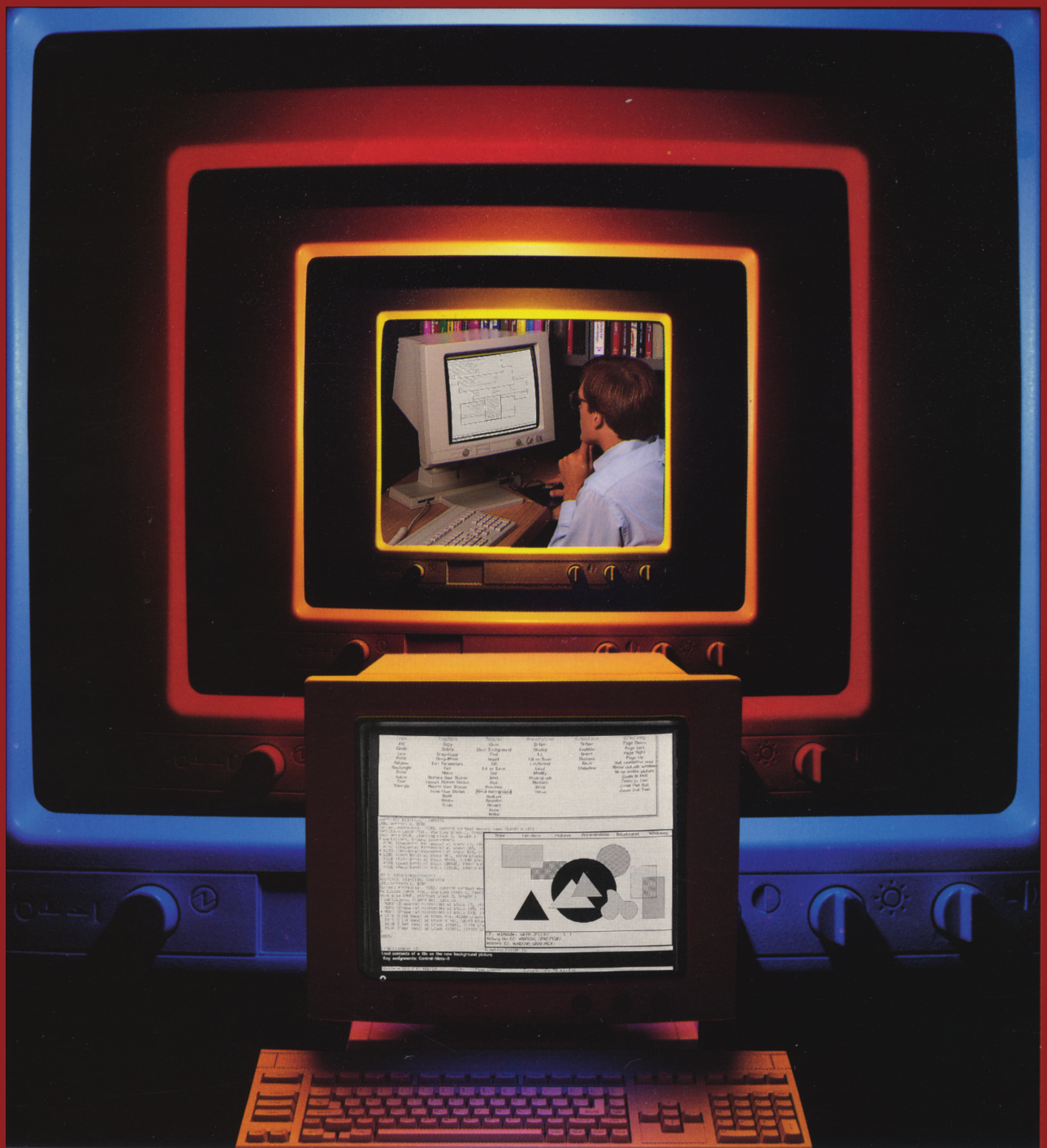
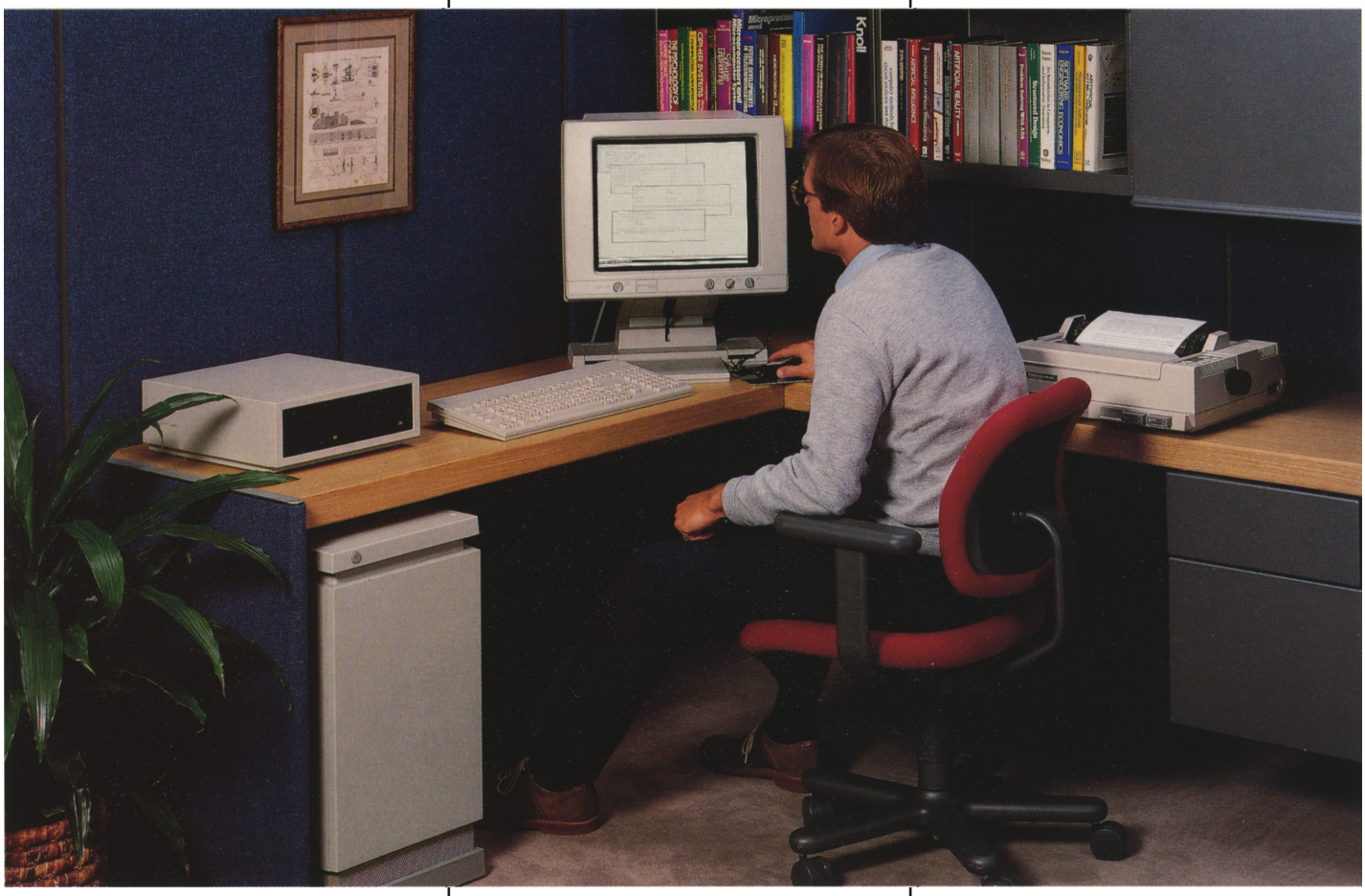
TEXAS INSTRUMENTS

