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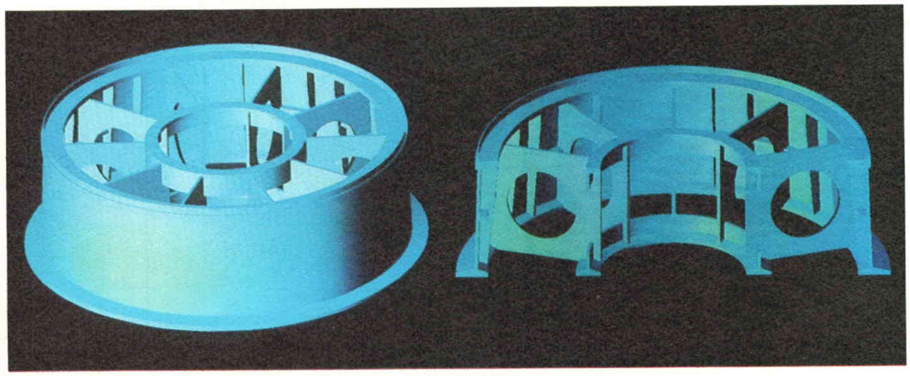
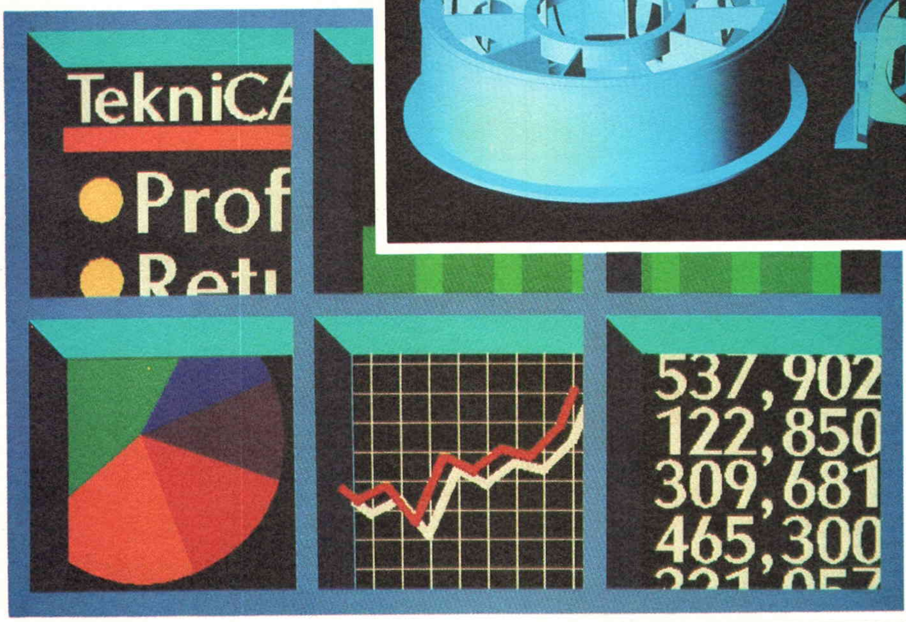
Tekniques



▲ **4120 Series Color Graphics Workstations Offer Multiple 2D/3D Pathways**



▲ **Introducing PLOT 10 TekniCAP Computer-Aided Presentation Software**

PLOT 10 TekniCAD at WJXT TV in Jacksonville ▸

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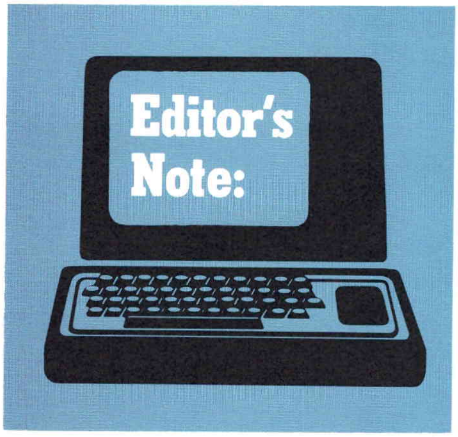


This issue of *Tekniques* highlights a representative sampling of Tektronix' range of information display products – hardware and software, systems and peripherals, some new lines and some you're familiar with. However, there is one recurring theme. Each of the product features and application stories illustrates the value of effective communication and communications tools in today's workplace.

As detailed in the opening article, effective communication for WJXT TV in Florida includes generating "up-to-the-minute" documentation of complex audio/video signal paths and creating professional quality facility layouts for a new transmitting tower. A TekniCAD drafting system helps WJXT station engineers handle each task.

In This Issue

TEKniques, the IDG Applications Newsletter, is published in the Information Display Group of Tektronix, Inc., Mail Stop 63-635, P.O. Box 1000, Wilsonville, Oregon 97070. It is distributed to TEKTRONIX computer and terminal users.

Also focusing on team communications, an article on the latest generation of graphics workstations offers insight into how these systems will change present engineering and design methodologies. Tomorrow's engineering teams are also likely to include the help of expert systems, as explained in the story about the 4404 Artificial Intelligence System.

The 3D wireframe and shaded surface capabilities of the 4120 Series Color Graphics Workstations allow computer graphics images to communicate a new dimension of information. These 3D imaging techniques as well as the perceptual cues they rely on are discussed in this issue.

PLOT 10 TekniCAP Computer-Aided Presentation Software, a new tool that eases the creation of presentation graphics is also featured. And, demonstrating how human ingenuity can enhance communications, an employee of the National Park Service authors an article about plotting large-scale images using a 4691 Color Graphics Copier.

Three separate articles discuss Tektronix tools that extend electronic communications capabilities, enabling greater flexibility in the transfer of information between computing environments. The first such article is a report on DaTek, the 6000 Family Relational Database Manager. It details how a shared database can strengthen the network link between remote workstations. You'll also read that TekniCAD support has been extended to DEC VAX and Tektronix 6000 Family Intelligent Graphics Workstations, and that Tektronix now offers a series of IBM-compatible Computer Graphics Terminals, the CX4100 Series.

Evident from this collection of articles, improved communication may take the form of a more efficient team, a tighter feedback loop, a more effective medium, a more flexible interface. Tektronix supports these goals by designing products that address customer needs, adhere to standards and expand with changing applications.

Program Exchange Discontinued

In November 1984, the IDG Program Exchange formally ceased operation.

The exchange was initially established in 1976 as the 4051 Applications Library. It provided a means for users of Tektronix' first Desktop Computer to share program information by accessing a library of programs – through either a program contribution or a nominal fee. As the product series grew, the applications library expanded significantly with input from 4052 and 4054 Desktop Computer users. At its peak, the Program Exchange catalog had over 700 programs.

In the past several years, use of the Program Exchange has slowed significantly. Last year, it was used so infrequently that support for it has been discontinued. No new programs will be accepted.

A limited supply of program packages are in inventory, and may be ordered while supplies last by writing to:
Tektronix, Inc.
IDG Program Exchange
Mail Stop 63-575
P.O. Box 1000
Wilsonville, OR 97070

Customer Training Workshops

The following hands-on customer workshops are scheduled for the summer and fall of 1985:

Graphical Kernel System (GKS)

June 17–20	Dallas
July 15–18	Boston
Aug. 12–15	Santa Clara
Sep. 23–26	Gaithersburg
Nov. 11–14	Santa Clara

Interactive Graphics Library (IGL)

July 15–18	Gaithersburg
July 22–25	Santa Clara
Aug. 19–22	Dallas
Sep. 16–19	Gaithersburg
Oct. 14–17	Santa Clara

Computer-Aided Drafting

June 17–21	Gaithersburg
July 15–19	Santa Clara
July 29–Aug. 2	Gaithersburg
Aug. 5–9	Dallas
Sep. 9–13	Gaithersburg
Sep. 16–20	Santa Clara
Oct. 7–11	Boston
Nov. 4–8	Gaithersburg
Oct. 28–Nov. 1	Dallas

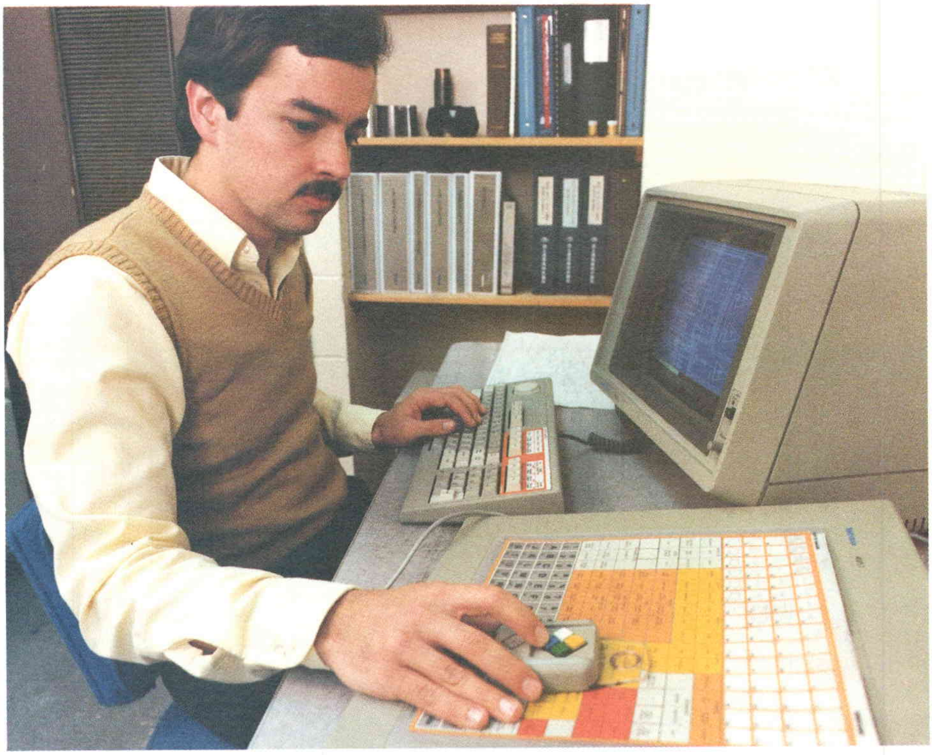
4050 Series Programming

June 17–21	Beaverton

Cost is $800 per student, and each class is held at the Tektronix Regional Support Center in the listed city. Or, on-site classes can be arranged for up to 12 students for $8000. For schedules and registration information call collect (503) 642-8953 or write to:

Carolyn Wilson
Tektronix, Inc.
Customer Training, MS 54-076
P.O. Box 1700
Beaverton, OR 97075

TekniCAD – Live From WJXT Jacksonville



WJXT engineer, Tim Derstine, creates cabling documentation using a 4170-based drafting system that includes TekniCAD software and a 4957 Graphics Tablet.

When watching a nightly newscast or local talk show you're likely to witness any number of complicated feats of television engineering. A reporter conducts a live interview from some remote location. A meteorologist reports the weather while satellite-generated maps flash in the background. A tennis match is covered from the vantage of the entire court, with an inset close-up of the server. Though the broadcasting techniques involved in these telecasts don't command your attention – subtlety is the mark of their success – the dynamic nature of the technology and people behind them shouldn't be underestimated.

To plan and execute their everyday functions, television engineering teams must demonstrate a wide range of specialized skills. Video and audio signal routes must be specified for each studio and remote broadcast. Performance testing of all equipment must be conducted regularly to assure the synchronization of all signals. And, satellite and microwave transmissions must be continually monitored to assure signal quality. In order to keep pace with the number and complexity of the tasks, engineering talent and equipment must be applied efficiently.

The engineering team at WJXT of Jacksonville, FL, handles its range of tasks with the aid of a multifaceted tool – a Tektronix drafting system that includes PLOT 10 TekniCAD computer-aided drafting software, a 4170 Graphics Processing Unit, a 4107 Computer Graphics Terminal, a 4957 Graphics Tablet and a CalComp 945 Plotter.

Audio/Video Layout

One of the most challenging aspects of television station engineering – and one of the primary applications for WJXT's TekniCAD system – is directing and documenting the flow of audio and video signals. Typically, thousands of cables are required to conduct signals generated by microphones, cameras, video tapes, audio recordings and satellite receivers. Adding to the complexity, signals must often travel lengthy paths through several pieces of equipment before arriving at their destination.

For example, video signals from a camera in one room may be sent to a frame synchronizer in another room several dozen yards away. The synchronizer accepts signals from several sources, compares them to a common reference signal and makes adjustments to assure that they are all in sync. Synchronized signals are then sent to a control room where they can be selected for output to the transmitter for immediate broadcast or to a video or audio recorder for a taped production.

Creating and maintaining cabling layouts that trace these complex signal paths is a critical engineering function because audio technicians and maintenance engineers rely on the diagrams to coordinate their respective roles. Also, any station trouble-shooter must have a reliable reference to all cable interconnections so that if a problem occurs during a broadcast, it can be quickly located and corrected.

