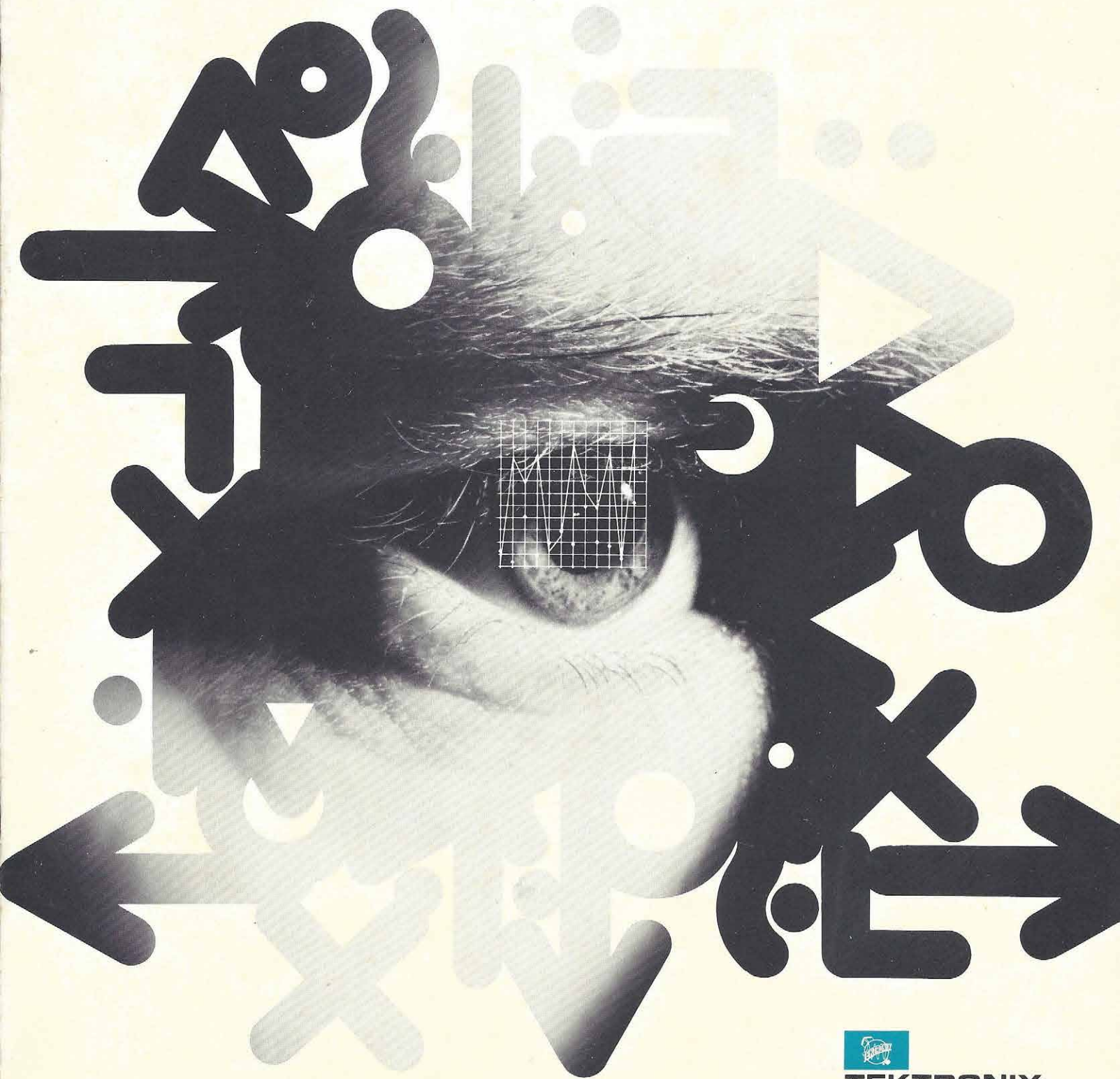


TEK GRAPHICS

FEBRUARY 73
NUMBER 4

INTRODUCING APL

Product news
and application
notes



On the following pages, we introduce to you a Tektronix innovation that means a lot more to us than just "business as usual." The launching of our 4013 APL computer display terminal has involved Tektronix in a juncture of computer language innovation and technical advance that may well prove historic.

Our specialists in marketing, engineering, software research, and manufacturing have devoted their best efforts to this task, and management has risked considerable monetary expenditure. The atmosphere around here might roughly be compared to the feelings of an electrician carefully wiring an operating room for tomorrow's heart transplant.

We're certain the results of our efforts are a computer display terminal—and software system—with problem-solving capability that will make APL indispensable to the computer-using community.

We sincerely believe that APL inevitably, and on its own merits, will become the language of choice in scientific, business and educational programming.

We are pleased to be able to offer advanced hardware and software to hasten implementation of the vast promise of APL.

Lawrence Mayhew
Manager, Information Display Products
Tektronix, Inc.