EXPLORER™ COMPUTER SYSTEM

For high-performance symbolic processing.



The Explorer computer system from Texas Instruments: A vehicle for discovery.



Artificial intelligence promises to open new dimensions in the ways that machines serve people. The Explorer computer system from Texas Instruments will play a vital part both in extending the boundaries of knowledge and in delivering the products emerging from AI research.

The Explorer system is an advanced, single-user computer optimized for high-performance symbolic processing. The Explorer hardware architecture was designed specifically to support both the capabilities of the LISP language and the system's extraordinarily powerful software development environment. This design makes the system ideally suited for the development and execution of software that employs artificial intelligence techniques to help solve complex application problems.

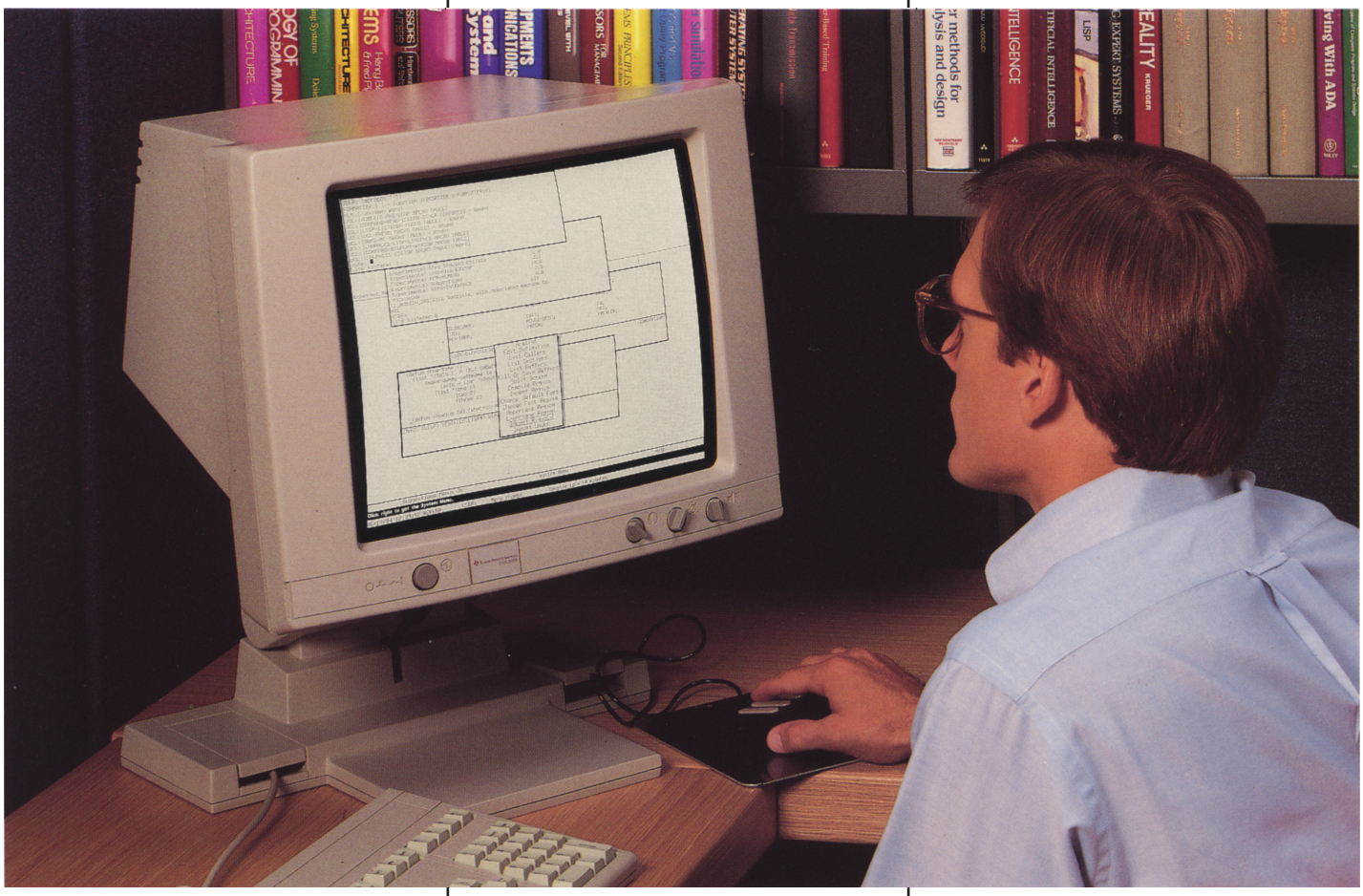
Exploring new dimensions through symbolic processing.

