPPORTED BY:

Same as above

COMMENTS:

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: KINEMATIC ANALYSIS

SOFTWARE PACKAGE: ADAMS

PRICE: Contact Distributor

PACKAGE CAPABILITIES:

Useful in the design/analysis of three-dimensional systems such as vehicle dynamics, high speed mechanisms, robotics, accident reconstruction, etc.. The software allows a variety of applied forces such as constant forces and torques, linear spring and viscous damper forces, and user-written applied force routines.

Output is presented as animated drawings and XY plots of forces, accelerations, velocities and displacements.

HARDWARE/SOFTWARE CONFIGURATION:

Standard configuration MPS or PS 300. This software currently runs on VAX, IBM, CDC or PRIME computers.

DISTRIBUTION SOURCE:

Mechanical Dynamics, Incorporated
Attn: Gary Dawson - Vice President, Marketing
555 S. Forest Avenue
Ann Arbor, MI 48104

(313) 994-3800

SUPPORTED BY:

Same as above

COMMENTS:

Written in ANSI Standard FORTRAN. Can be run either in batch or time-sharing environments. Library of graphics symbols including circles, cylinders and arcs.

There is a $2,500 installation fee.

Post processing graphics on Tektronix is also available.

Package can also produce extensive hardcopy output.

7/22/83

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: KINEMATIC ANALYSIS

SOFTWARE PACKAGE: DRAM

PRICE: Contact Distributor

PACKAGE CAPABILITIES:

Useful in the design/analysis of two-dimensional systems such as vehicle dynamics, high speed mechanisms, robotics, accident reconstruction, etc.. The software allows a variety of applied forces such as constant forces and torques, linear spring and viscous damper forces, and user-written applied force routines.

Output is presented as animated drawings and XY plots of forces, accelerations, velocities and displacements.

HARDWARE/SOFTWARE CONFIGURATION:

Standard configuration MPS or PS 300. This software currently runs on VAX, IBM, CDC or PRIME computers.

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COMMENTS:

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There is a $2,500 installation fee.

Post processing graphics on Tektronix is also available.

Package can also produce extensive hardcopy output.

7/22/83

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: MOLECULAR MODELING

SOFTWARE PACKAGE: FRODO

PRICE: Contact Distributor

PACKAGE CAPABILITIES:

Originally written by T. Alwyn Jones while at the Max Planck Institute (Munich) in 1979, FRODO is primarily used in fitting models to electron density maps obtained by x-ray crystallographic techniques. It is also a useful tool to display and study the detailed three-dimensional structures of proteins and enzymes, especially the stereochemistry of ligand protein or substrate protein complexes. FRODO features a single display and command menu of prominent molecular components and computer functions to enable the experimenter to construct, display and modify models efficiently. Besides displaying entire structures, the user may also look at portions of the structure or display only certain atoms within it.

HARDWARE/SOFTWARE CONFIGURATION:

Multi Picture System or PS 300 using a DEC PDP-11 or VAX computer

DISTRIBUTION SOURCE:

MPS
Dr. Joseph Andose
Merck & Co.
Bldg. R80 - A1
126 E Lincoln Avenue
Rahway, NJ 07065

(201) 574-6376 ext 4391

PS 300
Dr. Florante A. Quiocho
Dept. of Biochemistry
Box 1892
Rice University
Houston, TX 77251

(713) 527-4872

SUPPORTED BY:

Same as above

COMMENTS:

SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: SHIPBUILDING & DESIGN

SOFTWARE PACKAGE: HULCIG (HULlform Computer Image Generation) **PRICE:** N/A

PACKAGE CAPABILITIES:

HULCIG may be used for interactive wire frame ship hullform generation and display. Descriptive geometry is used to characterize the form of a ship's hull on a drawing known as the "lines drawing". This lines drawing is placed on a digitizing board and the necessary nodal points on the transverse sections (body plan) are digitized to initiate the interactive development of the wire frame image. A PS 300 program (function network) has been written that generates a vector list from this digitizing and allows the display of the hullform transverse sections on the terminal screen. Using the PS 300 Data Tablet and associated functions, longitudinal lines are added interactively to complete the wire frame image. In addition, vector lists for more complex shapes, such as the ship's superstructure, may be added independently of the Data Tablet. The complete image data file is thus generated interactively without any programming requirements on the part of the user. Additional networks exist for using the PS 300 interactive devices to aid the user in other aspects of visual inspection. These include image rotation about three body-fixed axes, three translations in screen coordinates, scaling, and viewing in either orthographic or perspective projection, including depth cueing.