Tekgraphics

Tekgraphics is a quarterly publication of the Information Display Products Division of Tektronix, Inc.

In it you'll find the latest information on software development for graphic computer terminals, as well as customer applications of both software and hardware, which may suggest solutions to problems similar to yours. If an article does strike your interest and you want further information, please address your inquiry to Mr. Colin Barton, Advertising Supervisor, P. O. Box 500, Beaverton, Oregon 97005.

A RATHER OLD NEW LANGUAGE

Unlike a lot of fancy acronyms you may know, full of sound and fury and signifying little if anything, APL is easily deciphered. It stands for "A Programming Language," and derives from a book by the same name, written by one Kenneth E. Iverson in 1962. In its infancy, APL was developed as a means of concisely describing a plethora of computer languages to Harvard grad students. In the beginning, Iverson planned nothing so mundane as implementation of the language, even though it had the sweet scent of interpreter capabilities almost from the first.

Even two years after publication of the book, the only available application of APL was a complete formal description of IBM's system 360. Complete on three pages, it was a real tour de force, but hardly a tool for the masses.

Meanwhile, IBM nestled Iverson and co-worker Adin Falkoff into its Thomas J. Watson Research Center, and for almost a decade APL led a relatively sheltered existence.

In 1964, for an APL lecture, Iverson got IBM to come across with a remote terminal set-up for his APL keyboard. In 1966, an APL Terminal System was officially launched into the unsuspecting IBM-user's world, but not until 1968 was APL/360 released as a full terminal system, and IBM withheld Class A maintenance until 1971. Then, in 1972, Tektronix announced a storage CRT APL terminal, the 4013, that at last put APL's long-obvious graphic capabilities at the fingertips of the average user.

What has the careful, decade-long upbringing done for APL? To speak bluntly, in an age of bastardized languages, APL stands alone as the beamish boy of one father.

And what a well-mannered offspring it is. The internal consistency of its symbols, the unique simplicity of its right-to-left operational hierarchy, its unflinching acceptance of all arguments, whether scalar or vector—all are product of rigorous development, and they make APL a joy to use.

All power to the problem

It is no accident that APL's simplicity lends itself to problems of great complexity. Iverson's major intent was to give

the computer user a tool that would get him out of the garble of temperamental language and into the arena of problem-solving. The APL user can now input one of the powerful few-line programs for which APL is becoming famous, press the carriage return, and get the output he needs to carry on time-sharing (read: cost-sharing) now affords each user the time to think and interact, and APL allows efficient interaction by handling complex tasks quickly and simply.

The clash of symbols

Now a word for you who suspect that APL programs are written by advanced Egyptologists. The word is alphabet. Remember the good ole alphabet? It wasn't learned in a day but it sure has been handy. The APL symbols are designed to be learned as needed, and they might be even handier. Furthermore, the children of the Atlanta Public School System, who are using APL in their math lessons, might shame you remaining scoffers into giving APL symbols the old college try.

Twenty-six of them you already know; they're printed in slanted capitals. Other old friends are +, -, x and ÷, which can be either monadic or dyadic operators. For example, "-x" (with x the only operand) means "0-x," (monadic), while "y-x" means "x subtracted from y" (two operands, hence dyadic). Then there's the exponential operator *, for example "*3" (e³) or "10*3" (10³), and a few other algebraic operators.

