



PC TAP

Consumer Report

Color Hardcopy Output

Technology Assessment Around EPA

Open Forum:
PC 386 Upgrades

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From the Editor's Desk

In this *PC TAP Consumer Report* we are pleased to publish the report on our study of color hardcopy devices. The article, which begins on Page 2, addresses some of the factors one should consider when using color in graphics and other computer-generated output. The experiences of users who participated in the study are summarized for each device.

On page 17 you can review the results of a survey we conducted in RTP to assess the quality of the output generated by our test devices. Copies of our test files were placed on public display, and we asked local users to vote for the images they considered the most attractive. Admittedly this was a very unscientific, subjective judgement; but in the final analysis beauty is really in the eye of the beholder, isn't it? We think this was a suitable way to conclude our study of color output devices, and that publishing results of a color output beauty contest judged by consumers of color output is appropriate for our *Consumer Report*.

The *Open Forum*, beginning on Page 21, features three accounts of PC 386 upgrades that were submitted by Floyd O'Hara from Region V, Region VII's Craig Patterson, and Mark Tolton, manager of the RTP information centers. These descriptions of actual experiences installing and using the Hauppauge 386 and Intel Inboard upgrades are a treat to read, and we're happy to share them with you.

Our ongoing analysis of the evolution of the PC Technology Assessment Program has made it clear that the nature of our studies often makes definitive, timely project conclusion difficult. In other words, it's tough to get all the far-flung pieces completed at the same time. Our dependency on input from geographically dispersed participants, and on borrowed software and hardware, is a major factor in this phenomenon. On the other hand, this same diversity is one of the unique strengths of PC TAP, and is a key element in the philosophy of the program.

To help minimize the problems inherent in this aspect of TAP while maximizing its positive attributes, we are going to begin publishing more "pieces" of projects whenever we can. Instead of waiting to assemble *all* the parts of a given report, when it's possible we'll publish segments that make sense when they stand alone. This means you'll be getting more reports in installments, but you'll also be reading the information when it's fresh ... and our *Consumer Reports* will contain more variety each time.

In upcoming *Consumer Reports* we will be bringing you accounts of our studies on graphics file conversions and desktop scanning, and we have a number of other studies in the planning stages. We look forward to preparing those reports, and we hope you'll continue to enjoy reading them.

David A. Taylor
PC TAP Coordinator

COLOR HARDCOPY OUTPUT DEVICES

Introduction

In *PC TAP Consumer Report #2* we reported on the suitability of various computer graphics packages for presenting scientific data. An extensive study is in progress on the topic of converting graphics files between various software environments. We have been devoting a lot of space in our publications to the topic of graphics, and with good reason: graphics currently is a very hot topic in microcomputing. And with the advances that have been made in graphics software and hardware--and those that are continuing to be made almost daily--there's little doubt we will continue hearing a lot about computer graphics.

Within the exploding world of computer graphics, color processing is presently getting a lot of attention. While just a few years ago the technology for creating color output from microcomputers was severely limited, today a number of options are available for producing high-quality color graphics output from desktop microcomputers. Significant strides have been made in both the software to produce color images and in the hardware required to output those images.

As usual, microcomputer users throughout EPA have been on the leading edge of new technology in the area of color output. That interest led to the PC TAP study of color output devices; our assessment project was conducted in response to requests from users for more information about available printers and plotters that support color processing. This study has been interesting and informative. We hope you will enjoy reading about it.

About Color Output Processing

At the beginning of decade of the 80's, only very specialized applications using very expensive equipment enjoyed the capability to produce color graphics output. Except for those specialized situations, when color graphics were required a graphics art department produced them.

As the 80's come to a close, color graphics processing has come a long way. Users of desktop computers now have the software tools at their disposal to create their own high-quality graphics output at a fraction of the cost and time a graphics arts department would require with manual methods. And the weakest link in the color output production chain--the output device--is almost measuring up to the task at last.

Why Color?

The most common use of computer graphics is to communicate information. Everyone has heard the old adage, "a picture is worth a thousand words." Properly used, color enhances the messages conveyed by graphics, enabling us to increase the effectiveness of the thousand words' worth of information a picture represents. Notice we said this happens when color is *properly used*; poor use of color actually can *detract* from the message one is trying to send.