Conventional computing excels at problems that can be expressed in numerical terms and which lend themselves to repetitive, algorithmic solutions. However, traditional computing has not been effective in dealing with unstructured problems, interpreting information, using "rules of thumb" gained by experience, or dealing with uncertain or incomplete information. Symbolic processing is one set of techniques that researchers have developed to address these problems.

Symbolic processing is the utilization by computers of information and knowledge represented as symbols—analogous to the way humans reason with knowledge they possess.

Symbols are used to represent real-world objects and properties associated with them. Symbols can be linked together, using structures such as networks or graphs, to represent such relationships as hierarchy and dependency. For example, the words *cat*, *pet*, *carnivore*, and *animal* can be designated as symbols. The hierarchical relationships among these symbols can be established by using the symbolic operator *IS-A* to associate the properties of pet, carnivore, and animal with cat.

The techniques of symbolic processing represent such a significant departure from traditional programming that conventional languages designed for repetitive operations on numbers have proven to be inadequate. As a result, symbolic languages, such as LISP, have been designed with unique abilities to incorporate and utilize these new problem solving techniques.



LISP: A language for symbolic processing.

LISP (List Processing) is the leading programming language for symbolic processing and artificial intelligence research and development.

LISP differs from other programming languages in that it is not an algebraic or algorithmic language, but instead was developed specifically for symbolic processing. In addition, LISP can be interpreted, encouraging a highly productive style of interactive programming, or compiled for increased performance. A major strength of LISP is that it is extensible. New functions may be defined and implemented by users and added to the language. Moreover, problem-specific languages may be developed in LISP to run "on top of" LISP.

Hardware optimized for symbolic processing.

While the flexible data structures supported by LISP are extremely useful for representing knowledge, they are not handled efficiently by conventional computers. This has driven the development of computers specifically designed to optimize execution of symbolic processing software coded in LISP.

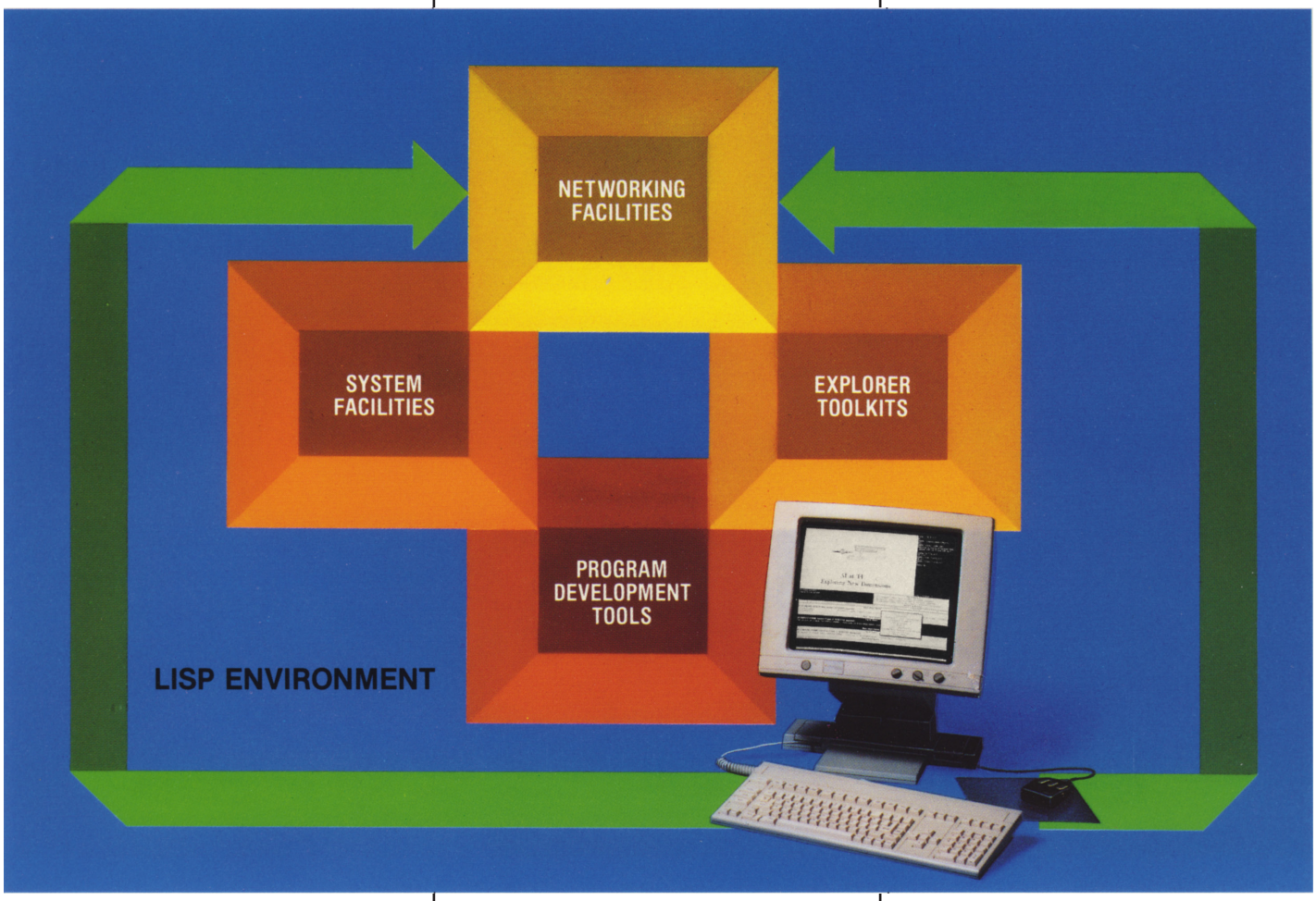
The special features that set symbolic processing computers apart from conventional computers typically include a dedicated LISP processor, large virtual address space, large amounts of physical memory, a high-resolution graphics display, and high-performance mass storage devices. In the past, such features have commanded a very high price, limiting symbolic processing computers to laboratory and research applications.