Rolling along, we also have logical operators such as A

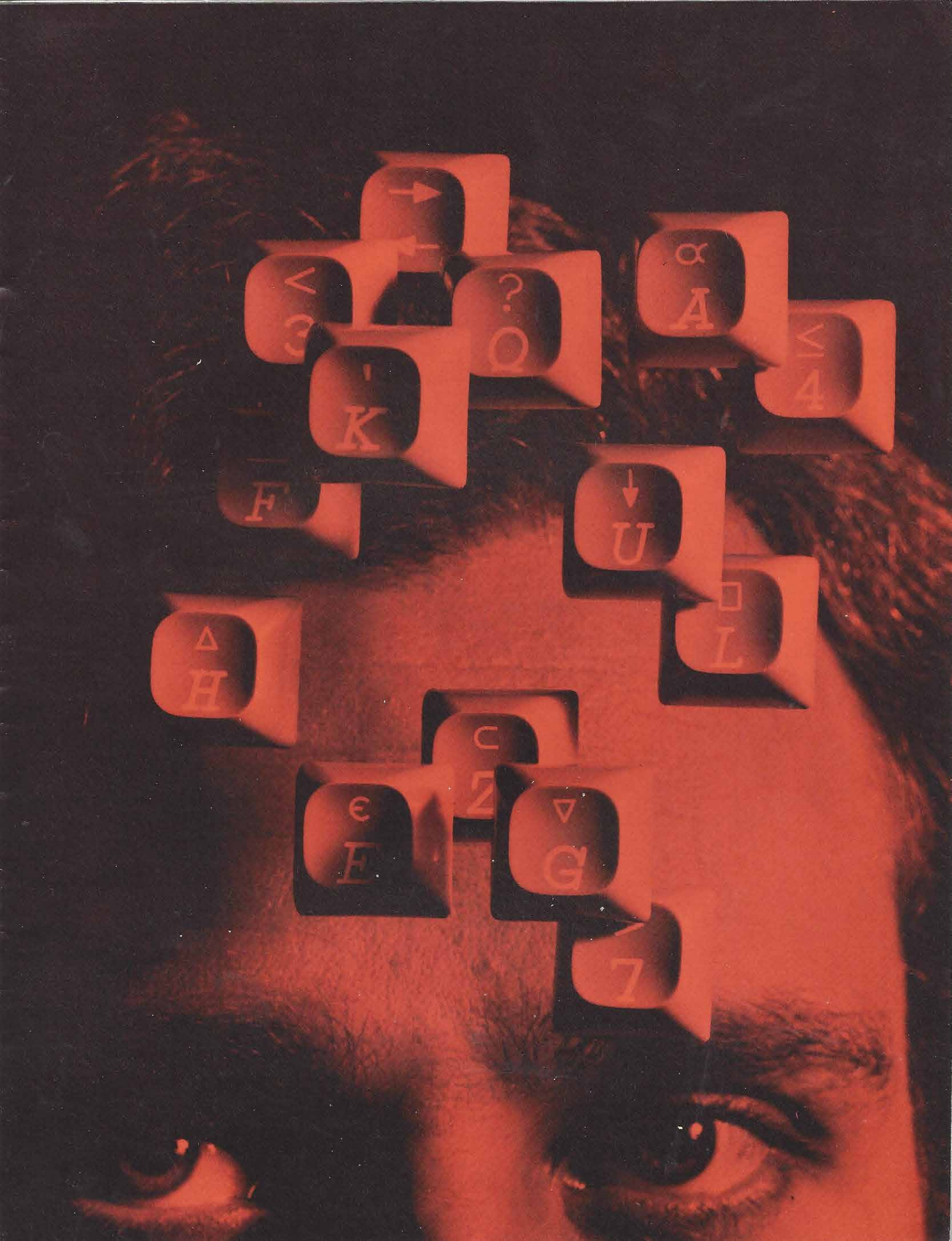
and V (the familiar "cap" and "cup"), relational operators (=, >, <)—which yield 1 if relationship typed is true, 0 if it's false—and a smattering of composite operators composed of one symbol overstruck another.

Fully twenty APL symbols are devoted to simplified handling of vectors and matrices—column and chart users, this means you. Rotation, inversion, transposition, reversal, minimizing, maximizing, and numerous others all are punch-one-key operations.

Defined operators use up about 55 symbols on the keyboard, leaving about 45 for the user to call his own. Any representation of input can be given a one-key label, so you can change the shape of numonics or literals with the punch of one operator and one label key.

Terminal APLitis

A disease common to programmers who have tried APL graphics the only way it should be tried—with their very own eyes and fingers at a Tektronix



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4013 Terminal. APL's exact symbology makes most operations so easy that the programmers can input almost as fast as the computer can output.

APL error statements have a reputation for intelligibility. And graphics make the man-computer interface really face to face. To quote Dr. Patrick E. Hagerty of the University of Maryland Computer Science Center, "Perhaps the most important feature of APL is that it relieves the problem solver from many of the details of programming, enabling him instead to concentrate on the problem itself. Computer graphics has much the same objectives, allowing data to be input and output in a form suited to the problem, rather than constrained by the limitations of the printed page. Thus, the marriage of these two problem-solving tools is especially fortuitous. I would expect other terminal manufacturers to follow Tektronix' lead when they realize the importance of this development."

Workspace: the 32k bite

Control information for a session-in-progress, as well as any program, function, or chunk of data, can be defined, labeled, and placed in a workspace in the central computer assigned to the terminal user. System commands are provided for loading, modifying or saving a workspace.

Back in the primitive days of '62, Iverson looked forward to increasing core storage capability, and the trend seen for the third generation and beyond is certainly bearing him out. Current feelings of workspace claustrophobia are mainly a state-of-the art concern for some, but by no means all, users who outgrow the usual 32 kilo-byte workspace.

While waiting for hardware technology to catch up, one does well to remember that APL is an interpretive language. Batch programming of massive data files is too big a bite off the APL workspace, although APL is valuable in designing algorithms for data handling that are then translated to a batch-oriented system.

Graphic APLications

A great many terminals have been able to produce typewriter graphics, by ingeniously (also laboriously and slowly) using typed symbols to simulate lines, curves and shapes. To those who have suffered through the noise and inadequacy of such systems, the quiet precision of APL graphics will come as a boundless relief.

The Tektronix 4013 gives you a 1024 by 780 raster unit screen on which to roam around. We really hate to spoil your fun or suggest limits by listing uses. But, to whet the appetite, here are a few:

. . . For science and engineering students, APL/GRAPH can take the tedium of point calculation and plotting out of prob-

lems and exams. (Scientists and engineers, take note.)