Appropriate applications of color include differentiating between values in a range, highlighting certain items in a group, or emphasizing the intensity of an element or condition (like gradients of heat or cold). Attempting to create a dazzling show through the use of bright, varied colors--without regard to whether they work together to enhance your message--is an inappropriate use of color technology.

Beginning users of color graphics would be well advised to spend a little time getting acquainted with the subtleties of tasteful color usage. For example, certain colors complement one another, working together to create a visually attractive effect. On the other hand, when colors that don't work well together are used in the same visual image, they can *detract* from the intended effect, rather than enhancing it. Learning how to use colors wisely is the first step in creating attractive, effective color graphics output.

Producing Images in Color

In addition to learning how to use colors wisely, it's also important to understand how colors are displayed on computer screens and how they're reproduced on output devices. The processes are quite different, as we shall see, and significant variations in screen images and hardcopy output can occur as a normal course of events. This can lead to the impression that "something went wrong," when in fact you got exactly what you should have (even if it wasn't what you wanted or expected). Let's look a little closer at this aspect of color output production.

As you will see when you review the basics of color production and usage, various shades and hues are created by mixing the three *additive* primary colors: red, green, and blue. For example, most of you will probably remember that green is actually a mixture of the primary colors blue and yellow. On your terminal screen, colors are *emitted* using this *additive* method (hence the term "RGB," for red, green, and blue, in connection with color monitors). When equal amounts of all three additive primary colors are mixed, white is created. When we move to the domain of the hardcopy output device, however, things change. Color printers and plotters work with the *subtractive* primary colors: cyan (blue-green), magenta, and yellow. They're called *subtractive* because they *absorb* (subtract) certain color wavelengths and reflect others. When equal amounts of the three primary subtractive colors are mixed, black is the result.

So you see, the process by which colors are mixed and displayed on the terminal screen is quite different from that process in hardcopy output devices. Additionally, screen images are usually displayed on a dark background, while hardcopy output is printed or plotted on white paper, and there are wide variations in resolution between CRTs and hardcopy devices (with the hardcopy getting the edge in higher resolution and resultant sharper images). These factors must all be considered when comparing screen images to hardcopies, and in analyzing why what you see isn't always what you get in terms of shades and intensities of color output.

Another aspect of color output is whether you will be outputting to a *vector* device or a *raster* device. Vector devices, such as pen plotters, receive commands to "draw a box," or "draw the letter A." Along with these commands the device receives information about where the object is to be drawn, what color it should be, and whether or not it is filled. The objects that comprise a vector image are drawn one at a time. For example, in an image containing white text within a blue box, the plotter will draw the blue box but the white text won't appear. If the text were yellow it would draw the blue box, then draw the yellow text on top of the blue. In the latter case, the text would be faint because it would be "lost" in the darker background. Vector output devices are appropriate only for simple images, those where filled images don't overlap.

The commands that are sent to raster devices give instructions for printing "dots" in certain colors at specific locations. A raster device, then, would print the blue box with the white text correctly. Raster devices are suitable for complex images. Color cameras are raster devices, as are thermal, ink jet, and laser printers.

Creating Color Hardcopies

In the jargon of computer graphics, the specialized conversions and mathematical algorithms that transform a CRT image into printed output are referred to collectively as *image processing*. A fundamental step in this transformation is called *dithering*. Although dithering isn't necessary for line

drawing or for images using only the basic eight colors supported on most printers, it is required for smooth shading and blending of colors. Dithering techniques smooth out the rough edges and give images a more natural appearance. Without dithering, complex images lose their smooth transitions between colors and have very sharp, delineated color boundaries. The actual dithering process is a complicated one, and software vendors guard their methods carefully, just like they do with copyrighted software.

Users should be aware that, while dithering is usually accomplished in high-end, intelligent color output devices, some software also performs dithering. When a software product that dithers is used to create an image, and the image is then output to a dithering printer, interference is sometimes experienced between the two dithering patterns. When this happens, unusual and unexpected output can occur. If you encounter this problem, turn dithering off in the software and leave that function to the printer.

Most color printers are capable of producing only seven *pure* colors. Additional colors are the result of dithering, or combining dots of two or more pure colors to achieve other colors. When the dithering process is subtle and well done, the resultant shades look almost as good as the pure colors. Poor color dithering results in a crude image made up of obvious patterns of mixed color dots.