Aside from general cabling layout and maintenance tasks, WJXT currently has some special circumstances compounding its drafting load and spurring the move toward automated drafting:

- A new transmitter building and tower is being planned, requiring the generation of building layouts, room floor plans and new cabling diagrams.
- The station is preparing to switch to stereo broadcasting, a move that adds a second channel of audio signals to generate, direct and document.
- Also, WJXT is continually upgrading equipment. For example, in the last few months the station replaced a master control switcher. Installation required significant rewiring and the updating of all related cabling documentation.

Designs on Demand

The switch to TekniCAD drafting has helped WJXT engineers merge these additional drawing tasks into their already busy schedules. For example, they now find that cabling layouts are easier to keep up-to-date and thus more reliable than manually produced drawings. According to Jim Biggers, WJXT's chief engineer, "When drawings were done manually, small changes were often documented by bits of paper clipped or taped to drawings. These notes tended to accumulate until the entire drawing had to be redone. With the 4170-TekniCAD system, all changes can be entered quickly and a new drawing run out on the plotter."

In addition to reducing the turnaround time for cabling updates, the system has streamlined the layout conceptualizing and drawing phases. Tim Derstine, a WJXT maintenance engineer, states "With the drafting board, I had to know the direction of the entire drawing from the first box drawn. With the 4170 TekniCAD system, I don't worry about the details. I have the flexibility to move things around, to make changes. I'm not afraid to sit down and start drawing."

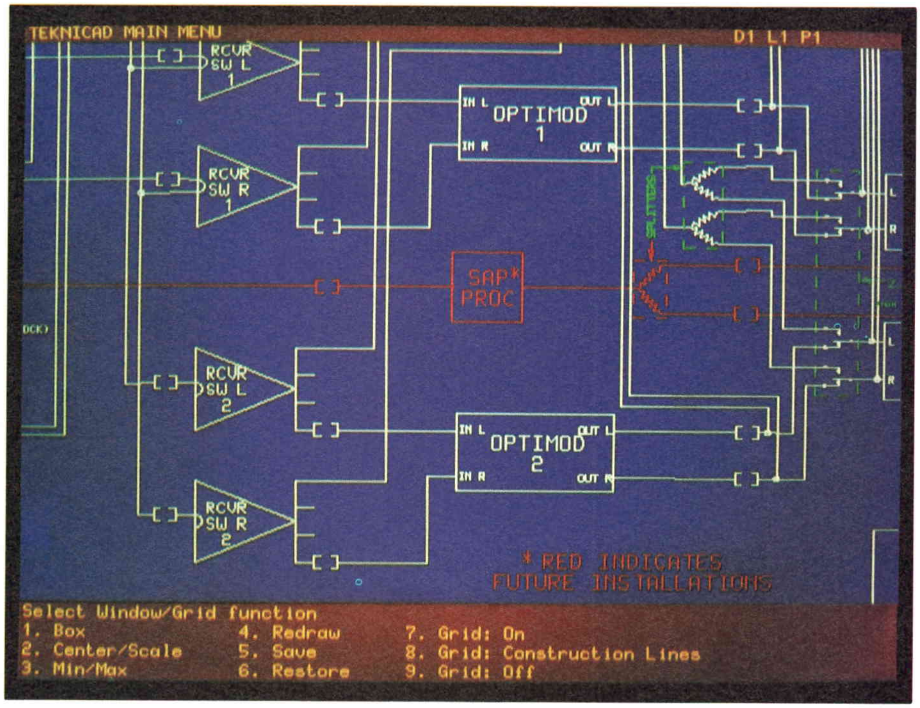
Tim typically develops a preliminary drawing, generates a hardcopy plot and reviews it with other members of the team. Based on this review, he edits the drawing and plots another iteration or a final version. This iterative process was less feasible when a new drawing had to be manually redrawn in order to incorporate changes. By inviting more input from team members earlier in the design process, designs are more effective and there are fewer last minute changes.

With his many maintenance and repair responsibilities, Tim didn't have much time to devote to learning a new drafting system. However, it didn't take him long to adjust to TekniCAD drafting, though he relied only on the manual and TekniCAD menus for instruction. "TekniCAD menus step through a fairly natural drawing process," states Derstine. "You're asked the same questions you'd ask yourself when manually drawing a diagram – about drawing scale, units, labeling, etc."

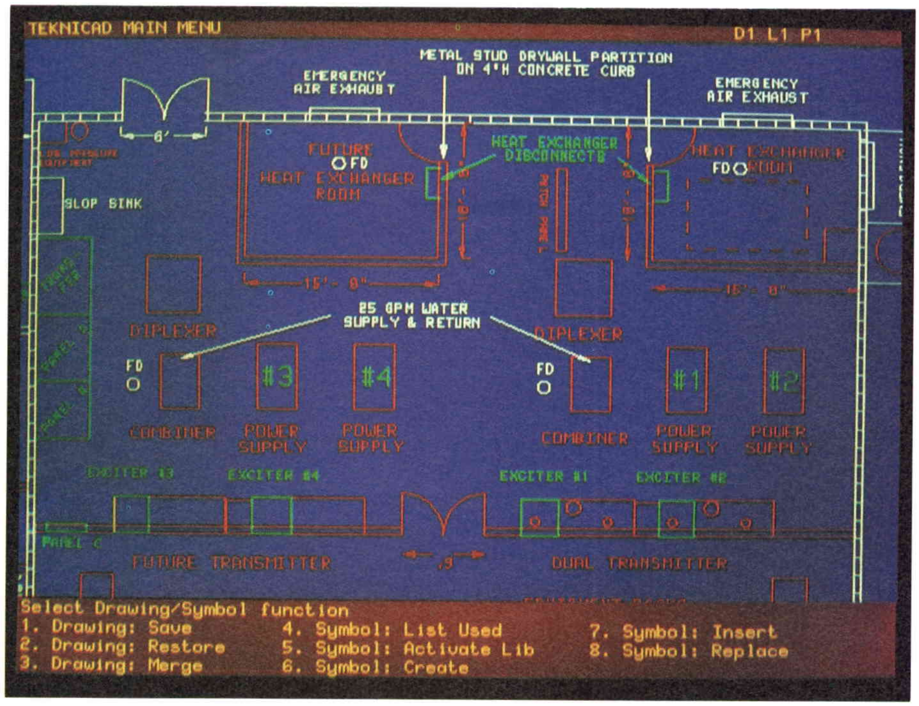
Tim currently applies about 70 percent of TekniCAD's feature set to his drawing and design functions and is continually learning more about the system. The features he relies on most include:

- **Levels** Complex flow diagrams are simplified by entering related inputs on different *levels.* For example, audio flow is entered on a different level than video flow. Then, if only video flow is of concern in a drawing session, only that level is displayed or plotted. Temporarily *blanking* the audio level helps to focus attention and to speed the drawing process.
- **Worksets** A drawing is easier to organize when related groups of items are defined as a workset. Up to eight worksets can be specified in a drawing, and each can then be moved, copied, scaled or otherwise manipulated as a unit. For example, lines representing output from a particular audio or video source can be defined as a workset and moved as a unit when the location of the equipment source is changed.
- **Symbols** Any combination of lines, arcs and text can be defined as a symbol and stored in a symbol library. It's useful to define a drawing element as a symbol if it is repeated a number of times throughout the drawing or series of drawings. Because all symbols are stored in the same default size, they don't have to be individually scaled each time they are displayed.
- **Color** A range of available colors allows different types of information to be clearly distinguished. For example, audio and video flows can be represented in different colors. Color wasn't an option with the manual drafting board.
- **Copy, Modify and Blanking Functions** Cabling diagrams can be designed, drawn and updated in less time when individual drawing items and groups of items are easily manipulated. These functions provide greater flexibility and control in the drafting process and often eliminate the need to completely redraw a layout.

Tim finds that the more TekniCAD functions he masters, the more time he saves. For ex-



A portion of a TekniCAD-generated diagram that documents audio flow for stereo transmission. The distribution amplifiers are defined as symbols for quick inclusion in any drawing.



WJXT engineers created this facility layout as a basis for planning and discussion with the architects designing the station's new transmitter building and tower.

ample, he recently constructed a new drawing by simply merging worksets from two different drawings. He completed the task in 30 minutes. He estimates that generating the same diagram manually would have taken two to three hours.

Working Documentation

Tim Derstine is also using the 4170-TekniCAD system to design a master layout that plots audio flows to and from each technical area in the studio – quite an undertaking considering the amount of equipment and cabling involved. He represents each area in a different color and on a different level. In this way, signal flows from the news room, the edit suite, the rack room, and other key locations are distinguishable when an integrated layout is output.

This scheme also makes it easy to display and manipulate the cabling layouts of individual rooms and areas. Specific diagrams can be recalled and used as templates whenever a reconfigured flow diagram is needed for a new production. Once this project is complete, an engineer will rarely have to start a layout diagram from scratch.

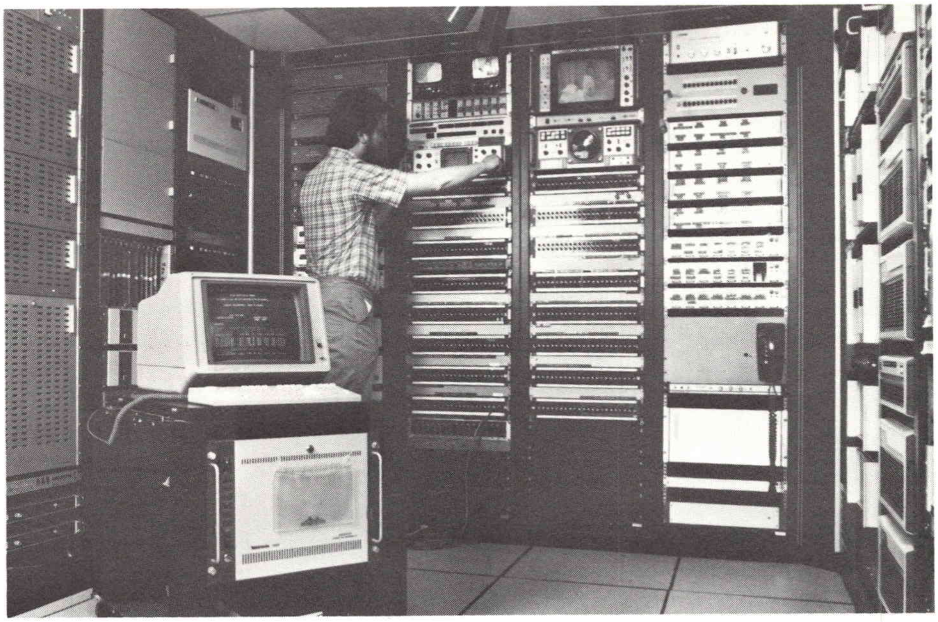
Though Tim had to invest a certain amount of his time translating written documents into TekniCAD files – the rack room alone took eight hours – he felt his time was well spent. According to Tim, "There's no way a diagram like this could be drawn by hand without starting over five or six times."

WJXT currently maintains a looseleaf notebook that documents small portions of the total video signal flow on 30 to 40 8-by-11 inch pages. Tim plans to create a master video flow diagram based on this document, much like the audio flow diagram he is now working on. He expects his efforts will be repaid in better cabling documentation and faster drafting turnaround time. Also, with TekniCAD, he can generate a drawing that offers a total perspective of the studio's audio/video flow. This wasn't possible with the notebook file.

TekniCAD On-Location

TekniCAD-generated layouts also facilitate communication between studio technicians and remote camera crews. For example, when a mobile unit is dispatched to a sports event or political convention, an equipment van must be custom-configured for the taping task. Patch panels within the vans provide input and output jacks for each piece of available equipment. Typically, a video/audio layout is designed and plotted prior to dispatch, and the plot is displayed for reference during the taping.

Not only are the D-size plots created by the CalComp plotter appropriate for display inside the van, TekniCAD's symbol capability has eased the job of patch panel labeling. Tim Derstine has created a library of symbols, each representing an item of mobile unit equipment and its function. He uses color-coding to distinguish separate functions, such as red for audio signals, blue for video signals. Now, when he designs a mobile unit layout, he incorporates symbols from the symbol library rather than re-entering the information. After plotting the layout, he generates enlarged versions of the symbols and uses them to label patch panels. The crew can then clearly identify appropriate jacks by matching the symbols.



Much of WJXT's signal generating and monitoring equipment is housed in the rack room, a key location on the studio's audio and video flow diagrams.

Site Planning

WJXT's plans to build a new transmitter building and tower were a prime motivation for the purchase of the 4170-TekniCAD system. Steve Flanagan, Director of Engineering for Post-Newsweek Stations, Inc., WJXT's parent company, decided to invest in the drafting system in order to draw building plans for the new facility.

Typically, architects develop preliminary building layouts based upon verbal instructions from their clients. However, because the layout of a transmitting facility involves a number of specialized concerns – FCC requirements, signal interference patterns, microwave links – Steve wanted to submit his own preliminary drawings to the architects. The TekniCAD drafting system enabled him to create his own professional-quality layouts.