. . . Business administration and info management problems often translate readily into matrix operations. APL graphics can quickly manipulate arrays of sales figures, product cost factors, quarterly statistics—even individual ratings or vacation schedules can be APL/GRAPHed. Curves and projections can be programmed. And the results are easy-to-read visual displays, or instant hard copies fit for even a client's scrutiny.

. . . Maps, product drawings, plant layouts can be programmed with ease, and instantly sent to or retrieved from storage. And APL/GRAPH can enlarge, reduce, or rotate drawings at the punch of an operator.

. . . For purely mathematical applications, the simplicity of APL graphic commands knows no equal. When it comes to tackling impenetrable problems, graphically clear output saves a lot of mind-bending for the scientist and mathematician.

But these short descriptions can only sketch out the possibilities. It will take a session with a real live Tektronix 4013 to give you the big picture, and your own sense of the possible will fill in the details. And then—you'll just have to believe your own eyes.



APL SOFTWARE

Soft on APL

APL software has often been the object of attack in the computer profession, largely because its symbology tends to look martian and its programs can rapidly get pretty obscure. The detractors occasionally have valid arguments, but we APL softies think the proper target for their attacks should probably be the introductory and training materials for APL, rather than the programmed language itself.

Much like calculus, organic chemistry, or double entry accounting systems, APL can become an eloquent tool of communication. But it must first be learned well. Since training materials have been scarce until just recently, APL software has suffered some damage at the hands of programmers who were content to let form follow function—by about a country mile.

Get a taste

Furthermore, as most APL buffs will tell you, the only proper introduction to APL is at a terminal. APL manuals, like marriage manuals, can only do so much. When the novice experiences at his fingertips the amazing range of APL's talents, from the simple desk calculator mode to complex computational

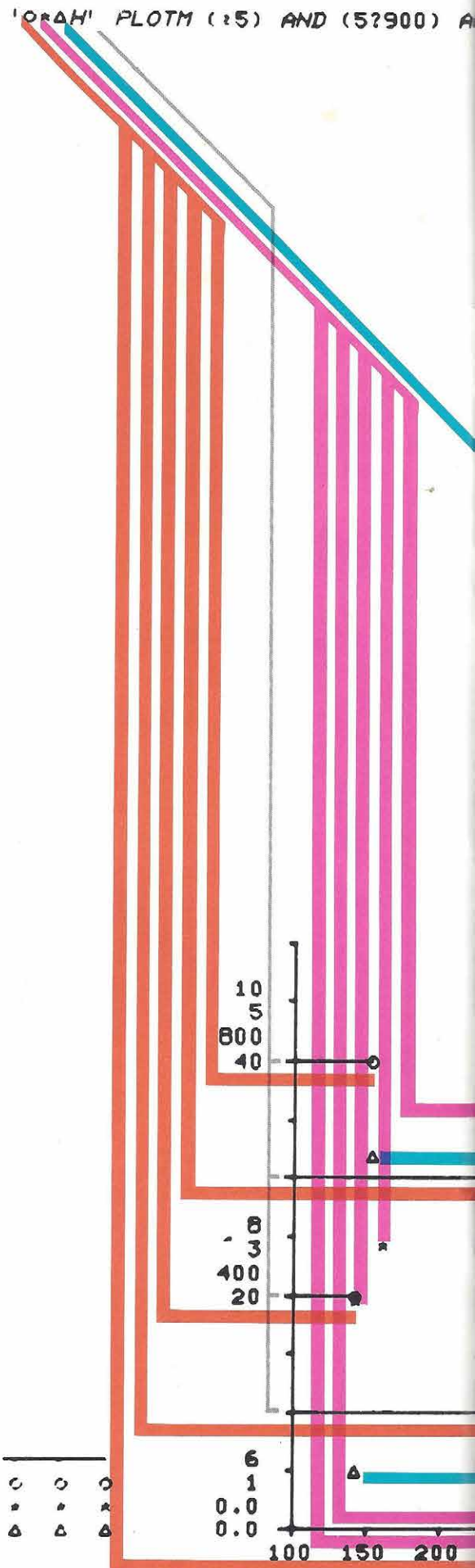
capability, he or she will find the very specificity of the language a real asset.

After spending only time enough to learn the symbols he initially needs, the user can actually begin programming a great many routines. The symbols will then come more naturally, as will the realization of a flexibility and ease of use that FORTRAN and BASIC programmers can only dream of.