Full of Surprises

For a variety of reasons, including those we have been discussing, the process of producing attractive color visuals is full of surprises. It is significantly more complex than working in black and white. To effectively use color, one should test each program with each color output device to learn how the screen colors translate to hard copy. A useful preparatory step is to create a labeled "color palette" of the colors your software can produce. Then output the palette to your output device for later reference when choosing the colors for a particular image. Remember, a good-looking screen image will not necessarily result in a hard copy of comparable quality; each hardware/software combination is different.

Assessment Strategy

For our color hardcopy assessment project, we selected a set of five images to output on each device: a bar chart, a word chart, and three graphics images of varying degrees of complexity. We chose images created in the RTP information centers by IC staff and users that represent a typical range of user applications. Whenever it was possible, these five images were output from both the IBM PC environment and the Macintosh environment on each device we tested. This allowed us to evaluate not just the hardware itself, but also the interface between the printer or plotter and the agency's two major desktop computing platforms.

The state of the art in color graphics varies between the PC and Macintosh environments. Color screens and output have been available for some time in graphics software for IBM PCs, and color is widely supported in PC software. It's usually safe to assume that if a software product supports a color output device you will get color output with little or no difficulty. Except for Windows and Zenographics, PC software tends to support a limited number of colors--usually 12-16. We tested the high-end color devices with Freelance Plus, Harvard Graphics, Arts and Letters, Designer, and Zenographics.

Color is still being integrated into the Macintosh environment. Color PostScript is available only with Version 6.03 of the Macintosh operating system. Some Mac programs still don't support color; others only support the earlier limited 8-color model. However, new Macintosh presentation programs like Aldus Persuasion, PowerPoint, and Cricket Presents support a dazzling array of colors.

The approach to color driver software is also different between the PC and Mac environments. The Macintosh assumption is that the color device vendor will supply a single "chooser" driver that will allow the device to work with all Macintosh graphics programs. Our experience in this project indicates that this goal often is not being achieved. The QMS printer would not work at all with Aldus Persuasion; the Tektronix driver worked better with PowerPoint than with Persuasion. Many drivers had problems with sophisticated features of Canvas. The Pagemaker color extensions failed with our color PostScript printer.

PostScript printers are supported through the basic PostScript driver included in the latest version of the Macintosh operating system. We hope specific drivers will be developed for these printers. The image size on a laser printer (for which the Mac PostScript driver was developed) is much larger than the image area available on most color PostScript printers. As a result, unless you adjust the size of your image, the top and bottom simply do not print.

When testing the high-end Calcomp, QMS, and Tektronix printers, in addition to our standard test files we also output a number of additional images that were available to us. This was done to exercise the capabilities of the hardware to the greatest possible extent and to assess their more extended capabilities. It was through this extended testing that some of the more interesting aspects of the project surfaced. We tried the high-end machines (QMS ColorScript, Tektronix 4693DX, CalComp PlotMaster) with PowerPoint, Aldus Persuasion, Canvas, MacDraw, Pagemaker, Excel, Cricket Presents, and Cricket Graph. Failures and "awkwardnesses" are noted in the discussions of each device.

With the rising popularity of color photocopy machines, we also included one of those devices in our study. The photocopier report follows the reviews of printers and plotters.

Product Reviews: Printers and Plotters

The color printers we tested cover a wide range in terms of price, capabilities, and performance. Although there are a number of devices available in the marketplace that we didn't manage to get our hands on (and couldn't find anyone else who had experience with them), our list is fairly representative of what was available when we were trying to acquire test devices. As has been mentioned before in this report, color graphics currently is a very dynamic area, and product announcements seem to be appearing almost daily. We will give a brief overview of each printer, then present some tables summarizing our test data. The devices are presented in alphabetic order by name.

CalComp PlotMaster

The PlotMaster is an excellent color printer. It operates on the principle of thermal transfer, using a plastic ribbon coated with colored bands of heat-sensitive ink that can be "welded" onto a page by the thermal print head at a resolution of 200x200 dpi. Compared to the 300x300 dpi resolution of the other high-end printers we tested, it sounds like the PlotMaster's output will suffer in quality by a factor of 30%, but we didn't find this to be the case. The CalComp's resolution is more than sufficient for producing overheads and color handouts. It is only when very small text (about the size of typewritten text or smaller) is encountered that the lower resolution has a noticeable affect. Desktop publishing or printing of fine detail maps probably should not be attempted on this device.