Rooms designed for television production also have unique power, illumination and ventilation requirements. As Jim Biggers states, "Architects don't always foresee all the implications of designing a room to accommodate communications equipment and activities." The WJXT engineering team expressed their layout concerns through preliminary TekniCAD-generated floor plans. The drawings provided a sound basis for planning and discussion with the architectural firm and gave the engineering team greater influence over the ultimate design of the facility.

As soon as the preliminary floor plans were available, Tim Derstine began work on audio/video flow diagrams for the new transmitter site. Thus, WJXT's need for an automated drafting tool is not diminishing. In fact, as the team becomes more familiar with TekniCAD's dynamic design aspects, the number of uses and users continues to grow.

Conclusion

As the WJXT engineering team demonstrates, you don't need to be a dedicated draftsperson to appreciate the benefits of drafting automation. Though drafting is only one of the many functions handled by WJXT engineers, their 4170-based TekniCAD drafting system has had an overall impact on productivity. The ability to create a range of accurate, detailed drawings in a minimal amount of time has helped them document their processes, respond to change and communicate their ideas with greater precision and efficiency.

Workstations Bridge the Generation Gap

By Jon Reed, Vice President
Information Display Group
Tektronix, Inc.

Tektronix' 6000 Family of Intelligent Graphics Workstations integrate engineering tools for a complete range of design and administrative tasks.

The biggest challenge facing the electronics industry today is to discover ways to significantly increase engineering productivity. Several trends are forcing the issue. First, products are becoming far more complex, and, as a result, the engineering process itself is becoming more complicated. Complex products mean longer development times, more engineering resources needed and, unfortunately, an increased error rate as designs become more intricate.

A second trend is that the demand in the U.S. for qualified engineering talent today far exceeds the supply of engineering graduates from our universities and colleges. Also, many engineers are not yet intimately familiar with design automation tools and techniques.

While these forces naturally lengthen development time, competitive pressures to keep ahead of technological obsolescence are creating shorter product life cycles. Shorter product life means less development and manufacturing time and necessitates reducing the cost to market. Better, cheaper, faster – that's the mandate.

Unfortunately, neither the current tools nor the design methodologies are keeping pace with the growing demand for complex designs that are right the first time! There is a real need for better computerized tools to aid engineers throughout the development process.

First Generation Workstations

The first generation of workstations that appeared over the last few years was an initial response to this need. Electronics engineers began to exploit their own technology to improve productivity. These computer-aided engineering (CAE) workstations gave engineers standalone tools to aid in certain phases of the design process and provided a dedicated computing resource. Some even contained a measure of interactivity for tasks such as data capture and were an improvement over the batch-oriented tools typically found on mainframes.

However, first generation workstations had drawbacks that kept them from significantly improving overall engineering productivity. Most ran with proprietary operating systems and databases, making it difficult to integrate them into the larger computing systems already in place. For the same reason, they were also unable to access a wide range of application software.

Most engineers found first-generation workstations difficult to use. Typically, the designer could display only one type of information at a time, and he had to contend with complex software commands and modes. Also, because of limitations in the processing power and storage, these workstations could only handle one fragment of a design problem at a time. The engineer was forced to deal with large complicated databases in many different formats, each describing a different aspect of his design. Obviously, there was a lot to learn about how a CAE workstation could benefit the engineer in his daily work.

Second Generation Workstations

Second generation workstations are now emerging with a new emphasis – to integrate engineering tools into a total design environment. Only then can they address the productivity issue.

Reaching the goal of a single integrated engineering environment is an evolutionary process. As a practical matter, a CAE environment must develop as an extension of existing computing resources in order to protect hardware and software investments. To do this, second generation workstations are based on industry standard processors, graphics formats, programming languages, operating systems, networks and interfaces.

The new systems are also expandable and upgradeable to accommodate future change. This allows a user to increase computing power, system memory, mass storage or graphics performance without incurring software obsolescence or loss of utility.

Another important requirement is the ability to purchase just the capability needed at any point in time, yielding the maximum incremental benefit for the minimum incremental expenditure. These systems enable the use of application products from the many specialty vendors in the marketplace.

Second generation workstations also incorporate state-of-the-art graphics by combining both display list and bit-mapped techniques. Display list (or vector) graphics provide higher information content for complex drawings and also allow true zoom capability.

Bit-mapped manipulations are optimal for text and icon generation, pop-up menus, area fills, smooth scrolling, and streamlined user input from a mouse or other pointing device. Bit-mapping also facilitates multiple window management which allows the user to perform several tasks or review data from several sources simultaneously – a major improvement for many applications.

These workstations reflect an increasing awareness of the human factors of the user interface. For example, we can now define color shades for maximum data discrimination and minimal eye fatigue. Displays and keyboards have optimal shapes and spatial relationships to the user, and they have adjustable heights and tilts to further relieve fatigue.

Probably the most significant ergonomic advances have come in the form of new user interface management systems that act as an intermediary between the user and the application program. Using standard icons, menu configurations, message areas and input sequences, these systems let the user interact with all applications in a consistent manner, reducing the learning curve and frustration level of new users. Ease of learning and ease of use are key to maximizing the productivity of existing engineering personnel.

Another important feature of second generation workstations is the increased availability of application software for each step of the design process – from the initial specification through verification of the prototype and generation of production tests. Because design engineers spend as much as 80% of their time doing administrative and management tasks, rather than engineering, design tools are now complemented by general productivity tools, including documentation, spreadsheet and project management software.

Scenario – The Design Environment

These concepts can be best described with a scenario. Imagine a team of design engineers supported by a network of compatible graphics workstations, terminals, storage subsystems and hardcopy peripherals. Color graphics displays vary from medium resolution to very high resolution. Each intelligent workstation has a powerful general-purpose processor that can execute custom or third-party application software under an industry standard operating system. Workstation architecture also incorporates a dedicated graphics processor to perform rapid graphics manipulations on the display. In addition to traditional keyboards, graphics input devices such as joy sticks, trackballs, joydisks, and "mouse" pointers are connected to many of the workstations.

Terminals are connected to a large mainframe via RS-232 lines, while the workstations are connected to the mainframe, peripherals and to each other by a high-speed local area network. Each workstation can access a variety of peripherals including mass storage, multi-pen plotters, ink-jet color copiers, printers and film recorders.

Each engineer has a medium-resolution, color graphics workstation that can perform many tasks in a standalone mode. In addition, he or she can use the mainframe for large "number crunching" tasks and can access data from the mainframe or other workstations.

The engineering team is also supported by a shared database. Supporting multiple design methodologies, it allows each designer to work in a preferred style, at any level, from top down to bottom up, or in any combination. For example, within an electronics design team, one member may choose to define and display blocks at the functional level, another at the logic level, and still another at the circuit level.

While engineers can work simultaneously on different parts of the design, all members have access to the entire design as it progresses. Data entered at any design level updates the database, so communication is automatic. Analysis and simulation results are also available to all members.

Now let's follow a typical design cycle from initial concept to production. First, the project leader uses the word processor on her workstation to write the product description for a new semicustom chip. To prepare a proposal for management, she sketches some concept drawings on her display screen using an interactive drawing package and her mouse, and inserts them into the text.

She also prepares some rough development and manufacturing cost estimates using a spreadsheet program that runs on her workstation. The final spreadsheets are also inserted as tables directly into her report file. The report is output onto hardcopy, with the concept illustration portrayed in color. Then she prepares a few word slides on her workstation and outputs them along with her design sketches onto overhead transparencies using an ink-jet color copier connected to the network.

Several weeks and a few presentations later, the team gets approval to develop the product. Now the leader needs to plan the schedule and nail down costs. She uses a project planning program employing the critical path method to identify the project stages and to coordinate support activities.

Next, each team member further refines his or her part of the design specification using the word processing and graphics capabilities of the workstations. The document resides in a shared database so they can each have access to the latest version.

The specification complete, the designers move to high-performance graphics workstations to begin circuit design. These stations can be shared by several engineers to better utilize their capabilities. The designer can build a circuit by assembling a schematic diagram from a cell library or he can create one from scratch using basic gates and registers.

Either way, this schematic is converted into a database that completely describes the circuit in terms of primitive logic structures, performance parameters and connectivity lists. The powerful graphic editing capabilities of the workstation enable him to easily modify his drawing until it matches his design concept.

The designer also has a variety of analysis tools available. For example, the engineer tests the circuit's performance with SPICE or other simulation programs by sending his circuit database over the network to the mainframe computer. The results, in the form of simulated timing diagrams, are sent back to the workstation for viewing and analysis. At this point, any problems that are detected are traced and remedied by modifying the original circuit description and rerunning the simulation.

Integrating analysis into the design process improves productivity because the more easily and quickly a design can be evaluated in the early stages, the less likely the need for time-consuming and expensive redesign and prototyping. An engineer can complete many more design iterations in a given time with automated tools than with the former manual design and physical prototyping approach.

When the circuit is verified, the cell lists, net lists and placement and routing information are incorporated into the manufacturing database. Then a mask is manufactured and sent on to the foundary. Finally, since test patterns were automatically generated in the design phase and the semiconductor tester is part of the network, production testing will be more accurate and efficient. Meanwhile back at her workstation, the project leader is updating the project status so that she can issue timely status reports to management. And the rest of the team is busily at work on a new project.

Engineering productivity shortened each stage of the described development cycle. The engineering team had general-purpose tools to help them with all the non-design tasks that formerly took up a large portion of their time. And, they had the specific tools needed to make precious design time more effective. This is the type of integrated design environment made possible by the newest generation of workstations. And, it should be the ultimate goal of any technology-based company concerned with making the most of their engineering talent and resources while advancing their product line.

4404 Artificial Intelligence System for AI Development and Delivery

The 4404 Artificial Intelligence System provides a complete exploratory programming environment that includes a powerful microprocessor, mass storage, a sophisticated user interface and optional networking capability.

With the introduction of the 4404 Artificial Intelligence System, Tektronix has established a new tier of AI support. Formerly, the performance and processing power requirements of inherently complex AI languages and applications relegated AI work to large mainframe computers or multiuser workstations. The 4404 is the first personal system designed for AI research and development. Priced under $15,000, it's also an affordable system for delivering AI-based software products to end users.

AI Research

Put simply, AI research involves designing machines that solve problems like people do – by searching for solutions in a maze of possibilities. AI researchers are concerned with problems such as how to acquire knowledge from people and nature, and how to represent it in a machine.

The 4404 was designed to support research and development activities in AI application areas including:

- *Expert Systems Development* – the replication of human problem-solving capabilities in particular fields. Medical diagnosis, mineral exploration and electronics design are a few of the fields presently emphasized.
- *Natural Language Processing* – enabling humans to communicate with computers in everyday language.
- *Intelligent Robotics* – the creation of robots that perform complex real-world tasks and react to changing environments.
- *Vision Systems Development* – providing computers with image processing and pattern recognition capabilities.
- *Theorem Proving* – researching high level symbolic mathematics.
- *Automatic Programming* – the use of AI-based software to write other computer programs.

AI Languages

Languages preferred by AI researchers include LISP, a language developed in the 1950s at the Massachusetts Institute of Technology, and Prolog, a language popularized in Europe in the 1970s. Each language was designed as a software development tool and each has strengths in different application areas. LISP facilitates the manipulation of large, complex lists and symbolic expressions. Prolog is an elegant tool for solving problems that involve a set of facts and logical rules defining their interrelationships.

Smalltalk-80*, a language developed at Xerox Corporation's Palo Alto Research Center (PARC), has also gained acceptance as an AI development language. One of the first languages to offer a graphical user interface, Smalltalk-80 supports the use of icons, overlapping windows and pop-up menus. The language is well suited to exploratory AI programming because it allows complex data structures to be defined progressively. An overall framework can be built based upon symbolic descriptions of objects, deferring the testing and definition of individual elements within the framework until later.

The 4404 supports all three popular AI languages, allowing users to adopt the language most appropriate to each project. An optimized version of the Smalltalk-80 Language is offered with the system, and Franz LISP and Prolog languages are available as options. Tektronix proprietary Smalltalk-80 implementation achieves execution speeds that are twice as fast as any other AI system available for under $100,000.

Programming Environment

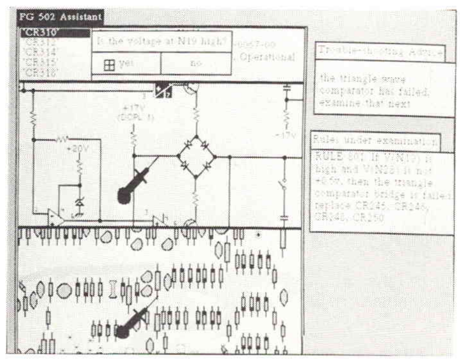
A complete exploratory programming environment is provided by the 4404 AI system including 32-bit processing power, mass storage, bit-mapped graphics, a mouse/menu-driven user interface and networking capabilities.

The 4404's Motorola 68010 processor operates at 10 MHz with no wait states. A hardware accelerator supports floating point operations. User memory is 1 Mbyte of RAM, expandable to 2 Mbytes. Page-on-demand memory management provides a large, 8-Mbyte virtual memory address space which permits development of complex programs without segmentation or overlays. The mass storage system consists of a 40-Mbyte hard disk, plus a single 5 1/4-inch floppy disk. A second 40-Mbyte hard disk with a streaming tape drive is optional.