Entering a new era.

With the introduction of the Explorer computer system, Texas Instruments has made dramatic progress in moving this class of powerful machines from the laboratory into the office. TI has set a new standard for symbolic processing computers by bringing together the latest developments in artificial intelligence with its renowned expertise in manufacturing and its worldwide customer service and support organization.

The Explorer system combines state-of-the-art hardware with a rich set of programming tools to create an ideal environment for LISP-based artificial intelligence applications. Attractively packaged for the office setting, the Explorer system features the quality, reliability, support, and service that customers have come to expect from Texas Instruments.

A powerful software environment for solving complex problems.



The Explorer system furnishes one of the most productive software development environments available today. It permits the developer to focus full attention at the conceptual level of the problem without being preoccupied with lower-level details.

The Explorer software environment consists of the LISP language, the system software and the user interface, a rich set of integrated program development tools, a number of complementary optional toolkits, and network communications facilities. Source code provided with the system permits the developer to incorporate elements of the system software, as well as components from the toolkits, into applications. This extends the environment to help solve new, complex problems in a highly productive programming environment.

The LISP language.

LISP is a powerful high-level language with capabilities beyond the scope of most other programming languages:

- LISP's ability to work with symbols and symbolic structures, rather than just numbers and characters, makes it ideal for representing, storing, and processing knowledge.
- LISP may be extended by the programmer, or even used to create specialized languages tailored to the application program at hand.
- LISP is well suited to recursive programming.
- LISP can be used in interpretive mode, encouraging highly interactive programming. Once a function performs satisfactorily, it can be compiled. Interpreted and compiled code are dynamically linked at execution time.This allows functions running in either mode to call (or be called by) functions executing in either mode. The developer benefits from a short design and debug cycle without sacrificing execution speed in the ultimate product.

The Explorer system is based on Common LISP to promote portability and consistency among different machine implementations of the LISP language. Common LISP is an emerging industry standard supported by representatives from both the industrial and academic symbolic processing communities.

In addition to Common LISP, the Explorer system provides high-level extensions to the language, including a powerful loop macro, an extensive library containing the MIT LISP Machine system functions, and Flavors—an object-oriented programming facility.

System software and the user interface.

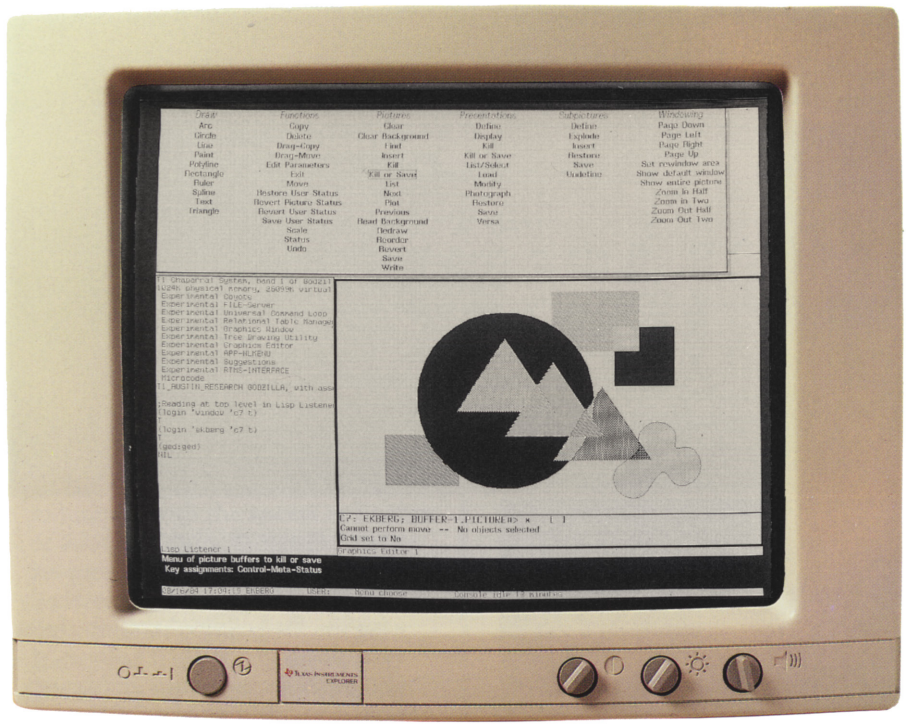
The Explorer system's user interface is designed to optimize the productivity of both application developers and end users alike. The interface takes advantage of a high-resolution graphics display with software support for multiple fonts, a keyboard that supports chording of multiple keys, and a mouse pointing device to facilitate quick access to any object on the display.