Drivers for a wide variety of graphics and desktop publishing software are available to support this printer. According to CalComp, the PlotMaster is compatible with more than 100 engineering, scientific, and business graphics software products. Standard features include an automatic sheet feeder, a 1,536-kb buffer, an RS-232C serial port, and a Centronics parallel port. The automatic sheet feeder accommodates up to 100 sheets of paper or 40 sheets of transparency acetate. The printer's memory capacity is sufficient to hold an entire graphics page of unlimited density, or up to 300 pages of text.

This device is available in three configurations. CalComp offers the *ColorMaster* and the *PlotMaster*. The *PlotMaster* includes 1 megabyte of memory that retains the entire image so additional copies can be produced quickly after the initial image is prepared. We think this option is well worth the additional \$300. Lasergraphics also sells their own version of the *PlotMaster* as a Macintosh output device with an external rasterizer. It costs about \$1,000 more than the Calcomp version, but it provides additional software and different dithering patterns, and since it's optimized for the Macintosh it may be faster. We have not tested the Lasergraphics printer.

We tested the *PlotMaster* in both the PC/AT and Macintosh environments. Installation and operation were trouble free in both cases. The copies of our five standard test files that the *PlotMaster* produced are of very high quality. Color reproduction and resolution are excellent, and the images are true to the originals with no noticeable distortion and no missing segments. Although the manual says drawings that take up to 15 minutes to complete on pen plotters will be finished in about one minute on the *PlotMaster*, our test graphics images weren't processed that quickly (see the timing chart on page 12).

For several years a *PlotMaster* has been in general use in our Information Center, and as an output device in our Graphics Department at RTP. It has performed reliably and well. Users are well satisfied with the quality of both paper copies and transparencies produced on the device, and we have found through experience that output produced on paper and transparency material sold by 3M is actually superior to output printed on CalComp's own materials. Compared to the other high-end devices, this printer is attractively small and simple, and it's the only one that could be moved around with ease. It also produces the largest image.

In the Macintosh environment the *PlotMaster* requires the installation of a Chooser printer driver, and more than 6 megabytes of disk space was required for the special fonts. The printer worked well with all our Mac software, except when trying to print small typefaces from Pagemaker. Although the printer driver is delivered with a cable for running the *PlotMaster* as a serial device, we found the printing speed under this configuration to be unacceptable. When we installed a Hurdler parallel card in the Macintosh (available for \$199 from Creative Solutions, 1-800-367-8465), significant increases in print speeds were achieved. For example, our Test Image #1 took 13 minutes and 15 seconds to output serially; with the parallel connection the time was reduced to 4:15.

Although the *PlotMaster* turned in the slowest times of our three "high end" printers, its output quality, reliability, and ease of operation keep it in competition with the others. Furthermore, its significantly lower cost--around \$3,500--makes it an attractive option in comparison with the top-of-the-line QMS PostScript at \$14,000+ and the Tektronix 4693DX at approximately \$8,000.

Hewlett-Packard PaintJet

Users who evaluated the *PaintJet* for us had high praise for this device. Although it's the least expensive of the printers in our study (under \$1,000), the consensus is that it's very good at what it does: generating color output of an acceptable quality at a low cost. Almost every PC graphics program includes a driver for the *PaintJet*.

While the *PaintJet* is a very satisfactory MS-DOS printer, the same isn't true in the Macintosh environment. We tested a variety of Mac drivers, including Hewlett Packard's. Since our *PaintJet* is a parallel device, we used a Versadapter to convert the serial signals from the Macintosh modem port to parallel signals for the printer.

The pin-fed paper supply will produce 250 8.5x11-inch copies before resupply is necessary. The paper-handling mechanism is reminiscent of the Epson FX-80. It can be tortuous to get the pin-feed paper

inserted properly. On the bright side, once the paper is loaded jams are extremely rare. **YOU MUST USE PAINTJET PAPER**; weak, pallid output results when ordinary bond paper is used. The PaintJet also handles acetate for producing transparencies. It was reported that the ink cartridges last much longer than advertised, and the ink doesn't drip on the paper. Also, the ink jets are quite clog-free. While speeds for printing paper copies are quite acceptable, we found that transparencies take up to ten minutes. Furthermore, transparencies require about five minutes to "develop" after they come out of the printer.