Compact and quiet, the 4404 features a 13-inch monochrome display operating at 60 Hz noninterlaced. The 640-by-480 pixel display acts as a window into the 1024-by-1024 display address space, with smooth panning over the entire display. A mouse pointing device is part of the 4404's highly interactive user interface.

The system comes with a Centronics-style parallel interface, an RS-232 interface ,and a Small Computer Standard Interface (SCSI) for connection to host computers, hard copy devices and other peripherals. An ANSI X3.64 compatible emulator allows immediate access to existing computers. Networking capability is available through an optional Ethernet interface.

*Smalltalk-80 is a trademark of Xerox Corporation.



Electronics troubleshooting applications are well suited to expert systems development. AI programs such as the one represented here help quickly locate potential design flaws.

Each member of the 4120 Series is driven by an Intel 80286/80287 processor set and features a display with Dynamic Convergence; firmware with embedded commands for segment editing, segment subroutines and pick operations; a user interactive keyboard; and 4110 Series compatibility.

4120 Series – All Paths Lead to Greater 2D/3D Performance

Even the most foresighted manager often can't predict what the computer graphics needs of a company or department will be just a few years down the road. Recognizing this, Tektronix strives to offer its customers a logical upward migration path that protects their original equipment investment.

The recently introduced 4120 Series Color Graphics Workstations are a prime example of this commitment. The series offers varying degrees of 2D, 3D wireframe and 3D shaded surface capabilities. Each of the three configurations in the series can be purchased directly or can be gradually configured by installing one or a combination of available field kits:

- The 4115F55/4115F56 Field Kits provide 4115B Computer Graphics Terminals with the faster, more powerful 2D capabilities of the 4125 Color Graphics Workstation.
- The 4115F58 Field Kit equips either the 4115B or 4125 with the wireframe capabilities of the 4128 Color Graphics Workstation.
- The 4100F59 Field Kit can be installed on 4128 Workstations and units with the 4115F58 upgrade to achieve the surface shading capabilities of the 4129 Workstation.

In each case, the customer pays approximately a 15 percent premium for expanding workstation performance as the need arises.

Performance Features

An 80286/80287 processor set drives each member of the 4120 Series – including all field kit installations. The coprocessors provide sufficient local power for sophisticated graphics programs and enable host communications at rates of up to 38.4K baud.

4120 Series firmware incorporates commands for segment editing, segment subroutines and pick operations. Defined segments may be altered in whole or part by deleting unwanted portions, inserting additional graphics or replacing other information completely. This eliminates the redundant technique of totally erasing then recreating entire segments and offers a more natural and efficient method of editing.

Segment subroutine commands allow a segment to be referenced as part of another segment. This capability is particularly useful for local storage of pictures with many repeated elements such as integrated circuit design, schematic capture and mapping. Instead of repeatedly describing each object, the drawing may be built from primitive shapes which themselves are constructed of primitive elements. This conserves editing time and memory.

The graphic input function reports complete segment and segment subroutine information from within the pick aperture to the host. The viewport in which the cursor currently resides may also be reported. These pick operations supplement the 4120 Series ability to report the full tree of subroutine references, if desired.

Up to 64 scrollable dialog areas can be displayed simultaneously, providing valuable new capabilities for host window management. The user can edit one text file while referring to others on the screen at the same time. Since each dialog area has its own text buffer, it may be positioned to overlap others. And even though a dialog area may be partially obscured as a result, it may still be scrolled.

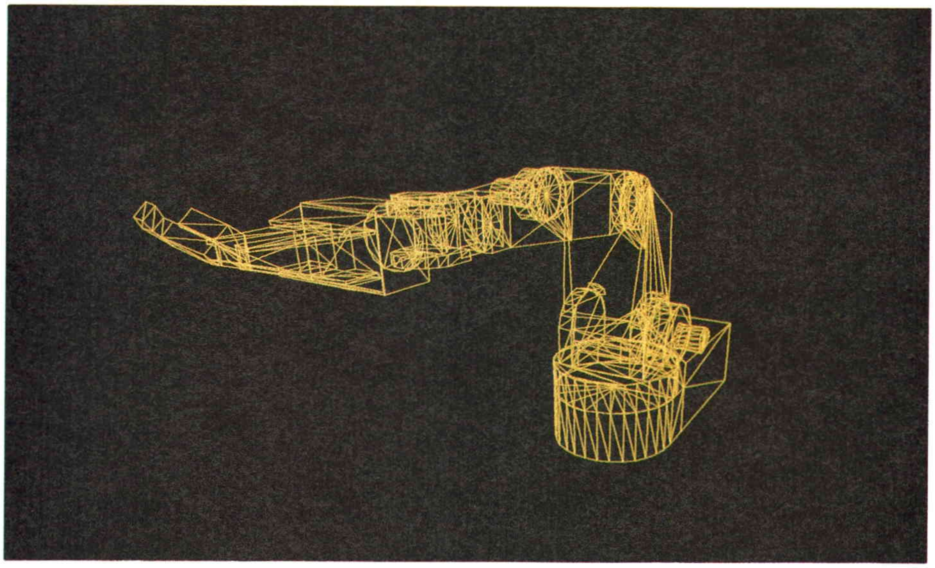
Pop-up menus are also supported. Small areas of screen text and graphics can be stored in local memory and then redisplayed as required. This transient information may be brought on and off the screen at the touch of a key without disturbing the main graphics under development.

Another valuable command allows circular arcs to be specified by only three points. These arcs are automatically drawn as a series of vectors with the benefit of saving host computation and communication time. Granularity may also be specified, making the arcs as coarse or smooth as the application warrants.

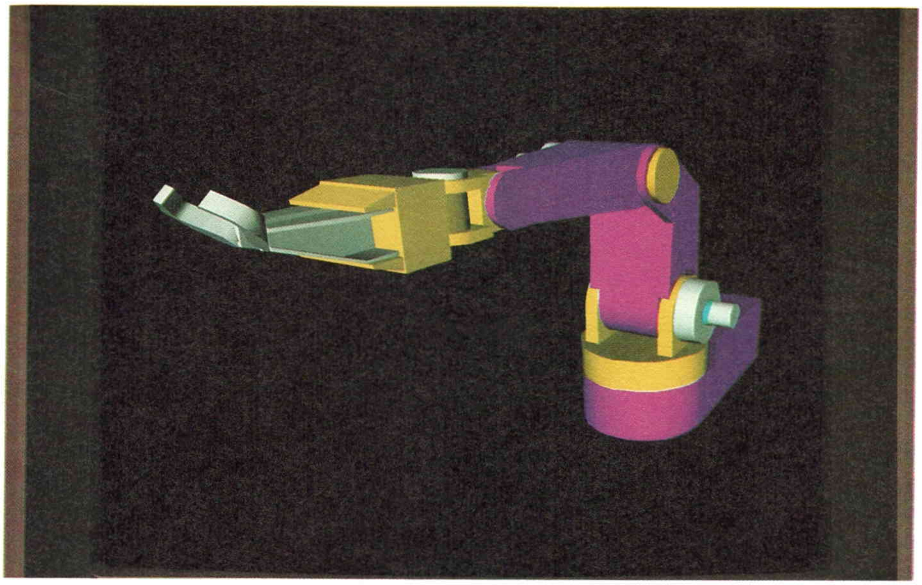
The 4125 provides two bit planes in the frame buffer for simultaneous display of four colors from a palette of 16 million. The 4128 offers 4 bit planes and the standard 4129 is equipped with 8 bit planes. All 4120 Series Workstations provide a standard 288K of RAM, expandable to 800K.

The 4120 Series keyboard includes a numeric keypad and ports for a joystick and mouse. Thumbwheels are provided for graphic input, and eight function keys are available for user programming.

All 4120 Series displays feature a precision in-line gun, 1280×1024 resolution and a 60 Hz non-interlaced refresh rate. Dynamic Convergence Correction, a feature that automatically adjusts convergence as it scans, delivers a convergence accuracy of 0.3 mm over the entire display area. Tek's Autoconvergence delta gun CRT display is available as an option and delivers a convergence accuracy of 0.25 mm..



3D wireframe capability, a feature standard with 4128 and 4129 Workstations, includes the ability to perform 3D matrix transforms, parallel and perspective projections, 3D zoom/pan and depth clipping.



3D shaded surface performance includes the ability to remove hidden lines and surfaces, to generate translucency patterns, to section models and to simulate local lighting, as well as the ability to shade solid objects according to three different methods. Surface shading is a standard feature of the 4129 Workstation and can be achieved by other 4120 Series with the 4100F59 Field Kit installation.

3D Firmware Enhancements

Both the 4128 and 4129 have 3D wireframe capability built into their firmware and microcode. Users can mix 2D and 3D information on screen simultaneously and employ local zoom, pan and rotation for 3D objects. These two systems offer a 24-bit integer terminal space for 3D vectors and wireframe polygons. A 3D segment can be displayed and moved as a cursor.

Planar polygons, which represent the surface of 3D objects, are also included. With the DRAW-FACETS command, the user can execute a number of specialized object surfaces including triangle lists, quadrilateral lists and quadrilateral meshes. These compact data types save considerable time in segment creation and local segment data storage.

Also resident in system firmware of the 4128 and 4129 is the ability to perform local 3D segment matrix transforms, further reducing dependency on the host. Available 3D transforms include rotation, scaling, clipping and skewing. Text is oriented according to a fixed point on the object so that it always faces the user.

Two different 3D viewing methods are offered: Parallel projection is employed when image accuracy is required in the design process. Perspective projection displays 3D images in a more realistic fashion and is useful for orientation in 3D space. Users may freely choose between the two views with two keystrokes. Multiple views of either projection may also be displayed.

4128 and 4129 users can employ 3D zoom and pan to alter the view. These functions are all performed locally, increasing system response time and eliminating the need to interact with the host or alter host data. A rectangular window on the viewing plane is manipulated by keyboard thumbwheels. When the desired area is in the window, the VIEW key is pressed and the corresponding view is displayed. This gives design professionals a wealth of viewpoints for thorough exploration of a 3D object's details. 3D zoom and pan operates identically to 2D mode zoom and pan.

The 4128 and 4129 additionally provide user-selectable front and back clipping planes that define the viewing volume of a 3D object. By removing extraneous clutter, this function reduces the complexity of a 3D object when zooming in on a particular area. In doing so, it also provides a depth cue for 3D orientation.

Surface Shading

In addition to all the features contained in the 4128, the Tek 4129 includes hardware enhancements for 3D shaded surfaces. The engineering designer is provided with all the necessary tools for local shading, hidden line or surface removal and the manipulation of surface-image 3D objects.

A 3D surface model may be stored locally in the 4129's display list. This model can then be used to produce either hidden line or hidden surface images. The 4129 has the ability to remove hidden lines from a wireframe rendition of a surface model and remove hidden surfaces from a shaded rendition of a surface model. Either wireframe or shaded surface modes may be selected by the user.

Also provided with the Tek 4129 is a set of 16 predefined translucency patterns with varying degrees of density. By selecting the most appropriate pattern or patterns for the application, users can display see-through 3D surfaces that ease identification of the surfaces or objects behind them.

A 3D shaded object may be sliced with two "cuts" or sectioning planes of user defined proportions. This allows the design professional to view an interior cross-section of the remaining object for a better understanding of its dimensionality.

The 4129 offers three different methods of surface shading:

- Constant Shading allows a single, user-selected intensity value to be assigned to all the vertices of a polygon. This is useful for shading a 3D object when a totally even color across the surface of the object is desired.
- Cosine Shading is similar in effect to constant shading, but with the same surface normal specified for all vertices of a polygon. The system computes the resulting intensity at each vertex, employing user-specified surface reflectivities and the local lighting model.
- Gouraud Shading, or linear intensity interpolation, generates a smooth transition of colors across a polygon. The user may assign different multiple intensities or normals to different vertices on the panel plane or facet. This greatly enhances the shading effect.

In each case, the colors used to shade a surface are defined in a contiguous set of color map indices that represent a range of intensities. Sections of the color map may be reserved to depict different surfaces so that they may be easily discerned.

By employing a dithering technique, up to 4096 colors can be perceived. This larger palette helps to eliminate "banding" when small intensity ranges of the color map are employed and provides a more evenly shaded surface. The dithering technique may also be combined with half-toning for an even smoother appearance and faster image display.

The 4129 also provides a lighting model that supplies local control over different lighting parameters for 3D views. Users can specify ambient light intensity as well as source intensity and direction for up to sixteen sources of white light. Objects are illuminated by these light sources from an infinite distance with user-selectable intensity. Assorted light sources may be active in any given view and other ambient intensities may be specified for different views.

Applications and Compatibility

The 3D capabilities of the 4128 and 4129 will find extensive use in the mechanical CAD environment, for such tasks as design, structural analysis, finite element modeling and interference modeling for piping layout. The shading capabilities of the 4129 make it well suited for cartography applications. The 4125 meets 2D design engineering needs in both electrical and mechanical environments.