The software that controls these hardware components incorporates a sophisticated window system, which manages the display of many activities on the screen and directs input from the keyboard or mouse to the appropriate program.

A notable characteristic of the Explorer software is the fully integrated on-line help facilities, which provide special assistance features to promote the rapid transition to expert user.

Graphics support.

The window system includes a number of graphics primitives for creating arcs, circles, lines, polylines, rectangles, text, and other objects on the display. The time-critical portions of the graphics and windowing functions are implemented in the Explorer hardware and microcode to enhance real-time performance. An advanced graphics toolkit is an available option, allowing users to create object-based representations of graphics elements.



Menus and choice facilities.

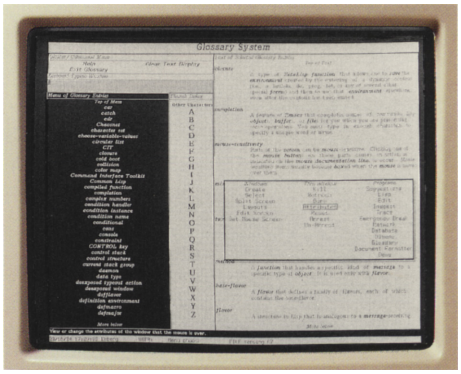
Menus consist of choices, each identified by a word or a short phrase, such as a command name. Menu choices are typically selected through mouse operations. Some menus apply to the system as a whole, while others apply to specific activities. For example, one window on the screen may show relevant system-level choices while another window makes application-specific choices accessible to the user at the same time.

Help facilities.

Most of the Explorer utilites include special assistance features to enhance ease-of-use, such as the completion of partially entered commands and pathnames, and suggestions regarding the use of available commands. Explorer help facilities include:

- **Help Key**—a dedicated key on the keyboard that presents a menu of various levels of information, including beginners help within the system and all major utilities.
- **Online Documentation**—detailed information on commands, groups of related commands, and individual functions.
- **Suggestions Mode**—a window on the display screen that provides a dynamic list of the available commands.
- **Mouse Documentation Line**—a window on the display screen that provides a short description of the currently available mouse operations.
- **Glossary Utility**—a program that provides definitions of terms that are specific to the Explorer and LISP environment.
- **Notification Utility**—a program providing information when certain events occur, unrelated to the user's current activities, triggered by other activities started previously.

The combination of these facilities provides a variety of ways for users to interface with the system, allowing the method of interaction to vary according to personal preference or level of expertise.



Power tools for program development.

Program development tools.

The Explorer system software provides a powerful set of tools for rapid program development. These highly integrated tools provide the developer with a unified programming environment where LISP programs can be created, compiled, executed, and debugged without leaving the editor. Program development tools are:

- **Zmacs Editor**—a real-time, window-oriented display editor that provides extensive support for writing LISP programs, as well as other types of text.
- **LISP Listener**—a window-oriented program that facilitates direct user interaction with the LISP interpreter.
- **LISP Compiler**—a program to convert LISP functions into machine code to optimize a program's execution speed and reduce its memory requirements.
- **Debugging Facilities**—a set of interactive tools to assist developers with the identification and correction of program errors.
- **Inspector**—a window-oriented program for viewing and modifying complex data structures, such as the properties of LISP objects.
- **System Definition and Patch Facilities**—a set of tools for integrating many separate programs into systems and managing new releases of systems.
- **Performance Monitoring Facilities**—a set of performance "meters" that are maintained by the Explorer microcode and can be accessed by LISP programs to monitor and analyze the use of system resources, typically for optimization purposes.
- **Command Interface Tool**—a facility for building user interfaces to applications on the Explorer system. A set of macros and functions supports a number of human factors engineering aids. These aids include menus of available commands, access to tutorials, lists of suggestions for current activities, and several types of abbreviated access to commands.

Optional application development tools.

A number of advanced features are common to many symbolic processing applications. Optional toolkits are offered for the Explorer system to provide these features. The components

of these toolkits are designed to be easily incorporated into application software and quickly modified to meet specific application needs.
Optional application toolkits currently available are:

- **Text Formatter**—a package for automatically rearranging text files into publication-quality documents, such as reports or manuals, with graphic illustrations.
- **Graphics Toolkit**—a set composed of the graphics window system, a graphics editor, and a tree editor. The set enhances the basic capabilities of the micro-coded graphics and window system and allows the user, or an application program, to create, modify, and manipulate individual graphics objects. The graphics editor allows interactive creation of pictures using objects or sub-pictures previously created. The tree editor graphically displays any tree-structured entity (such as hierarchically organized data) and provides commands to format the display and to pan or zoom in on the structure.
- **Natural Language Interface Toolkit**—a package to help the software developer build powerful but friendly user interfaces to application software. These interfaces allow users to interact with the system in English or another natural language. Tools are provided to design and debug a lexicon, a grammar, and screen descriptions for any application.
- **Relational Table Manager Toolkit**—a set of routines to build, access, and manipulate relational tables with LISP. It provides for a wide variety of user-defined relations and system-defined formats. All manipulation takes place in virtual memory. Database elements can be saved to and loaded from disk. There is no limitation on the size or number of relations in a database, provided that the database fits within virtual memory. While most use of the Relational Table Manager will be with queries from applications programs, there is also an interactive interface to assist with building and debugging the database.

Knowledge engineering tools.