One of our study participants particularly likes the PaintJet for producing transparencies, a function for which users often prefer ink jet printers over other types of color output devices. However, we found the Tektronix ColorQuick produced better transparencies. All our evaluators reported some minor variations between originals and final output in terms of colors, fonts, and sizes/shapes of figures. Considering the cost, ease of use, and overall capabilities of this device, however, any such variations were generally seen as acceptable. On the other hand, it's also important to keep in mind that ink jet printers can't handle "sweep" patterns, with their graduated transitions from one color to another. The consensus on the HP PaintJet seems to be that despite its limitations it's a straightforward, dependable performer.

The Hewlett-Packard 7550A Plotter

The 7550A seems to be by far the most widely-used plotter in EPA, and we received evaluation data on it from a number of users. The consensus is that it's a very good choice.

The reasons for choosing the 7550A were fairly consistent among users we asked: good value for the money, high reliability, produces high-quality presentation graphics quickly, and with the optional sheetfeeder can function unattended. This plotter accepts acetate for transparencies, and both size A and size B paper. The optional sheetfeeder, which one user listed as a "best feature," holds 50 sheets of paper.

Evaluators rated documentation, ease of installation and use, paper handling, noise control, speed, and quality of output average-to-excellent. The 7550A was not given a "poor" rating in any evaluation category by any of our evaluators. One person said the plotted output consistently is far superior to the screen image. Another summed up the evaluation with this comment: "The HP 7550A is a very nice, fast plotter. Although the price is high, the quality is too. It may have too many features for the average user, but would be an excellent choice for a technical support center. I recommend it." Remember, though, that the HP 7550A is a vector device, so it won't do a good job on a complex graphic image.

IBM PC Color Printer

When we heard of a user who has an IBM PC Color Printer, we requested a report for this study. Just as we never actually laid eyes on the Tektronix 4696, this is a device we didn't touch ourselves. However, we're pleased that we are able to include this assessment in our report.

Our evaluator's device is an older model--it's been around "since 1985 or '86." During that time, it has served *very* reliably as a general office printer, and has been used chiefly for printing colored words, phrases, and text blocks. Color graphics use has been minimal, and printing our test files was reported as "probably the biggest challenge this device has faced."

The PC Color Printer is the only impact printer in our study. Given the limitations of color ribbon technology, the output is quite acceptable. The only reported problem is its tendency toward paper jams. Colors aren't as vivid as those in other devices we tested, and the ragged edges typical of dot-matrix print heads can be seen in curves and slants in the output--any time a character or shape is being printed that isn't a straight line either horizontally or vertically. It's also by far the slowest device in our test group. But it has reliably produced satisfactory output with limited color applications for a number of years, and the endorsement of a satisfied user speaks well for this device.

QMS ColorScript

At \$14,325 installed, plus \$240 per month for a service contract, the ColorScript is the most expensive device in our study. It's also the only PostScript printer we tested. The chief shortcoming of this printer is that since PostScript color printers still aren't commonplace, there are fewer drivers available for them. We encountered this problem in our tests, and there were some test images that we couldn't print in color due to lack of an appropriate driver. However, in the ColorScript's favor, instead of aborting the operation it did a superb job of printing those images in black and grey shades. Windows supports color PostScript in the PC environment, and so does the latest version of Zenographics. Unfortunately, we weren't able to test the QMS extensively with the PC during the limited time we had access to the printer.

Version 6.03 of the Macintosh operating system is required when working with the QMS printer, because System 6.03 contains the Apple LaserWriter printer driver that the ColorScript uses. The printer connects to the Mac's AppleTalk port. We found that existing color files could be printed from a Mac SE to the ColorScript, even though the SE itself doesn't support color processing. The ColorScript was also used successfully on an AppleTalk network, and it worked well in that configuration. However, when the printer was set to 9600 baud for testing with the PC while it was still connected to AppleTalk, confusion was created on the network. This is not an acceptable situation unless a software interchange is installed.

The ColorScript prints at a resolution of 300x300 dpi using Adobe's PostScript page description language. It accommodates most micro, mini, and workstation environments with RS-232, RS-422/AppleTalk, and Centronics parallel interfaces. It also supports up to seven SCSI devices. The ColorScript comes with 35 resident fonts, and support for downloadable fonts is provided. Like most PostScript printers, this device has a defined border for graphics images that effectively reduces the area that's available for the image. Thus, images have to be "pre-shrunk" to avoid having the top and bottom cut off when they're printed.