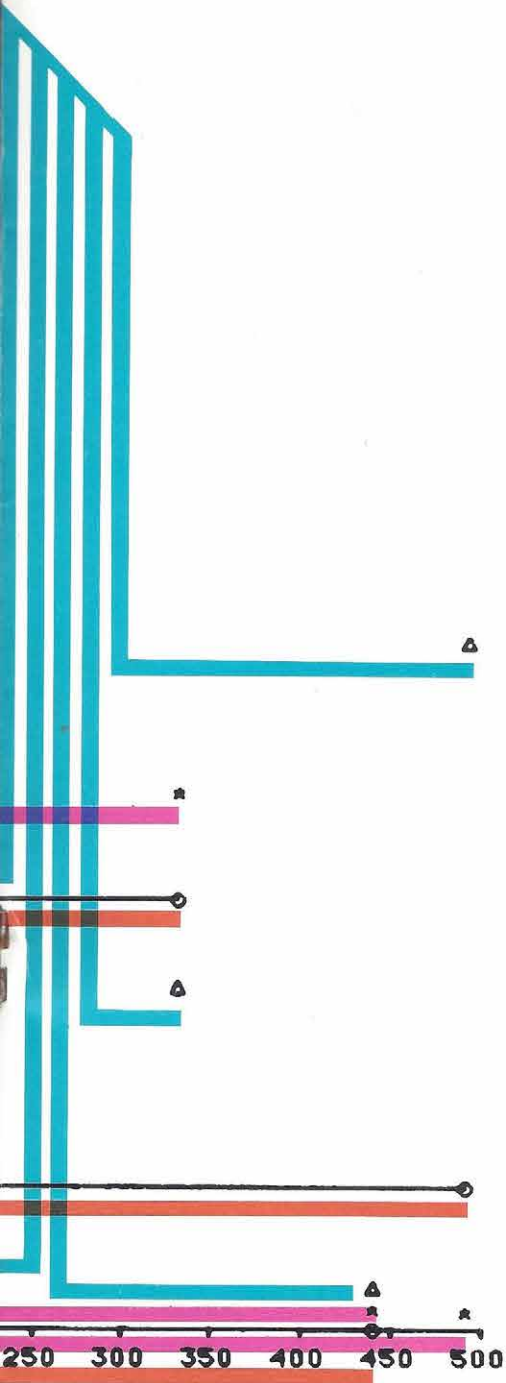
Enter APL/GRAPH

With the Tektronix 4013 Graphic Terminal, both of these qualities are maximized. To capitalize on the capabilities of the terminal, Tektronix has introduced an APL version of its PLOT-10 Terminal Control System, and Advanced Graphing software. Using these tools, the APL user can see the fruits of his labors almost instantly.

APL/GRAPH (pronounced "apple graph") is a series of functions in APL that can be easily moved from one APL system to another. It provides functions that let the user put a line on the terminal's screen merely by specifying (x, y) co-ordinates of its end points. Advanced Graphing functions do a complete graphing job on the user's data in his choice of co-ordinate systems, including polar, semi-log, log-log, and rectangular. The user starts by mapping off his territory. From the virtual (actual) display produced by a program, he can readily select part or all of the big picture. This area-of-interest, termed the "virtual window," can be rapidly manipulated to any given size, and placed on any part of the screen. Once this "screen window" has been designated in screen units, any scales and co-ordinates needed can be



D (5:50) AND (5+25) US (5:500)



specified in the user's data units (feet, meters, years, etc.) or in pure numbers. All this happens a lot faster than it takes to tell it.

The 4013 terminal screen is a 1024 x 780 raster unit surface on which the programmed picture is drawn. The user signals his hard working control functions to order up a screen window and these functions handle all the details of mapping the virtual window onto the screen window. Since window definitions can be changed at any time, composite displays can be quickly and easily arranged.

For our next act . . .

The functions available in APL/GRAPH let the user draw with nearly the speed of thought on both the virtual display and the screen window. Function MOVEA, for instance, gets you to a beginning point for your graphics, by drawing a "dark," or invisible, vector to a specified point. POINTA gets you to a point in the same way, but it marks the spot with a point. DRAWA connects specified points with lines to form a closed figure, while the Plots functions draw various kinds of graphs from (x, y)-specified points.

Using these facilities, the user is relieved of such pesky details as control codes, clipping, and data scaling.

A full family of graphing routines is provided in the Advanced Graphing Functions package. They make it almost embarrassingly easy for the APL user to see his data in graph form on the screen, without

worrying about details like axes, scales, or labels. Function PLOTS, for example, accepts a vector of (x, y) values, performs an analysis of the data, scales it, draws axes, labels them, and then creates a line drawing, point plot, or bar graph of the data. PLOTD performs the same function, but includes several curves on the same graph. PLOTM extends the user's ability a little further, by displaying two curves with different Y axes on the same X axis. Your friends will be amazed.