All three workstations are compatible with Tektronix' 4100 Series products and the recently introduced Tektronix 6000 Family of Intelligent Graphics Workstations. Color hardcopy can be obtained with Tektronix 4691, 4692 and 4695 Color Graphics Copiers. The 4120 Series also supports Tektronix Computer-Aided Drafting (TekniCAD) software. Other graphics software packages will be available through the company's Solution Vendor Program.

Perceiving the Third Dimension

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A childhood favorite, the View-Master® Viewer is a 3D viewing system available since 1938. Tektronix now also offers its customers 3D viewing. However, in Tektronix computer graphics products, 3D is a powerful tool that helps scientists, engineers, and other professionals abstract the essentials of their disciplines from the clutter of reality.

With 3D computer graphics tools, users can manipulate abstract information to do things impossible in the real world – to get inside a machine part, to explore the outside of a tunnel deep under a river, to ride down the "streets" of an etched circuit board.

In essence, computer graphics are used to apply form and logic to the concepts that make a thing work – the bearing members in buildings, the connect lists in computer-aided engineering, the presence of oil shale along a fault. Computer-generated 3D images are not intended, in most cases, to be realistic in the sense that View-Master attempts realism in their images.

View-Master's almost palpable shapes wrap-around the observer leaving no doubt as to depth and form. The images are exaggerated, more surreal than real. That's what the customer wants when enjoying 3D views of Niagra Falls, the Grand Canyon or their favorite celebrity. That's what View-Master gives them by spacing two cameras six feet apart when filming their subjects. In this way, they exaggerate the cues by which the brain perceives depth. Computer graphics exaggerate too, in the sense that they abstract certain elements from a mass of data.

3D Perception

Human processing-systems are complete with "software" designed for viewing and interpreting spatial relationships. View-Master built a business on one of these, a powerful system called stereopsis. Stereopsis is a perceptual system based on triangulation; it uses the slightly disparate images created by the binocular parallax of two eyes spaced inches apart.

Leonardo Da Vinci recognized and analyzed this phenomenon. In 1838, Charles Wheatstone built the stereoscope to investigate it. Other 3D viewing devices followed. No Victorian-era parlor was complete without a stereopticon to view the pyramids or other World Wonders. View-Master, today, is a 20th-century application of centuries of scientific investigations. Computer graphics also share in this heritage.

Perceptual Cues

In a world where everyone had one eye like Cyclops, View-Master would not exist. Computer-generated 3D could – since it is mostly monocular. Images are done on a single, almost flat display. With the right cues on that surface, the viewer will perceive three-dimensional spatial relationships. And with carefully managed exaggeration, images can have the "feel" of depth as well as the "information" of depth.

Among the many monocular cues we rely on when interpreting 3D spatial relationships are two that involve motion: *head motion* and *object motion.* Head motion is a difficult cue to use in computer graphics, but it's easily demonstrated by moving your head to the left or right while walking a few steps. Those objects that shift the most in your field of vision are those closest to you. If your head were stationary, the object moving fastest across your field of vision would probably be nearest. Motion-based cues are often mixed with other monocular cues to increase the accuracy of a viewer's spatial perceptions.

Relative size is a static monocular cue first employed by painters during the Renaissance. If two squares of different sizes are presented on a flat surface, the viewer will usually assume the squares are equally sized and, therefore, the "smaller" is further away. Even when the objects are irregular or differ from each other fundamentally, observers, in the absence of other cues, will still "place" the larger in front.

Another static monocular cue is *familiar size.* Known coins, for example, will be "seen" in a depth field according to their familiar size. A silver dollar displayed as the equal of a dime in size will be seen, almost certainly, as the farthest away.

Interposition is the cue provided when an object hides part of another object. The object fully in view is "in front" by interposition.

Linear perspective, a cue provided by converging or diverging lines, conveys the concept of distance with little ambiguity. For eons, man and his primate ancestors rarely saw a straight line. Today – in a world filled with buildings, streets, railroad tracks and overhead power lines – our minds readily process linear cues.

The effects of *angle of regard,* another static cue, are felt when looking at the horizon. Objects "below" distant objects appear "nearer." The nearer they are, the sharper the angle down. A similar effect is perceived as objects "above" a distant reference point increase their angle of regard by moving toward the viewer.

Relative size, familiar size, linear perspective, interposition, and angle of regard are cues achievable with simple graphics systems such as a drafting board. The cues of *contrast, clarity* and *brightness* are more difficult to create. The natural interpretation of these cues is that sharper, more distinct objects are "nearer" and that duller objects are "more distant." These aspects cannot be created with ordinary drafting tools nor with ordinary computer graphics.

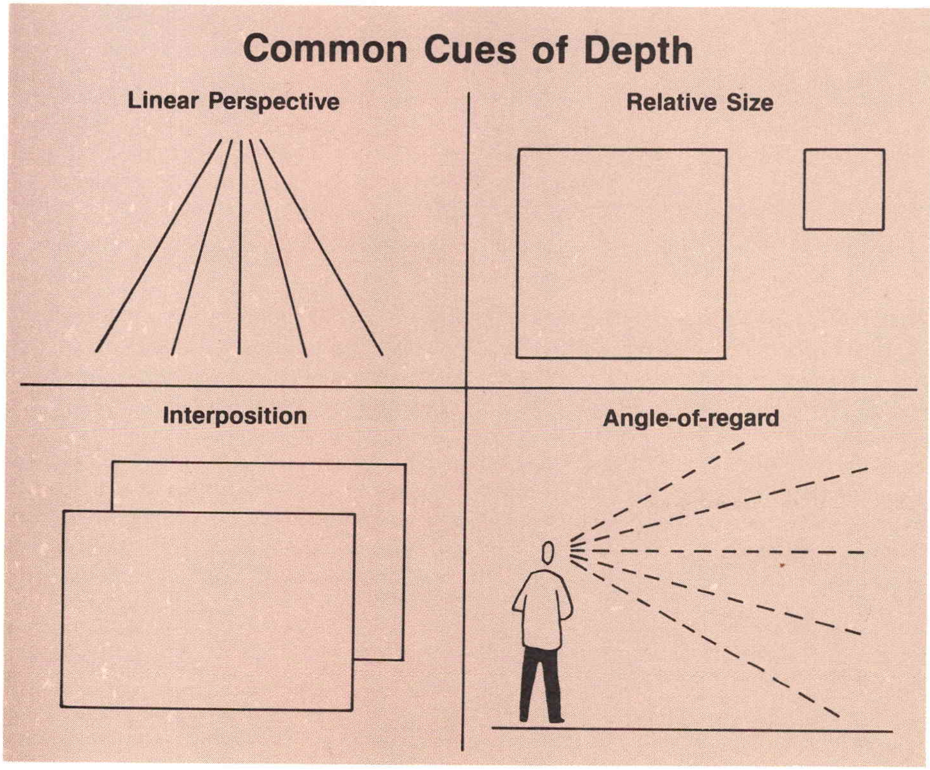
Light and *shade* are among the more sophisticated cues as to depth. For example, the position of a light source in relation to the image gives observers clear information about distances, spatial relationships and details such as contours. But if the light's location is misunderstood by observers, their perceptions of contours can be the reverse of reality.

Texture gradient is the cue that causes the texture of a detailed surface to appear less distinct as the distance to that surface increases. A regular surface, such as a brick wall, enhances this perception.

3D Computer Graphics

Perceptual physicists and mathematicians, software and hardware engineers, and human factors specialists have studied human perceptual cues and have applied their findings to the creation of 3D computer graphics. Though essential to the advancement of computer graphics, their efforts are as invisible to most users as View-Master's twin cameras are to those of us who enjoy gazing through the viewers.

*Viewmaster is a registered trademark of View-Master, Inc.



PLOT 10 TekniCAP— Software for Presentation Graphics

As competition for an audience's attention increases, so should the emphasis on effective presentation. This is true whether the presentation involves a production team suggesting a quality improvement idea to management, an engineer explaining a new product development plan to support personnel, or a corporate officer outlining next year's budget to the board of directors.

Clarity, conciseness, flair – they all play a part in the layout of an effective technical or business presentation. With PLOT 10 TekniCAP Computer-Aided Presentation Software, these components can be incorporated into your communications with ease. The raster-oriented software package automates the creation and production of color presentation graphics. TekniCAP provides tools to enhance presentations with graphs in a variety of styles, with type in a variety of fonts and sizes, and with free-form illustrations in shapes, sizes and colors selected by the user.

The TekniCAP system configuration may include a range of devices including Tektronix 4107, 4109 and 4115B Computer Display Terminals, as well as the recently introduced 4120 Series of Color Graphics Workstations. Paper or film transparency copies of TekniCAP images can be generated by Tektronix 4691, 4692 and 4695 Color Graphics Copiers. With an RGB camera, 35mm slides can be produced from 4109, 4115 and 4125 displays.

With interaction directed by a series of menus and prompts, using TekniCAP requires no memorization of complex commands or procedures. Graphic information is input using a joydisk, keyboard cursor keys, thumbwheels or an optional graphics tablet. Graphic decision-making is simplified through a series of system-wide defaults. So, for example, users don't need to be concerned with deciding appropriate proportions or type sizes. TekniCAP automatically makes such decisions through its template-driven facilities, such as the GRAPH module and *formatted text.* When users require a unique layout, they use the free-form portion of the package, such as the DRAW module and *free-form type.*

TekniCAP is organized into modules which can be used in any order or combination:

Type

The TekniCAP TYPE module provides the capability to annotate graphs, to label charts or diagrams and to create text-only graphics, such as a list of bulleted items. TYPE consists of three submodules: *font set selection, free-form type,* and *formatted text.*

Font set selection, enables the user to select from sets of fonts specifically designed for TekniCAP.

Free-form type is a facility for creating and placing individual lines of type. Options are provided to select type size, color, justification (left, right or center) as well as letter and line spacing.

The *formatted text* portion of the TYPE module allows for the efficient creation of bullet lists, tables and titles for presentations. Using a built-in text editor, copy for formatted text images can be entered and edited.

Data

The DATA module provides a convenient interface for entering and managing the data on which a graph is based. The DATA screen displays 7 columns and 21 rows at any time from a possible 250 columns and 9,999 rows. (The total number of possible entries is a function of the number of active columns and rows.) Data can be entered directly from the keyboard or read in from an ASCII file.

Arithmetic functions are provided for column-to-column calculations, with the number of decimal positions set by the user. Graph titles and subtitles and general annotation such as date, author, and data source are defined using the DATA module. If additional annotation is required, the user can easily place more text on a graph using free-form type.

After data has been entered and edited, columns are "activated" or selected in any order for graphing. The sequence of column selection determines the position of the represented information on the resulting graph. For example, sequence selection provides control over which variable is displayed on the bottom, middle or top of a stacked bar graph.

Graph

Using the information provided in the DATA module, the GRAPH module creates pie, bar or line graphs from a template selected by the user. The GRAPH menu offers a choice of pie graphs, vertical or horizontal bar graphs, and band graphs, that is, line graphs with the area filled between the curve and the X-axis. Selections are also included for combination bar and line graphs.

A single key stroke generates a graph, making it easy to view a number of alternative presentations before making a final selection.

Draw

The DRAW module contains facilities for defining and placing a variety of graphic elements. Users have full control over the size, orientation and color of each element. They also specify line width and figure type, determining whether the circle, box or other figure will be displayed as outlined, open or solid.

T-square alignments and user-sized grids can be activated for precise positioning of drawing elements. Or, users can interactively move elements anywhere on the display screen until just the right placement is found.

DRAW contains a graphic backspace function for altering or deleting elements already placed in a picture. Also, object manipulation functions allow a set of elements to be treated as a single entity, or object. For example, once defined as an object, a commonly used item, such as a logo, can be scaled, moved or rotated as one unit.

Color

Sixteen palettes have been predefined to maximize the use of color. These palettes provide a well balanced set of color combinations, optimized for use on TekniCAP displays and output devices. If a certain color combination is not provided by TekniCAP, the color user-interface allows the construction of a palette to suit individual requirements.

Edit

The EDIT module is for altering images after creation. Since TekniCAP images are constructed as display lists, each graphic element in a picture can be individually edited. Users pick the object to be edited and then can either delete or redefine the object itself. This includes merging it with other objects, changing its display priority (to put it behind another object, for example) or even giving it a new name.

View

The VIEW module is used to combine images created with various TekniCAP modules into a single picture. Using VIEW, different portions of the screen can be designated as "active areas," allowing output from the GRAPH module, for example, to be directed to one area and output from TYPE or DRAW to be directed to another. In this way, a supporting table of data or illustration can appear alongside a graph.

Input/Output

The INPUT/OUTPUT module is the file administration portion of TekniCAP, providing utilities to save and restore images and review them for a presentation. It also contains hardcopy options for use with all Tektronix color graphics copiers. Multiple copies, black-and-white reversal, image reductions and other settings are chosen in hardcopy I/O.