This printer is very large and heavy. It is simple to use when things are going well, but when an error condition was raised it often seemed to take a long time to get everything up and going again. We never were sure exactly why. We were sorry to discover that the ColorScript would not work with Aldus Persuasion at all (a driver is promised in the next upgrade of Persuasion). It also refused to output in color from PageMaker when the color extensions were used.

Of the devices that we tested in the information center at RTP, the ColorScript was clearly the most popular among our users. As word spread of the ColorScript's presence, everyone wanted to find out how *their* image would look coming off this device. Few were disappointed. Colors have superb definition, and clarity, and with 16.8 million of them available smooth shading and subtle transitions between colors are possible. Through printing user's files we also discovered that this PostScript device was the *only* one in our test that would handle text printed at an angle on an image. The QMS ColorScript is another example of the old adage, "you get what you pay for." Unfortunately, at the present time few of us can afford the price of this superior color printer.

Tektronix 4693DX

The Tektronix 4693DX is a 300 dpi color thermal wax printer. This device originally was designated the 4693D, with the DX model being the latest version. Tektronix points out, however, that many "D" models have been upgraded to DX status, with its "memory efficiency mode," improved color matching, and optimization of fine lines. This printer handles 8.5x11-inch paper, legal size paper, A4, and A4 special paper sizes, as well as transparency sheets. It has one 8-bit parallel port and 4 megabytes of RAM image memory. According to Tektronix, print time is approximately one page per minute; see page 12 for the times we recorded for printing our test files.

IBMPC and Apple Macintosh interfaces and drivers are available for the 4693DX. Although beautiful output is possible with this printer and it does produce the most vivid colors of any thermal device, our evaluators were less than thrilled with the performance on the PC side of the house. The number of drivers is limited, and it took so long to print an image from Micrographix Windows that it isn't even a reasonable option. Tektronix lists print times of "from 10 minutes to 1 hour for full 300 dpi resolution images."

In our extended tests on the PC, the previously-mentioned slowness was encountered in both Windows 286 and 386, but when the image finally prints it looks good. In Pagemaker, large Designer CGM files lost all detail and printed as solid colors, although smaller Designer CGM files were OK. Varying degrees of success were achieved in Pagemaker with images from Arts & Letters, Harvard Graphics, and Freelance. The results were unpredictable, and you really have to evaluate on a case-by-case basis. The best results were achieved with Zenographics, where beautiful output was quickly obtained. However, the Zenographics batch mode, which works fine with other printers, failed with the 4693DX. A slower batch option was successful.

When printing from the Mac, problems were encountered with image sizing. For example, in Aldus Persuasion the background (which is common to all images in a slide presentation) does not resize. It was necessary to manually resize each slide image, then resize the backgrounds. In Powerpoint, the images resized automatically, but to a size significantly smaller than the maximum available image size. Often we couldn't get all the image within the "frame" that was presented on the screen, and we couldn't get rid of the generous margins that were being protected by the software. In addition to sizing difficulties, sometimes colors were lost completely, and the image was printed in black and gray shades on white. It occurred to us that the graphics software drivers and the printer drivers might be conflicting with each other, but we weren't able to verify this.

The 4693DX also is available at around \$16,000 as a PostScript device. This version, called the *Phaser*, would be supported in many more programs, and possibly would work more consistently with the Macintosh. We did not test the Phaser.

An even more serious issue relates to text handling. Fonts behaved strangely; some lines would be high-resolution text, others would be very jaggy, when no font at all was indicated in the menu. Sometimes entire lines of text were just left out of otherwise good-looking output. On a text chart containing short bulleted items, 3 of the 6 bulleted lines were omitted from the final output. When resizing an image from Aldus Persuasion, the graphic is affected but the background isn't.

The Tektronix 4693DX shows a lot of promise, but based on our test results we can't recommend it at the present time. Perhaps after more refining, this \$8,000+ device will be a more attractive option.

LATE NEWS FLASH

As this Consumer Report was going to press, we learned that Tektronix has just announced new drivers for the 4693DX. The availability of additional drivers should dramatically change the utility of this printer in the MS-DOS graphics area. One in particular, called the "Superprint," is said to provide output from Microsoft Windows in under two minutes.