Come and get it

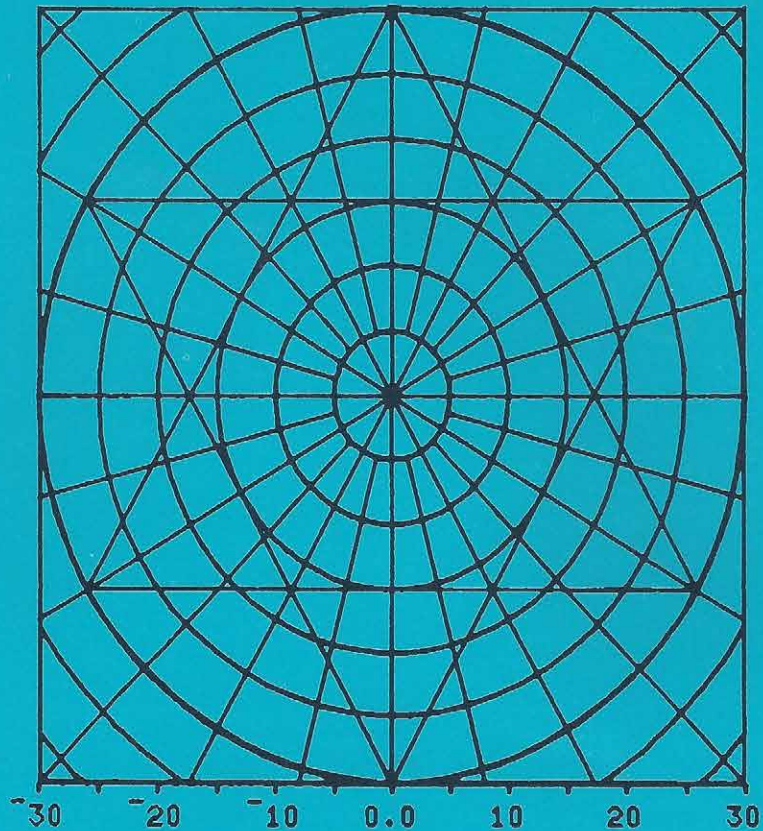
APL/GRAPH is supplied as a series of APL functions, easily installed on in-house APL systems. It is also available on several commercial time-sharing APL services. For users of the IBM Program Product, Tektronix will provide APL/GRAPH on a distribution tape complete with the changes necessary to adapt the OS or DOS version of APL to ASCII terminals.

Tektronix has recognized a need within the APL community for a graphic terminal backed up by the software to support it. The 4013 and the APL/GRAPH software package comprise our response to this need. They represent such a step forward for the APL user, that we think your response to our response may very well be the key that unlocks APL for widespread use.

This example plots four independent variables against a single dependent variable using APL's formatting flexibility.

TO BE BRIEF ...

These test routines compare two programs drawing the same graph. Brand X, the FORTRAN version, is considerably larger. While the new improved APL interpreter knocks it out in seven simple lines.



APL Program

```
▽ TEST04 Z
[1] INITA Z
[2] 1 15 UNWINDOW ''
[3] 'L' PLOTD(30 USO(1+4×z4)+6)
    AND(30 USO(3+4×z4)+6) AND ''
[4] 'L' GRAFS 30 USO(1+z101)+50
[5] GRID
[6] HOME
▽
```