Exercising Options

To illustrate how TekniCAP modules interrelate and how the user interacts with the system, consider the sequence of graphs shown in Figures 1 through 4. As evident by the titles and annotation, each graph represents a trend in the number of service calls made by a corporate service group, and each is based on data from the same source. However, by varying the TekniCAP menu selection process slightly, each graph was made to emphasize a different aspect of the data.

For example, the simple bar graph shown in Figure 1 focuses attention on a change over time, that is, the decrease in the number of service calls from 1979 to 1984 for the eastern service region. Such a graph could be created in a minimal number of steps using three TekniCAP modules: DATA, GRAPH, and INPUT/OUTPUT.

From the main menu, the user would first select the DATA module, then enter data values for the chart and labeling information for the X and Y axes. The title, subtitle and underlying note would also be entered while in the DATA module. Next, the GRAPH module would be selected from the main menu, and the simple bar template would be selected from the GRAPH menu. The chart with legend and appropriate labeling would then be displayed.

In this case, type size, font and color can be automatically defined by the default set. Thus, the only step left would be to call the INPUT/OUTPUT module to store the chart in memory. The resulting file could then be output to a copier and presented to the eastern regional service manager as an indication of the region's downward trend in service calls.

If this corporation had five service regions, it's likely that the corporate service group would want to graph service call trends for each region. In this case, service data for each region would be entered in a different column of the DATA module's screen display, and individual graphs could be generated for each region simply by selecting the appropriate column.

Such a series of graphs would be useful when reporting service statistics to individual regional managers. However, if the planned audience included all of the regional service managers, the grouped bar graph shown in Figure 2 would be more effective. This graph allows service data from region to region to be compared at a glance, and requires just two changes to the described TekniCAP procedure: All five filled columns would be selected from the DATA module and the grouped bar template would be selected from the GRAPH menu.

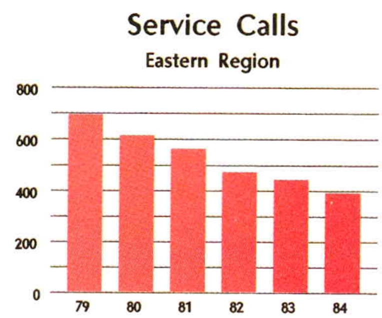


Figure 1. A simple bar graph is one of the most effective ways to represent a general trend, such as a change in quantity over time. Sufficient data to create a chart such as this would be entered in one column of the DATA module.

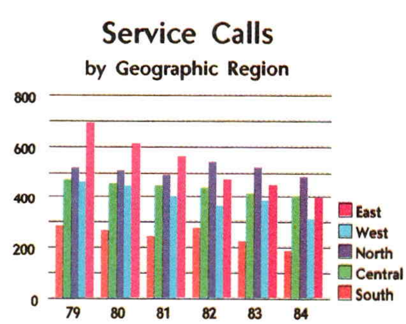


Figure 2. A grouped bar graph such as this makes it easy to compare several sets of related facts. In this case, each set of bars represents a change in quantity over time. Data for each region is entered in a different column of the DATA module display and is represented by a different color bar set on the resulting chart.

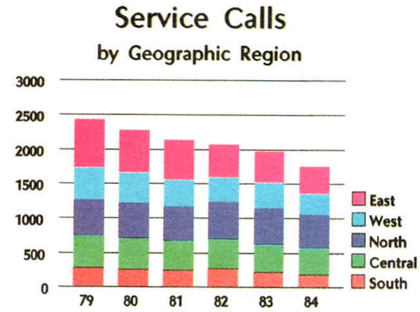


Figure 3. A stacked bar graph effectively represents a breakdown of values within a total amount. A set of stacked bars such as this represents how a set of total amounts relate to each other. As with the grouped bar graph, data for each region is entered in a different column of the DATA module display and is plotted in a different color on the resulting graph.

Figure 4. A presentation visual may include graph output from the GRAPH module, a bulleted list and extra free-form type from the TYPE module, and a special-purpose illustration from the DRAW module. Output from each TekniCAP module is directed to the appropriate area of the display using the VIEW module.

Suppose that the corporate service manager had to present the same service data at a meeting to overview corporate operations, that is to discuss engineering, manufacturing and sales, as well as service operations. In this case, the total national reduction in service calls from year to year would be of greater interest than individual regional trends. As shown in Figure 3, a stacked bar graph effectively represents the total number of service calls for each year, while still offering a geographic breakdown of the data.

Again, generating this chart requires only a slight alteration of the TekniCAP procedure – the stacked bar template would be selected from the GRAPH menu, rather than the simple or grouped bar templates. TekniCAP would automatically adjust the Y-axis values to reflect the larger total values.

Output Options

To take the scenario one step further, suppose that at the corporate operations meeting, several sales mangers were so impressed by the graph and its implications that they request a copy for inclusion in customer presentations. However, suppose also that they request a few adjustments to make the graph a more valuable sales tool: To emphasize the significance of the chart, they want the factors that contribute to and result from effective service planning to be outlined in text. Also, in keeping with corporate guidelines for sales support materials, they want a logo to be included in the same frame.

To create the resulting presentation visual, shown in Figure 4, TekniCAP modules were combined as follows:

- Using the formatted text portion of the TYPE module, the bulleted list of service quality factors was entered. The heading "Effective Service Planning" was entered and positioned using the free-form type portion of the same module.
- Using the VIEW module two active screen areas were defined: one area designated for output from the GRAPH module, the other reserved for output from the TYPE module. The upper-left VIEW area was then filled with the stacked bar graph, and the lower-right VIEW area was filled with the text description.
- Using the DRAW module a company logo was created and positioned on the screen. Once specified, a logo such as this can be saved for insertion in any presentation graphic.

This is only one of many examples of the use of TekniCAP. The tool can be applied to the creation of much more complex or imaginative graphics. The software is designed for free movement within the program, encouraging users to experiment with various ways to respresent data and to enhance and edit a displayed image until they are satisfied with the result. In this way, TekniCAP enables users to create support graphics that effectively and professionally convey their message.

The Automation of Presentation Graphics

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Presentation graphics and speaker support graphics are interchangeable terms describing images that amplify or clarify the communication of facts, statistics, plans, ideas or other abstract information. Graphs, organization diagrams, maps and simple illustrations are typical presentation graphics. Typographic images such as bullet lists, title frames, tables and other alphanumeric information often also fall into this category.

The format of a presentation differs from one setting to another. Sometimes, an 8 1/2-by-11 inch black-and-white illustration stapled to a report will suffice, and other times color is required. When making a presentation to a group of people, images are often projected from 35 mm color slides or overhead projector transparencies.

Traditional Production

Until recent years the creation of such graphics required a minimum of two people or corporate departments: the speaker - or presenter - and a graphic artist - or producer. The presenter controlled ideas, information and subject matter; the producer translated the speaker's information into well-executed, effective visuals.

The presenter couldn't make the graphics, because he or she was not artistically trained and had insufficient knowledge of graphics tools and materials. The producer, on the other hand, relied on the presenter for access to information and conceptual materials. Personnel trained in graphics translated that which was heard or stated into that which was seen, as they worked with presenters.

Any task depending on human communication and cooperation includes possibility for misunderstanding. Sometimes a presenter cannot state what is required clearly or is not familiar with production technicalities. Sometimes a producer makes errors due to lack of familiarity with the subject matter of the presentation.

In addition to communication difficulties, the production of presentation graphics in a traditional setting has other constraints. Turnaround time is long; material is passed between two departments for review and checking, and there are many steps necessary to produce a final image.

A graph, for example, requires availability of data first; then perhaps some manipulation of the data. After that, it might be useful to see it plotted several ways to choose the most advantageous representation. When the design is established, typesetting can be ordered; then the drawing can be inked and the type pasted up. It's a good idea to review after all these steps, because photography follows, and the cost of altering an image after this phase increases significantly.

Computer-Aided Presentations

Creation of even the simplest hand-made presentation graphics can get expensive, time-consuming and frustrating. Because of that, many people have enthusiastically embraced digital graphic production.

When computers are applied to a manual task, we refer to applications automation or applications software. Tektronix' PLOT 10 TekniCAP is an applications program in that it facilitates the application of digital devices to the design and production of presentation graphics. TekniCAP encompasses tasks that were formerly divided between presenters and producers. As a person becomes familiar with TekniCAP he or she will be able to control the content and look of presentation materials from start to finish.

Visual Experimentation

In graphics, it can truly be said that, "What looks right is right." There is no test for excellence beyond appearance - and this test is seldom passed with the first picture. Knowing this, artists start to visualize by making thumbnail sketches - small, rough drawings used for quick capture of visual concepts. When a solution is revealed through trial and error, thumbnails are discarded and the picture is executed in final form.

TekniCAP was designed with this process in mind - drawing and revising until the correct solution appears on the screen. Making digital thumbnails demands responsive software with sensible user options.

Good Design Is No Secret

Some people assume that the basis for color, placement, sizing and other design decisions is mysteriously wrapped up in the world of art and aesthetics. They are surprised when they learn that graphic judgment is based on the findings of vision research, mechanical constraints and physical reality; that there are guidelines for sizing type (not to be smaller than 1 degree of the visual field) and specifying color (do not use pure blue for small type), and that readability is the primary goal of typography (a combination of upper and lower case characters is easier to read than all upper case).

Good graphic judgment was the basis for TekniCAP. By examining the discipline, mechanics and activities of traditional presentation graphics first and applying automation to that task second, Tektronix has taken full advantage of digital technology in bringing together tasks faced by both presenter and producer of visual communication materials.

DaTek Database Manager—A Team Player

Today's computer workstations offer the intelligence and power to locally manage sophisticated scientific and engineering applications programs. However, the advantages of this level of computing independence are diminished if workstation users can't freely share their tools and information. For this reason, each member of Tektronix' 6000 Family of Intelligent Graphics Workstations support a Local Area Network (LAN) interface that facilitates the transfer of files between workstations and to and from host computers. This network link is even stronger when the LAN interface is coupled with DaTek, the 6000 Family relational database management system. As a common information resource for all workstation users, DaTek promotes efficient personal data management and team data sharing.

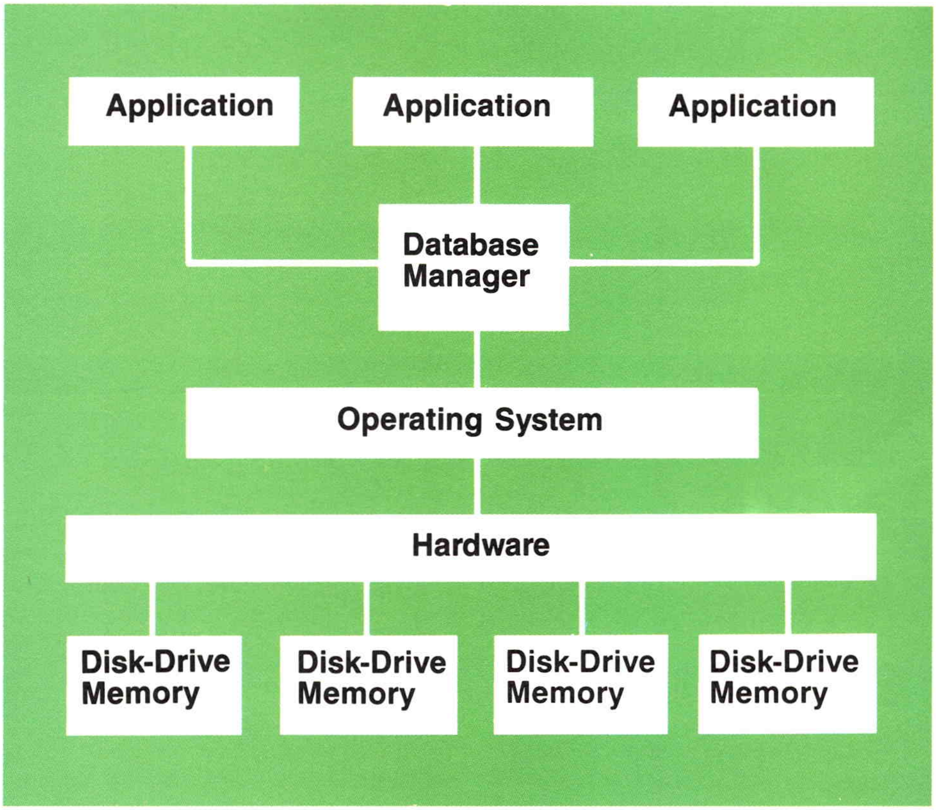


Figure 1. Position of database management system within system architecture.

Database Perspective

Prior to the advent of database management systems, application programs written to access database information always contained a portion of code devoted to data management functions such as creating files, searching files, sorting files, providing screen displays and generating reports. The advantages of a single program that performed these common functions for a group of applications programs were soon obvious (Figure 1). Database software developers were proposing database management models as early as the late 1950s.

The first model to be implemented in a commercial software product, the "hierarchical" model, was designed for use on IBM mainframe computers. As its name implies, the hierarchical model organizes data into clearly defined ranks. Each rank subordinate to the one above it.