The Explorer system's knowledge engineering tools are valuable for building complete symbolic processing solutions or expert system tools.
Knowledge engineering tools include:

- **Prolog Toolkit**—the Prolog toolkit has two components:
  - — Prolog Interpreter—includes the standard Prolog primitives. The interpreter can be called from the LISP environment and can be used in applications that mix Prolog and LISP.
  - — Sample Expert System Tool—uses a Prolog-based inference engine and a window-based interface. This package can be used to build simple rule-based expert systems, or it can be expanded to suit more extensive expert system building needs.
- **Network Representation Tool**—a utility to describe knowledge that is naturally represented as a semantic network. Primitives include functions to create, delete, bind, evaluate, and show the existence of elements in a network.

In addition to these, a number of tools are being made available on the Explorer system by third-party software vendors. TI will continue to cultivate offerings of quality software for the Explorer environment.

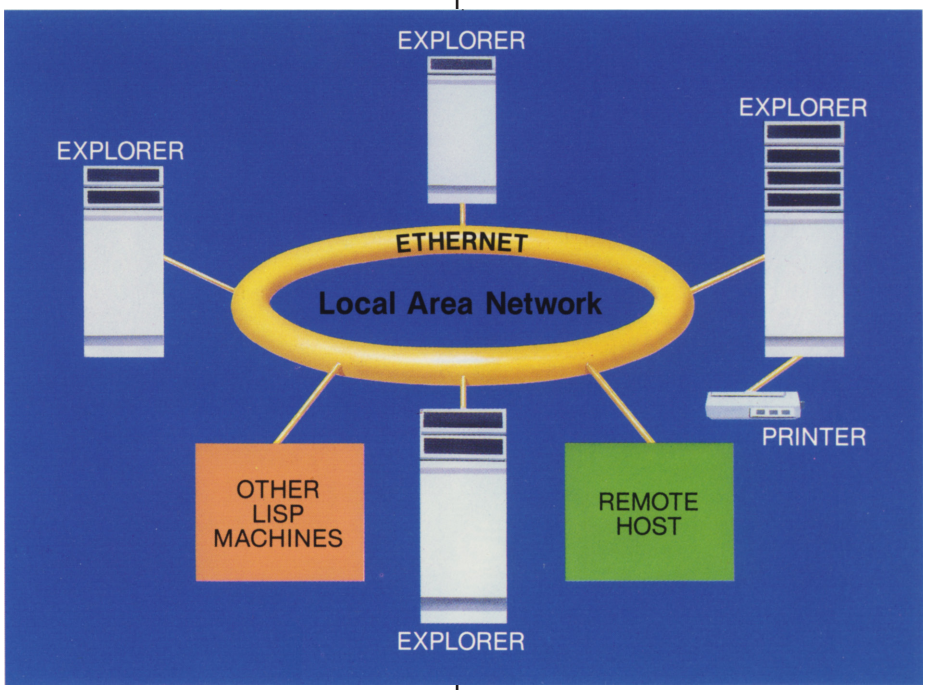
Networking.

The Explorer system supports local area networks (LANs) using the industry standard Ethernet™ interface. This enables the sharing of expensive peripherals and the communication with other LISP machines or conventional computers using standard protocols.

Programs can communicate with each other over the LAN using unidirectional or bidirectional data streams. Networking services include:

- **Transparent File I/O**—allows access to remote resources such as files, directories, and devices as if they were locally available.
- **Remote Log In**—allows log in to any host on the network using the Explorer system as a virtual terminal to the remote host.
- **Electronic Mail**—allows sending mail to a remote host and reading from a mail file in a remote host.

Initially the Chaosnet protocol will be supported. Other protocols, such as IP/TCP, will be made available in future releases.



Explorer hardware: optimized for symbolic processing...and for users.

The Explorer symbolic processing system uses leading-edge technology and innovative approaches in system architecture, processor design, and hardware packaging. The Explorer system architecture and hardware board designs provide reliable, high performance LISP processing, high quality graphics, and flexibility in system configuration at a very attractive price. Designed for a quiet office environment, the Explorer system features small separate enclosures for the System Processing Unit, Mass Storage Subsystems, and System Console.

High performance symbolic processor.

Built with high-density surface-mount technology, the Explorer processor contains 16K 56-bit words of writeable control store, microprogrammed for rapid and efficient LISP processing. Additional support for high-speed symbolic processing is provided by enhanced architectural features, including:

- Tagged architecture for hardware support of run-time data typing.
- Bit-field hardware for manipulating complex data structures.
- Hardware assisted memory management (garbage collection).
- 128 Mbyte virtual address space.

Flexible, high-speed system design based on NuBus™ architecture.

The Explorer provides high performance with flexibility in system design. The system is centered around two high-speed 32-bit buses. The NuBus, the basis of Texas Instruments Nu Generation™ computer product family, allows high-speed exchange of information among processors, memory, mass storage, and special devices. The NuBus features:

- Processor-independent architecture and multiprocessor support which allows addition of general purpose or application specific processors.
- 32-bit addressing and data transfer.
- 37.5 megabyte per second bandwidth.
- Block transfers of multiple words.
- 10 megahertz bus clock.
- Synchronous operation.

The Explorer system also incorporates a 32-bit local bus for high bandwidth access between processor, main memory, and the graphics bitmap. This leaves the NuBus available for system-wide operations. Use of the local bus is completely transparent to the software.

TI is licensing the NuBus technology to third parties or end users who wish to design their own processors, controllers, or other devices.

State-of-the-art memory system.

The memory boards designed for the Explorer system also use surface-mount technology. This technology allows much greater packing density than conventional DIPs, providing large memory capacities in a small enclosure.

The Explorer system uses a large main memory for high performance in a demand-paged environment, with each memory board containing 2 megabytes implemented with 64K bit DRAMs. Memory boards with an 8 megabyte capacity, using 256K bit DRAMs, will also be available. The local bus accommodates two memory boards; the NuBus can accommodate additional memory boards if required.

System console.