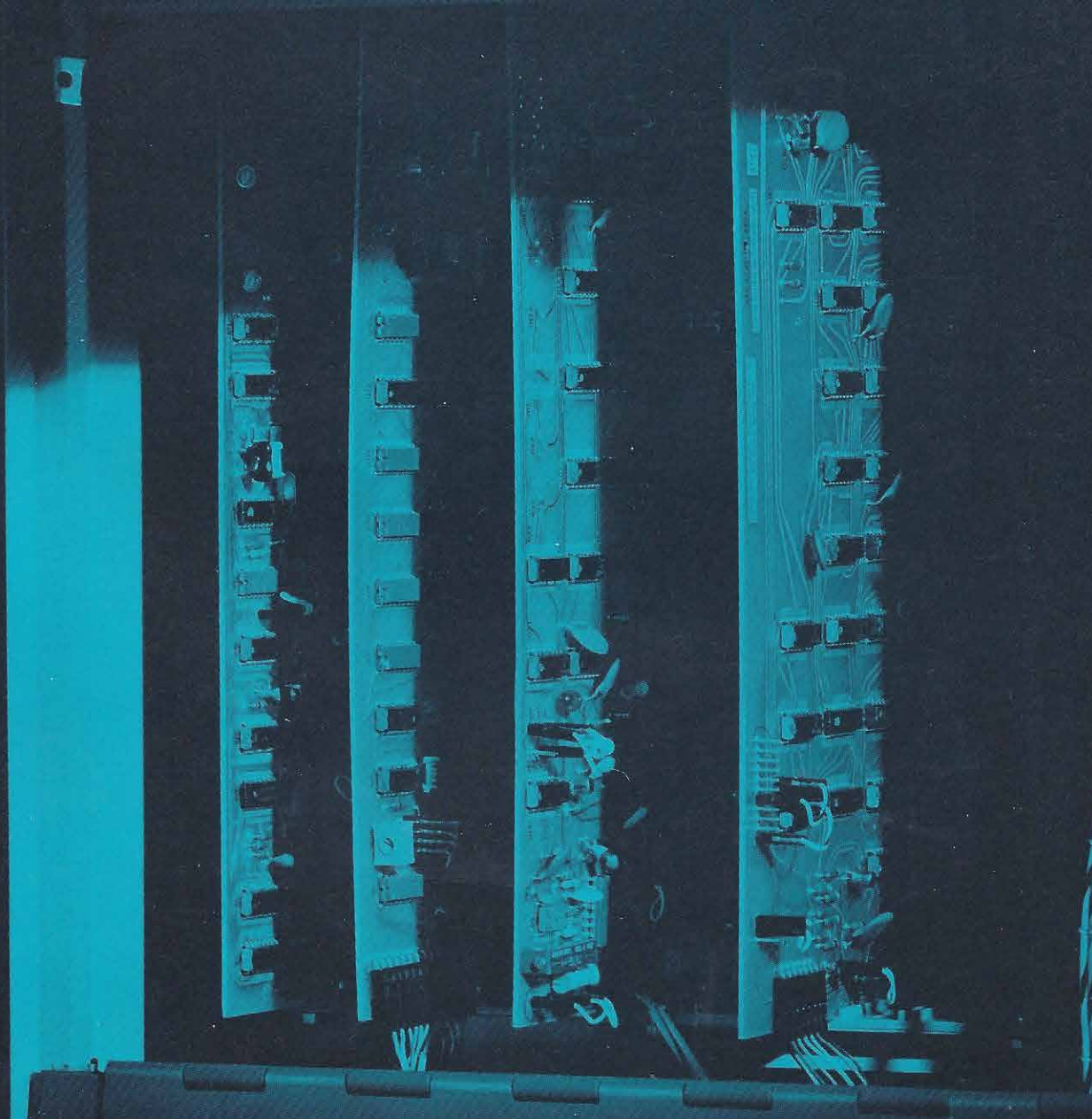
FORTRAN Program

```
DIMENSION A(109), R(109), N(3), ISYM(3)
DATA N/4, 4, 101/
DATA ISYM /'L', 'L', 'L'/
DATA R /109*30/
PI=3.14159265
PI23=(2./3.)*PI
A(1)=0
A(5)=PI23/2.
DO 2 I=2,4
2 A(I)=A(I-1)+PI23
DO 3 I=6,8
3 A(I)=A(I-1)+PI23
PI234=PI23/4.
DO 4 I=1,8
4 A(I)-A(I)+PI234.
PI50=PI/50.
A(9)=0.
DO 5 I=10,108
5 A(I)=A(I-1)+PI50
A(109)=2*PI
CALL INITT (30)
CALL PLOTPM (A,R,109,N,ISYM,3)
CALL GRID
CALL TINPUT (I)
STOP
END
```


THE HARDWARE STORY

4013

CAUTION- TURN OFF POWER BEFORE
REPLACING CIRCUIT BOARDS. DO NOT
APPLY POWER WITH DEFLECTION
AMPLIFIER BOARD REMOVED.



APL/GRAPHICS FAMILY TREE

The APL 4013 Computer Display Terminal grew out of two years of terminal design efforts that seem evolutionary enough to us, if a bit revolutionary to others.

First, we introduced computer graphics based on a storage cathode-ray tube in 1969, with the T4002. An improved version, the 4002A, and low-cost graphics with the 4010 both came along a year later. And now, with the 4013, we've been able to combine the proven merits of a storage display terminal with the great facility and power of APL programming.

APL's hard core

APL uses a character set of 88 printing symbols plus twelve composite symbols. The 4013 keyboard is labeled with APL symbols on the key tops, and non-APL ASCII symbols on the key fronts. Users can select APL graphics or print by means of a front-panel rocker switch, or by entry of a control key. Or you can press a TTY Lock key on the keyboard, and operate the terminal as a teletype using only upper-case ASCII characters.

Users of other Tektronix graphic terminals will no doubt fondly remember our direct-view stor-

age CRT. The storage CRT allows internal circuitry to be considerably simplified, since the display is in effect stored right on the tube. And there's none of the annoying flicker sometimes seen with "refreshed," TV-type tubes.

The display can be operated in three different modes. In the alphanumeric mode, the numeric and alphabetical characters of the APL and ASCII sets are display. In both Graphic Display and Graphic Input, vector displays, graphs, or line illustrations can be created from computer instructions.

Graphic Input is a truly interactive mode. The operator can actually use a thumbwheel-controlled crosshair cursor to send (x, y) co-ordinates of display points directly to the computer. And Graphic Display puts computer results up on the silent screen with equal ease.

The pedestal section not only supports the display and keyboard sections to make a handsome, stand-alone, desk-height terminal, but also contains many concealed weapons for the 4013 user. In it are all of the 4013's low-voltage power circuitry and terminal control circuitry, as well as a "minibus" connector that accepts interface cards to link the terminal with timesharing systems or with other peripheral devices. These peripherals can include a digital cassette tape unit, a paper tape reader/perforator, and a display multiplexer that can operate up to three remote displays. As many as four Display Multiplexers can be connected at one time, so you actually have the possibility of using as many as twelve

remote display units, just so no one feels left out.