HARDWARE/SOFTWARE CONFIGURATION:

PS 300, DEC PDP-11 with RSX-11M operating system and Tektronix 4954 digitizing board

DISTRIBUTION SOURCE:

D. E. Calkins, Research Associate Professor
Ocean Engineering Program
Department of Mechanical Engineering
University of Washington
Seattle, WA (206) 543-9443

SUPPORTED BY:

Same as above

COMMENTS:

This package is not yet distributable in its present state. For additional information, contact D. E. Calkins at the University of Washington.

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SOFTWARE PACKAGE DATA SHEET

PRIMARY APPLICATION: SOLID MODELING

SOFTWARE PACKAGE: ROMULUS

PRICE: Contact Distributor

PACKAGE CAPABILITIES:

ROMULUS is an interactive three-dimensional solid geometric modeler developed by Shape Data, Ltd. of Cambridge, England, a wholly owned subsidiary of Evans and Sutherland. ROMULUS is a design tool, providing the user with a comprehensive command language to build true geometric component models, modify them, manipulate them and interrogate information about them. It is a program that allows a designer to directly interact with the model being created.

Solid models are stored as explicit representations of the bounding faces, edges and vertices, as well as the geometric data, giving the coordinates of each vertex, the form of each edge, and the surface of each face.

ROMULUS provides an interactive, user-friendly interface, with features such as extensive user prompting and help facilities; keyboard, menu and cursor input; and comprehensive message and error output. ROMULUS comes with complete user documentation. Specialized training courses are available.

HARDWARE/SOFTWARE CONFIGURATION:

Apollo/Aegis (DN300,400,600), DEC (VAX/VMS - all models), IBM/MVS/VM/CMS (30xx,43xx series), Prime/Primos (50 Series models)

ANSI standard Fortran must be supported

Graphics displays supported include Apollo (see above), Evans & Sutherland (PS 300), Tektronix (4010,4014)

DISTRIBUTION SOURCE:

Evans & Sutherland Computer Corporation
Marketing Department
Box 8700
Salt Lake City, Utah 84108

(801) 582-5847

Europe:
Shape Data Ltd.
2 All Saints Passage
Cambridge,
England CB2 3LS
011-44-772-733-705

SUPPORTED BY:
Same as above

COMMENTS:

8/12/83

EVANS & SUTHERLAND USERS GROUP

The Evans & Sutherland Users Group was started by E&S in 1978 to provide a forum for the exchange of ideas and information, to provide an opportunity for problem solving, and for the distribution of non-proprietary software.

The goals today are very similar. There is still an opportunity for you to exchange ideas, feedback, and user-written software. However, since 1982 there has been a new emphasis on user control of the group, a change fully supported and encouraged by E&S.

A newsletter, Journal of the Evans & Sutherland User's Group, is compiled and edited by the president of the Users Group and is distributed by E&S. In addition to the "Journal," E&S distributes PS 300 Application Notes and a Software Referral Catalog that include contributions by members of the Users Group.

Evans & Sutherland encourages participation in the Users Group. It is particularly useful in putting you in contact with people who share similar interests or applications. The Users Group is also useful to E&S--the group provides us with fair and unbiased feedback about our hardware, software, and policies.

Much of the information is disseminated during the annual meeting held at SIGGRAPH, which usually occurs in July. This convention is widely attended by professionals in computer graphics and provides an excellent opportunity for the Evans & Sutherland Users Group to meet.

As a service to the Users Group, we have provided this section for releases of the "Journal."

If you are interested in participating in the Users Group, or would like more information, please contact Evans & Sutherland or your Evans & Sutherland representative.