The Explorer system console consists of the monitor, keyboard, and mouse. Connection of the console to the system is through a high-speed fiber-optic link, allowing a flexible lightweight cable of up to 200 feet and providing a transfer rate of 68 megapixels per second.

The 17-inch diagonal monochromatic display screen is mounted in landscape orientation providing 1024 pixels per line for 808 displayed lines. Brightness and contrast controls are set on the front of the monitor for easy accessibility. The monitor also includes a built-in speaker, with volume control, for future speech options.

The display incorporates state-of-the-art ergonomic features which allow easy adjustment of both height and tilt for comfortable viewing of the screen, maximizing operator efficiency. The monitor requires minimal desk space with a 15.6-inch by 12.3-inch footprint. User input is via a three-button optical mouse in conjunction with a low-profile keyboard designed specifically for the LISP programming environment.

Up to 896 megabytes of disk storage.

The Explorer mass storage subsystem sets new standards for high capacity and high performance in a compact package. The small, detached mass storage enclosure houses two 5¼-inch form-factor devices. The devices include 112 Mbyte disks (formatted) and 60 Mbyte cartridge tapes. Up to four mass storage enclosures can be daisy-chained on a system. The industry-standard SCSI bus provides a common interface to the system cabinet for all mass storage devices, as well as an easy upgrade path for adding future peripherals. Overlapped seeks and a minimum of 1 megabyte data transfer rates on the SCSI bus ensure high performance for the LISP system environment.

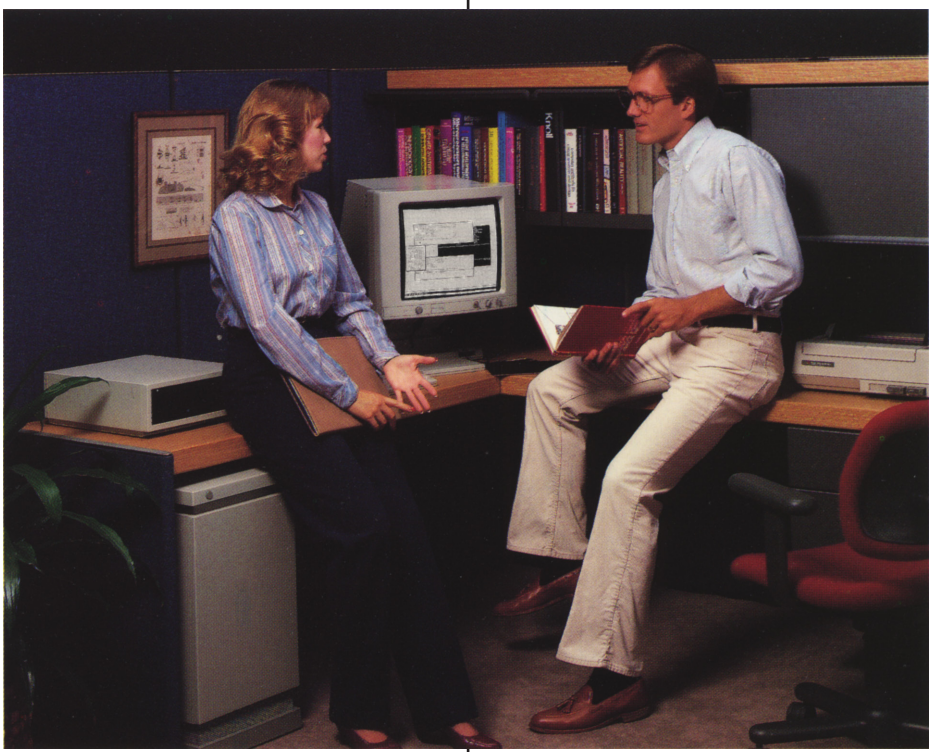
Modular packaging integrates into the office environment.

The Explorer system components are packaged in attractive, compact enclosures to make the system a pleasant and unobtrusive addition to an office setting.

Separate enclosures for processor and mass storage subsystems allow maximum configuration and placement flexibility. Advanced fan and motor designs provide effective cooling with minimal noise.

The Explorer processor, memory, and controllers are contained in a floor-standing, seven-slot enclosure which fits under a desk. Other office environment features of the Explorer design include concealed cable connections and casters to allow easy office mobility.

Three of the Explorer system's seven slots are allocated for the processor, the system interface board, and a memory board. Other slots are available for the mass storage controller, the Ethernet controller, and optional devices. Each system board uses a standard three-high Eurocard format. The boards contain self-test and autoconfiguration ROMs, allowing for dynamic configuration at power up. All board and cable connections are through the backplane using 96-pin DIN connectors. This provides easy access and removal of both boards and cables.



Customer assistance: a total commitment from Texas Instruments.

TI support.

At Texas Instruments, we are proud of our reputation for technological advancement and the reliability of the products we sell. But we realize that what happens after the sale is equally important to our customers. We've established an extensive network of customer support services that will help you get the most from your Explorer system and keep it running smoothly.

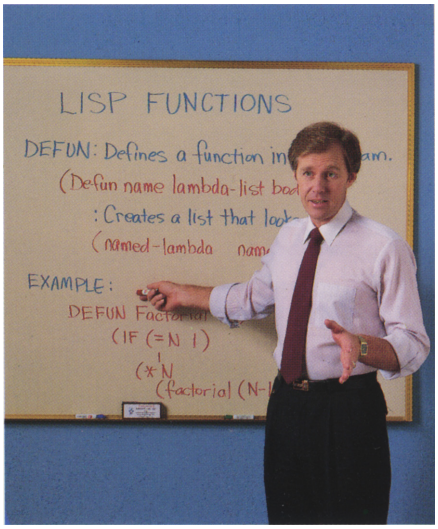
Documentation.

Experienced users and beginners alike will appreciate the detailed set of hardware and software manuals provided with the Explorer system. These thoughtfully organized handbooks are packaged in loose-leaf binders with dividers for fast and easy reference.