Navigating through a hierarchical database to access any desired data record is limited to following one branching path. In other words, you can't more directly from record to record if a relationship between the two was not defined when the data was first entered. Also, the number of subordinate records that can be associated with any higher-order record is fixed, and relationships established when the data was first entered cannot be changed without reentering all the information.

Due to the hierarchical model's inherent drawbacks, a more flexible alternative was soon introduced – the network database. Also called the "Schema" system, this model quickly gained popularity and was formalized by the CODASYL (Conference on Data System Languages) Standard in the late 1960s. The network model resembles the hierarchical structure, except that any number of relationships can be established between data records. Though this structure is less restrictive, it can become very complex, making database updates and other "housekeeping" chores difficult. The complexity is especially inhibiting to database users less familiar with computer architecture. Also, like the hierarchical model, relationships defined within a network database cannot be changed without reentering all the data.

A third model, the relational database, was suggested by E.F. Codd of IBM in 1970. Put simply, the model organizes all data into elemental values contained in two-dimensional tables. All queries are answered by generating additional tables through logical comparison of existing tables. The tables are called "relations," hence, the term "relational database." Relational Database Management Systems (RDBMS) are favored today because they offer the following advantages:

- Data is stored in its most basic form, thus it's accessible at any higher-level.
- Redundant records are unnecessary because all data is accessible from any location.
- Universal changes are possible without restructuring the database or reentering significant amounts of data.
- The simple two-dimensional structure invites quick searches and comparisons.
- All computers accessing the database are able to exchange data with each other as well as with host mainframes.
- There are no machine-dependent pointers and other structures integral to the data representation, only tables.

From the user's standpoint, information is simply easier to obtain and more reliable when stored in a relational database. DaTek is based upon the relational database model because these qualities are paramount to engineering workstation users.

Using DaTek

Though an understanding of various database models is valuable when evaluating database management systems, DaTek frees users from any concern about database structures or storage practices. Data management is simply a matter of performing one or more of the following steps:

- Create a database file by entering data interactively or loading a UTek operating system file.
- Modify the file, if necessary.
- Query the database for related information, if desired.
- Generate a report based upon the database file or files.

Even maintenance tasks such as updating database files and reorganizing the database are easily accommodated by DaTek. Its simple tabular structure reduces the duplication of data stored on-line and the duplication of effort that would be required if data were stored and maintained by individual application programs. When a change is made to a database file, every application program in the network has access to the updated file.

Also, because database files exist apart from any specific application, flexibility and data independence are built-in. The data can be put to new uses, information can be added, and files can be viewed in ways that weren't originally anticipated. For example, existing tables can be joined together to create a new table, in effect linking together information from several sources by tracing a common connection.

SQL Queries

Several data management tools incorporated within the DaTek structure (Figure 2) make

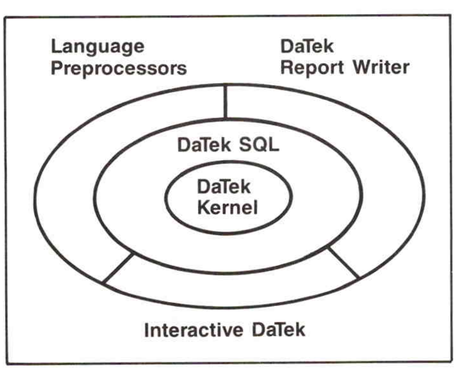


Figure 2. Data can be accessed interactively or through application programs written in languages recognized by DaTek's language preprocessors C, FORTRAN, ANSI BASIC and Pascal. DaTek's Report Writer also provides access to data by generating custom reports based upon information selected by the user.

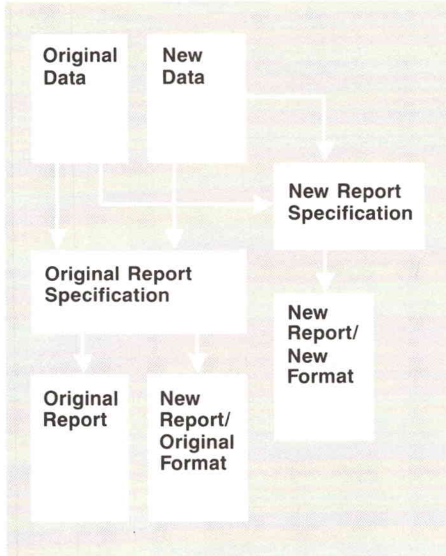


Figure 3. The Report Writer provides multiple ways to edit a report.

it easy to access and manipulate database files. Among these tools is SQL, a query language originally developed by IBM specifically for accessing relational databases. Using interactive SQL commands, workstation users can request database information without writing computer code.

For example, to retrieve information from a database file that contains the results of electronic circuit test data, the following query might be issued:

```
select time, max(voltage) from circuits.table
  where transistor1=A and transistor2=B
```

Based on this request, DaTak would return the time when the highest voltage reading occurred between transistors A and B.

In addition to interactive access, information in the database can also be accessed via command files or through an application program. With DaTek's language preprocessors, DaTek/SQL commands can be embedded in any of the workstation's four languages - C, FORTRAN 77, ANSI BASIC and Pascal. And, due to the populatiry of the SQL query language, programs that incorporate SQL commands are highly portable.

Report Writer

To extend the usefulness of database information, DaTek also features a built-in report writer. Reports based upon data from one or more database tables can be output in a format selected by the user. Page dimensions are adjustable, and data can be grouped and positioned on the page as desired.

As shown in Figure 3, reports can be modified in either of two ways: the user can edit the specification that defines the report format; or the contained data can be edited.

In either case, any updates can be submitted and a new report run without reentering unchanged data. Output from the report writer can also be included in a file created with other 6000 Family software tools.

DaTek's output formats are flexible, varying with the type of data represented. For example, dollars and commas can be included in financial numeric quantities, and formats for both American and international dating conventions (day, month, year) are available.

Workstation-to-Mainframe Compatibility

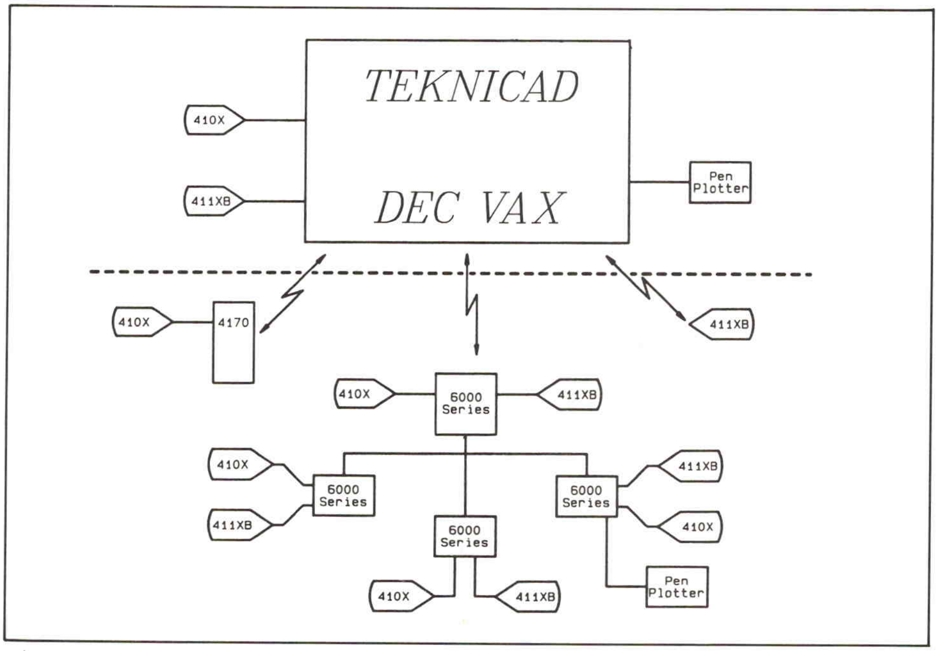
To enhance compatibility, the database manager provides such mainframe features as:

- Transaction management, including commands for initiating and terminating transactions, roll-backs, and save points.
- Relational data structures, including base tables, views, indexes, and built-in functions for statistics and arithmetic.
- Data dictionary with system tables, including user authorizations and column definitions.
- Security management with database administration functions including authorization tables, privileges, and resource control.
- Back up and recovery for data protection.

For further interfacing flexibility, database information can be converted to its ASCII representation for exchange with other computers and even with other database management systems. Thus, in addition to its flexible structure and efficient data management tools, DaTek offers engineering workstation users access to a greater pool of information, providing them with a powerful system for information sharing.

DaTek is available with the 6130, 6205, 6210 and 6212 Intelligent Graphics Workstations. It can be purchased separately or as part of a set of productivity packages designed for use with 6000 Family display systems.

TekniCAD Now Available to 6000 Family and VAX/VMS Users



TekniCAD now supports three operating environments: Tektronix 4110 Series Locally Programmable Terminals and 6000 Family Intelligent Graphics Workstations and DEC VMS-based VAX 11/750 and 11/780 systems. TekniCAD can be used to generate technical drawings in any one of the supported environments, and TekniCAD drawing files can be exchanged within a network that combines the various environments.

PLOT 10 TekniCAD Computer-Aided Drafting Software, Version 7, extends support for the computer-aided drafting package beyond Tektronix 4110 locally programmable terminals to include Tektronix 6000 Family Intelligent Graphics Workstations and Digital Equipment Corporation VAX/VMS operating environments. Now engineers, scientists, technical illustrators and drafting personnel have a selection of three programming environments with access to PLOT 10 TekniCAD dynamic graphics and text manipulation capabilities.

A single copy of TekniCAD resident on a host VAX computer can be shared by many users performing graphics functions locally on terminals or workstations. In this shared-image mode, TekniCAD software operates at one-third to one-fourth the CPU capacity of many larger drafting systems. In addition to conserving CPU power, TekniCAD/VAX drafting systems offer sharable files and peripherals, fast processing speeds and ample storage capacity for large, complex drawings.

Designed to ease the creation of accurate, detailed technical drawings, PLOT 10 TekniCAD automates common geometric drawing and dimensioning functions without requiring extensive computer experience. The software accesses powerful hardware features such as local zoom and pan, and offers multiple plotter drivers and an IGES interface to other CAD systems.

The following Version 7 features significantly increase PLOT 10 TekniCAD functionality:

- **Section Analysis** functions calculate the area, perimeter and center of gravity for enclosed shapes. Volume and surface area can also be calculated for rotations about the X and Y axes centered on a user-selected point.
- A **Region Stretch** feature simplifies moving, stretching or compressing enclosed objects or regions. When the position or size of a region is adjusted, all attached lines can be automatically shortened or lengthened to accommodate the change. This feature eases such tasks as relocating or resizing shafts, walls, and other constant-shape objects.
- A **Dynamic Copy/Move** feature will scale, rotate or mirror an object or group of objects when changing their position or frequency within a drawing. A full-scale image of the object or objects is displayed during the move or copy operation, so that the user is always aware of any overlap or alignment problems.
- **Control Keys and Macro Coding** capabilities allow experienced users to program "shortcuts" through TekniCAD menus, offering quick access to commonly used drafting functions. Programmed macros can automatically step through a menu sequence, supplying predefined responses to consecutive prompts. A macro can cause program control to branch to any TekniCAD function or can suspend execution until a response or series of responses is provided by the user.
- A **Construction Line** technique permits the creation of customized grids for "snap-to" positioning – the automatic movement of the cursor to the intersection of any two construction lines. This feature is especially valuable in the construction of orthographic (three-view) layouts or other drawings with irregular spacing between object lines.
- **Multiple Arrowhead** styles have been added improving TekniCAD's ability to adapt to different drafting conventions. Arrowheads may appear as open or filled circles, triangles and squares. Or a slash may be used in place of an arrowhead. Also, double-ended arrowheads can be created in one operation.

Support for two new plotters is available with TekniCAD, Version 7.1. The Nicolet Zeta Model 822 and Houston Instruments DMP-41 have been added to the register of supported devices which already includes Tektronix, Benson, CalComp and Hewlett-Packard plotters. This range offers TekniCAD users a wide selection of plotters in terms of both price and performance.

TekniCAD's increased functionality is available in all three supported operating environments – the 4110 Local Programmability Series, the 6000 Family of Intelligent Graphics Workstations, and VMS-based VAX environments. TekniCAD files can be freely transferred from one supported environment to another, providing new flexibility in allocating computer resources.

CX4100 Color Graphics Terminals offer IBM Compatibility

CX4106, CX4107 and CX4109 Computer Display Terminals offer direct coaxial connection to IBM 3270 controllers, giving IBM users access to the PLOT 10 graphics command set while retaining the IBM-style keyboard and alphanumeric capabilities.

The host compatibility of 4100 Series Computer Display Terminals now extends to IBM* environments with the introduction of the CX4100 Series. CX4100 terminals retain the full feature set of the original 4106, 4107 and 4109 Computer Display Terminals, while offering IBM 3270 plug compatibility.