Latent interior decorators can feel free to play around with the physical set-up of the terminal. If you don't like the stand-alone arrangement, you can remount the display and keyboard section on a table or desk. The cable from pedestal to top-section can be pulled out to allow a four-foot separation. Or the pedestal section can be drawer-mounted below the display.

And last but not least, the TEKTRONIX 4610 Hard Copy Unit can be connected quite compatibly to the 4013 without modification to either unit. The 4610 provides 8½ x 11 permanent copies of the 4013 display using dry processed 3M paper.

Quite a few experts have told us that the 4013 represents a sizable marketing gamble, since it is aimed at a hardware market that's just beginning to develop on any kind of scale. But we at Tektronix look at it the other way around: with APL/GRAPH and the 4013 now available to back up APL adoption, who's going to gamble on the side of the scoffers?

GOOD NEWS FOR IBM APL 360 USERS

When it comes to graphics, anything your IBM Selectric Typewriter Communication Terminal and plug-in plotters can do . . . the Tektronix 4013 Terminal with a special APL 360 Interface can do better! The reason is as simple as the installation. Our 4013 provides direct graphics faster than conventional APL systems. Installation? Simply unplug your present correspondence coded terminal and plug in the 4013. It's almost too simple.

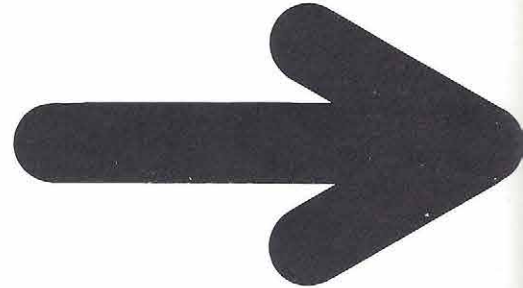
You'll see the difference. Instantly. Where mechanical output laboriously prints out data, ours displays it electronically. At selectable data speeds of 134.5 to 1200 bits per second. Name your data. The Tektronix 4013 makes fast work of control characters, upper and lower case alphanumerics, vectors and X-Y plots. It's almost like comparing television to teletype.

Thanks to a complete hardware and software package, the Tektronix 4013 permits direct and highly interactive communication between the user and the computer. Marry the 4013 to our PLOT-10 APL/GRAPH software package and you will have the first practical method of solving problems of varying complexities, ranging from the simple to the sublime. Accuracy checking? A continuous process, because the display is quickly and easily updated.

The 4013 system can operate with half-duplex or full duplex modems in a time-sharing mode with other terminals. Its hard copy accessory makes quick and accurate copies of the screen's content. Today's data can be corrected now or revised tomorrow, thanks to an accessory magnetic cassette recorder . . . a data storage system for Tektronix APL Graphics.

Gone is the rat-a-tat-tat of mechanical output. The 4013 system requires no moving parts to do its job. Which also means less maintenance to slow you down.

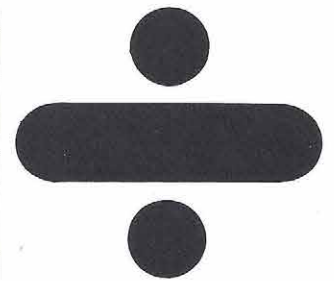
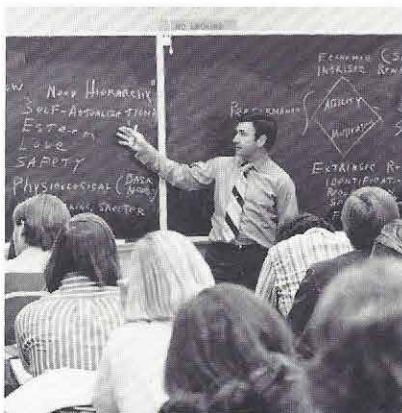
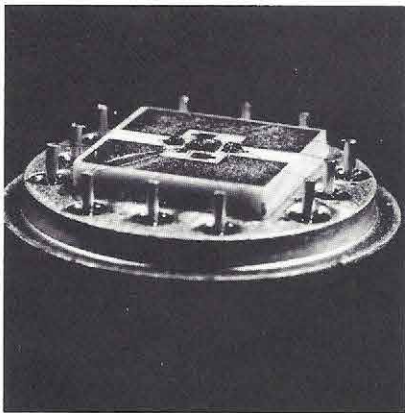
If you are an APL 360 user who wants to see your results faster. If you need data bases and the capability of finding relationships you can copy and record . . . the Tektronix 4013 system is indeed Good News.



THE END OF THE BEGINNING



Childbirth is the happy ending to a long and difficult ordeal. Such has been the case with APL. Over are those hard-nosed years of software skepticism. Gone are the blahs of recession. Today, an improving economy . . . and the growing emphasis toward interactive problem solving has given birth to robust APL with a great future. IBM is offering it as supported software. XDS has found in APL a valuable tool to offer with the UTS. And on the CDC 6000 series APL—and graphics—has been put to work on the KRONOS and SCOPE operating system. Univac EXEC VIII users can also have access to APL. For PDP-10 users a software company has made APL available. Infant APL is growing fast.





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