The hardware manuals explain the operation of the Explorer system in detail, from the system level to the subassembly level, including information about functional and circuit operations of the various hardware configurations.

The software manuals offer a thorough explanation of all aspects of the LISP environment and its related software tools. In addition to the reference material, the manuals include tutorial sections that can help you become familiar with the entire set of system and reference manuals.

Some customers may find that they want still more information about their system, or they may simply prefer a classroom environment for learning. If so, Texas Instruments is ready to meet their needs.



Training.

The Texas Instruments Education Center has developed a series of courses consisting of lectures and practice sessions designed specifically for the programmers and designers who will be using the Explorer system. Featuring live instruction by highly-qualified TI personnel, the courses are available at a Texas Instruments facility or at an alternate site of your choice.

Courses that are currently available cover LISP, the LISP software environment, the Explorer toolkits, and other advanced topics. Courses on other related subjects will be developed according to customer needs.

Our training program is designed to ensure that you'll have a broad range of knowledge about every aspect of your Explorer system. When you need specific information, and you need it fast, we're ready to provide that, too.

Customer Engineering Support.

TI engineering support is available at your site—or is as close as your telephone.

Our team of systems analysts, extensively trained in LISP and other aspects of artificial intelligence, can come to your facility to help you determine the most efficient ways to use your Explorer system.

And when you need immediate answers, help is just a phone call away. TI's customer hotline gives you instant direct contact with Texas Instruments, serving as a technical interface between you and our product-development personnel.

Field Service.

The Explorer has been specifically designed for reliable operation. If you ever do experience hardware problems, you'll be glad to know that it has also been designed for easy maintenance, including powerful built-in diagnostic tests and easily accessible components.

Our customer representatives are ready to provide you with several types of service, including installation, maintenance agreements and on-call service.

We also offer several different levels of maintenance contracts, so that you can select the arrangement that best fits your particular needs. Extended coverage, for example, provides you with first priority in both scheduling and parts allocation. Our fixed price repair service may be ideal for those customers who perform their own repairs and stock their own spare parts.

Explorer system specifications.

System Unit.

- Microprogrammed 32-bit LISP Processor.
  - 16K × 56 bits of writeable control store.
  - 142 ns micro instruction cycle (7 MHz clock).
  - Tagged architecture for typed data.
  - 128 Mbyte virtual memory space with demand paging.
  - Local bus for high processor-memory bandwidth.
- Advanced 32-bit NuBus Architecture.
  - Processor independent.
  - Multiple processor support.
  - 37.5 megabyte/second transfer rate.
- Main Memory.
  - 2 megabyte standard, expandable to 16 megabytes per system.
  - Surface-mount technology with byte parity.
  - Access time under 300 nanoseconds.
- Ethernet LAN Interface.
- System Interface Controller.
  - Fiber optic interface to monitor, keyboard, mouse, microphone, and headset with a 68 megapixel per second transfer rate to the display.
  - Graphics control logic using 1-megabit bit map implemented with 120 nanosecond RAM.
  - Parallel printer and RS-232-C ports.
  - System resources including clocks, timers, nonvolatile memory, and power failure event logic.
- Physical Characteristics.
  - 25-inches high, 13-inches wide, 18-inches deep (63.5 cm × 33.0 cm × 45.7 cm).
  - 115 volt, 7.5 amps.
  - Compact, quiet enclosure for office use.

System Console.

- Monitor.
  - 17-inch diagonal, in landscape orientation.
  - 60 Hz non-interlaced monochrome display.
  - 1024H × 808V resolution.
  - Adjustable height and tilt.
  - Small footprint, 15.6-inches × 12.3-inches (39.6 cm × 32.2 cm).
- Keyboard.
  - Economically designed, low-profile keyboard with coiled cord.
  - 111 keys including standard QWERTY keys, LISP-specific keys, numeric pad, and cursor control keys.
  - High-quality, snap-action tactile feedback for positive entry and silent operation.
  - Electronic locks for modifier keys, with indicator lights.
  - Tilt is adjustable between 5° and 15°.
- Mouse.
  - Optical, 3-button.
  - Motion tracked at 30 inches per second.
  - 200 dots per inch resolution.

Mass Storage.

- Separate Enclosures.
  - Can contain two 5¼-inch drives.
  - Self-contained 110 watt power supply.
  - Up to four enclosures (eight devices) can be daisy-chained to one system.
  - SCSI bus interface.
  - 5.2-inches high, 13-inches wide, 15.2-inches deep (13.2 cm × 33.0 cm × 38.6 cm).
  - Supports overlapped seeks.
  - 1+ megabyte per second data transfer rates.
- Winchester Disk.
  - 112 megabyte formatted capacity. (140 megabytes unformatted.)
  - 30 msec average access time.
  - 5 megabits per second transfer rate.
- Cartridge Tape Subsystem.
  - 90-inches per second streaming drives.
  - 90K bytes per second transfer rate.
  - 60 Mbyte ¼-inch tape cartridge.
  - Industry-standard QIC-24 format.

Printer.

- TI Model 855 Printer Support.
  - Dot matrix impact printer.
  - Interchangeable font modules, choice of pitch.
  - Variable resolution up to 144 dots per inch.
  - Mosaic graphics for borders, bar graphs, and patterns.
  - Raster graphics for pictures, graphs, and charts.
  - 4,000 character buffer.
  - Parallel printer port (Centronics compatible) included on the system interface board.

For more information on the Explorer system.

If you would like to know more about TI's Explorer computer system write us at Texas Instruments, P.O. Box 809063, Dallas, TX 75380-9063. Or call 1-800-527-3500.

TEXAS INSTRUMENTS

Creating useful products
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