Additionally they provide direct coaxial connection to an IBM 3274 cluster controller, as well as 32-line 3278/3279 alphanumeric emulation, an IBM-style keyboard, and an expanded range of drivers for Tektronix peripheral devices.

The new CX Series enables IBM host users to take advantage of Tektronix' PLOT 10 graphics command set while retaining IBM 3270 alphanumerics and a familiar IBM-style keyboard. PLOT 10 graphics are an alternative to IBM's 3279-style programmed symbol-cell graphics, the primary means of creating graphics in an IBM environment. Programmed symbol-cell graphics requires that the host transform all graphics to a set of special "symbol cells," then transform these cells into pictures and transmit the pictures to the terminal. This requires substantial host resources and produces lengthy data streams.

The CX Series, on the other hand, carries out a greater portion of the graphics task at the terminal. PLOT 10 graphics commands locally perform vector-to-raster conversions and rapid area fills, relieving the host CPU burden.

A wide range of software becomes available to IBM users when the CX4100 Series graphics I/O package is used. Software support includes Tektronix PLOT 10 Terminal Control System (TCS), SAS Institute's SAS/GRAPH* and ISSCO's DISSPLA* and TELL-A-GRAF*.

The series is fully compatible with existing application programs written for the 4100 Series terminals and is upwardly compatible with programs written for Tektronix 4110 Series terminals. The terminals retain their RS-232-C connection and can switch between IBM and RS-232 hosts without ending either session.

CX4100 Series terminals offer the same sophisticated graphics capabilities as the 4100 Series Computer Display Terminals. They feature a 60 Hz non-interlaced display with 4096×4096 addressability in a 640×480 matrix. Both solid and dashed lines can be drawn in up to 16 colors using eight line styles and 11 marker types. True zoom and pan are available along with user-defined fonts and macros, local picture storage, and transformation, scaling and rotation capabilities. The series also supports VT100 extensions and ANSI X3.64 editing and word processing standards.

Users can define up to 64 windows and create complex layered images using multiple bit-planes. Graphic input features, such as a joydisk, user-defined cursor, inking and rubberbanding, facilitate graphics input and manipulation.

In addition to the 3270 coaxial connection, the CX4100 Series terminals feature one host RS-232-C port, two peripheral RS-232-C ports and one Centronics-style parallel port. They support the Tektronix 4691, 4692 and 4695 Color Graphics Copiers, and the Tektronix 4510 Color Graphics Rasterizer.

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Copying to Scale on the 4691

Harvey Fleet and Peter Strong
Digital Cartography Section
Geographic Information Systems
National Park Service
Denver, Colorado

Most people think their 4691 Color Graphics Copiers are limited to 8½×11 inch output, or 11×17 inch output with rasterizing software or the 4510 Color Graphics Rasterizer. (The actual image size is about forty percent smaller.)

This limitation would seem to inhibit the production of scaled plots of mapped material with any but the smallest scale or geographic scope. However, using the local zoom capabilities of the 4115 Computer Display Terminal and a mosiacking technique it is possible to get an accurately scaled plot to any size.

The original of the plot shown in Figure 1 has a scale of 1:24,000 and is thirty inches wide by twenty-six inches high. The plot was generated by loading data into the 4115 and instructing the host to produce a series of window-setting macros (Figure 2).

These macros automatically define sixteen windows. When plotted by the 4691, each window produces an accurately scaled subsection of the original complete data set as stored in the 4115's segment memory. Simply by expanding the relevant macro (for example, 1002, or 3003) a full-screen image of that part of the whole data set is displayed.

Macros for output of any scale can be generated by the host software because the host stores the original digital map file indicating the known scale and magnitude of the data. The idea is to expand both the X- and Y-axes on the screen image so that, when plotted by the 4691, they will have the right size for a plot of a given scale.

For example, the distance from A to B on the full-screen copy of the plot shown in Figure 1 is 6.34 inches (Figure 3). Similarly, the distance from C to D is 4.54 inches. At a final scale of 1:24,000, these dimensions would have to be 28.13 inches and 20.10 inches, respectively.

These numbers can be determined by either carefully measuring a base map of the desired final scale, or calculating them from the known scale and magnitude of the data in the original data file. Setting up the following ratios:

$$\frac{6.34 \text{ in.}}{28.13 \text{ in.}} = \frac{X}{4095 \text{ screen units}}$$

and

$$\frac{4.54 \text{ in.}}{20.10 \text{ in.}} = \frac{Y}{3276 \text{ screen units}}$$

yields an X of 923 screen units and a Y of 740 screen units. (4095 and 3276 are the default window X and Y values for the 4115's screen.) Thus, the screen should be divided into separate windows 923 units wide by 740 units high. When zoomed to the full screen and copied on the 4691 each window image is output at a scale of 1:24,000. When carefully trimmed and assembled as a mosaic, the output images provide a full-size, properly scaled plot.

The same technique can be used with the 4107 and 4109 Computer Display Terminals and 4695 Color Copier. Only the ratios of screen size to plot size change.

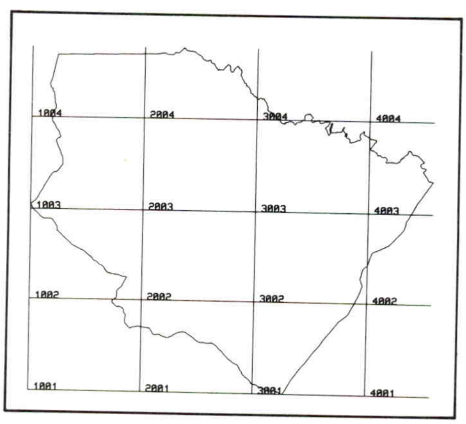


Figure 2. To produce the map shown in Figure 1, macros were defined to divide the 4115's display screen into 16 windows. Accurately scaled subsections of the original plot were then created by zooming in on individual windows.

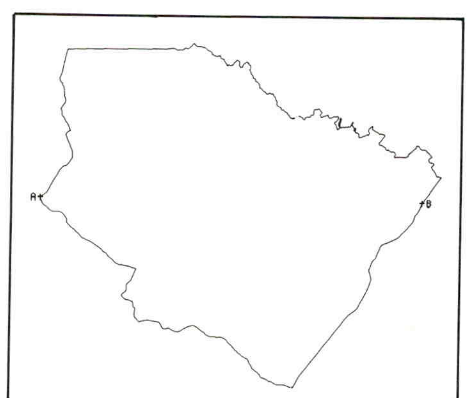
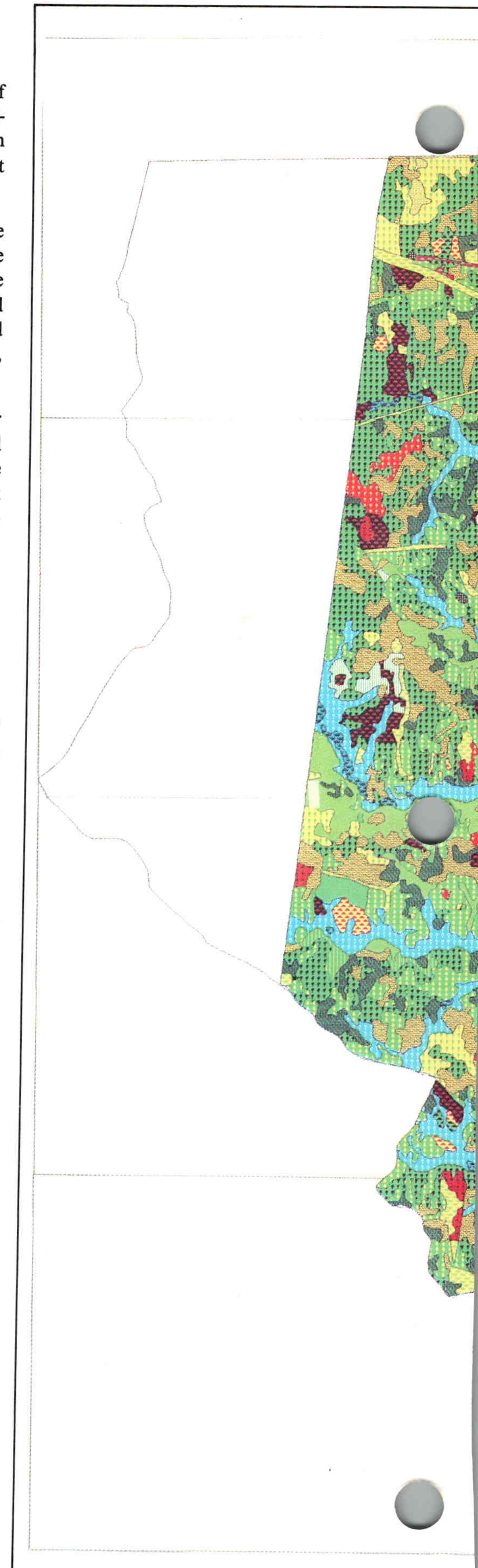


Figure 3. Measurement points were selected for calculating both X and Y scaling ratios to allow for rounding errors, integer conversion and slight irregularities in paper dimensions.



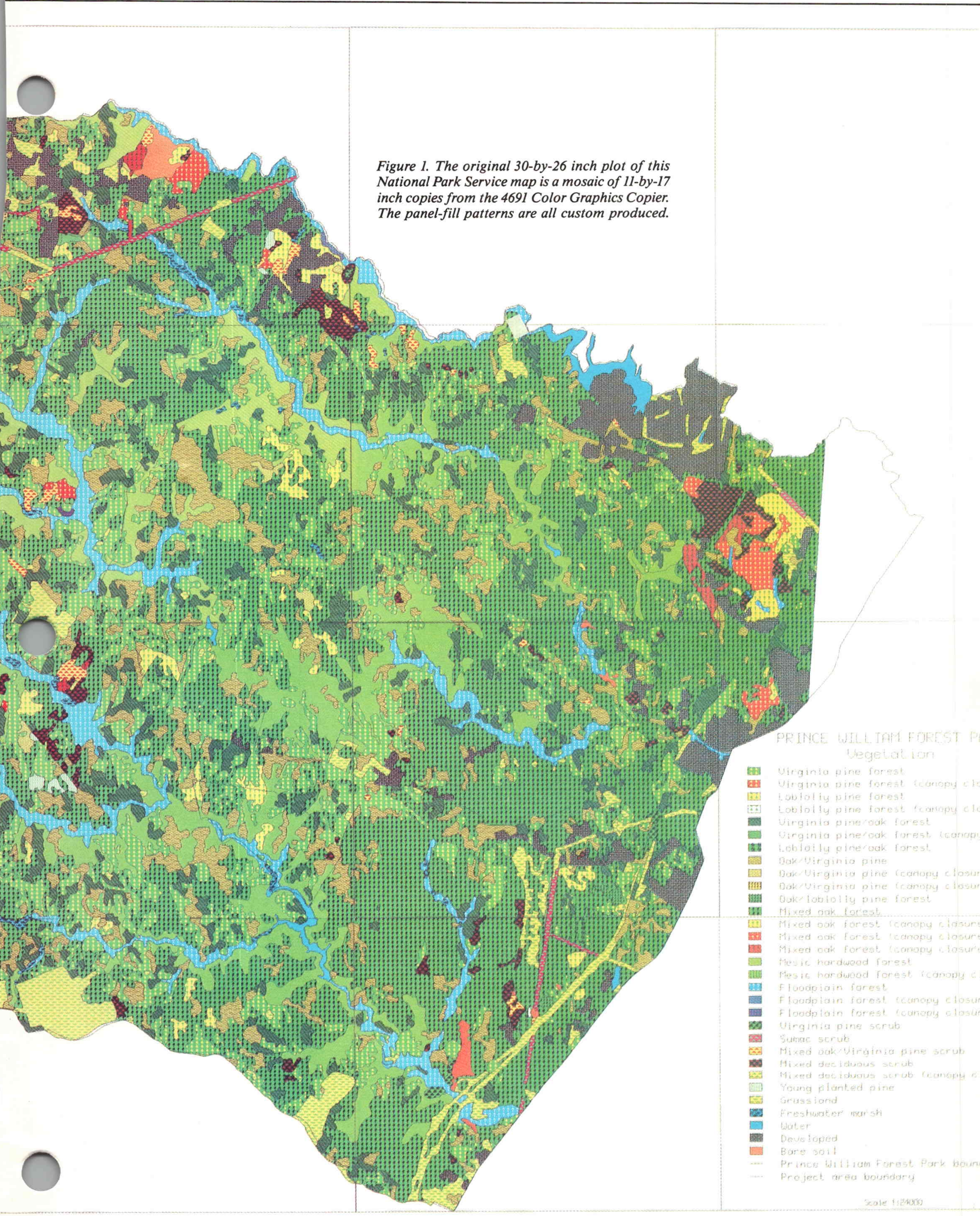


Figure 1. The original 30-by-26 inch plot of this National Park Service map is a mosaic of 11-by-17 inch copies from the 4691 Color Graphics Copier. The panel-fill patterns are all custom produced.

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