Tektronix 4696 Inkjet

Although input from outside sources was obtained for practically every device in this study, except for the Tektronix 4696 we were able to gain access to all the hardware locally too. Our sample output and evaluation for this device were provided by the Athens, GA lab, where it is used with a Tektronix 4106 terminal, primarily to print GIS output.

The cost of the 4696 Inkjet is about \$1,800. Using the recommended roll paper, the per copy cost is eleven cents, and 164 12-inch copies can be produced from one roll. Manually-fed sheet paper may also be used, and transparency output is supported for both rolls and manually-fed sheets of acetate. The 4696 received an "excellent" rating in these categories: cost, documentation, ease of use and installation, paper handling, noise control, and reproduction quality. An "average" rating was recorded in one category: speed. Output from this printer was said to be an exact replica of the screen image.

Tektronix ColorQuick

The ColorQuick ink jet printer, Tektronix' latest entry in the color printer field, was initially targeted at the Macintosh user community. Although drivers for IBM PCs and compatibles are planned, no announcements about their availability have been made.

We tested a new ColorQuick in our RIC II Information Center in RTP with a Mac II. The printer is a SCSI ("scuzzy" in Macintosh inner circles) device, which means it can be daisy chained serially with other peripherals. In such a configuration, it is important to have a "terminator" in the SCSI chain, and the user's manual goes into some detail about terminator placement in different configurations and about the importance of having the terminator in place. We soon learned the importance of heeding these instructions when one evening a mystery person pulled the cable out of the terminator at the back of the ColorQuick (leaving the terminator in place) and plugged it back into the other available (sans terminator) printer connector. The next morning when IC personnel turned on the Mac II, it fried the hard disk (see the writeup on Macintosh hard disk recovery in the *Open Forum*).

With our test files, the ColorQuick really was *quick*. The output had the usual earmarks of ink jet printers; for example, shaded images came out striped, and the striped bars in our bar chart were reproduced as textured solids. Occasional variations in colors were noted: some reds leaned toward orange, and greens and yellows were somewhat more intense than in the original images. None of these variations, however, were significant enough to really be objectionable, and the overall accuracy of shapes and the clarity of the output compensated for minor shortcomings in color reproduction.

Like the other paint jet printer we looked at--the HP PaintJet--the ColorQuick takes significantly longer to produce a transparency than to print a paper copy. The ColorQuick manual explains that more ink is ejected for transparencies, which slows down the process, and the device actually runs slower so the ink has a chance to dry on the acetate, thus minimizing the chances for smudging.

Overall, we feel the ColorQuick is an excellent lower-cost color output option. It is, however, more expensive than the HP PaintJet (\$2,495 vs. \$1,595 list), but it's also nearly twice as fast.

Tabulations

To help gather evaluative data on the devices that were examined in this assessment project, each participant was asked to complete a questionnaire. The table below summarizes some of the data from those questionnaires. Respondents rated items as excellent (E), average (A), poor (P), or not observed (N/A). Per-copy costs (except those printed in italics, which are based on available alternatives) reflect use of manufacturer's materials, and do not include the cost of pens, ink, or ribbons.

Table #1: User Assessments

Feature	P i l o t M a s t e r	I B M P C	C O L O R S c r i p t	T e k t r o n i x	T e k t r o n i x	C O L O R Q U I C K	H P P a i n t J e t	H P
Supports PC/Mac/Both	Both	PC	Both	Both	PC	Mac*	Both	Both
Quality of Documentation	A	A	N	A	E	A	N	E
Print Speed	P	A	A	A	A	E	A	E
Ease of Use	A	E	E	A	E	E	A	E
Noise Control	E	E	A	E	E	E	E	E
Paper Handling	E	P	E	E	E	E	A	E
Cost For Each Hard Copy	.13	.12	.06	.05	.11	.08	.84	.12
Cost For Each Transparency	.40	N/A	1.00	1.14	1.00	.50	1.30	.36
Font Reproduction	E	A	E	E	E	E	A	E
Text Reproduction	E	E	E	E	E	E	A	E
Color Reproduction	E	A	E	E	E	E	A	E
Overall Quality of Output	E	A	E	E	E	E	A	E

*Tektronix has announced that PC drivers for the ColorQuick are planned, but no projected availability date has been released.

Print Times

These tables report the number of minutes required to print various images on devices we tested. The letters accompanying the times show the machine that was driving the output device: P = IBM PC or compatible; M = Apple Macintosh. Times for our five standard test files are shown in Table #2; Table #3 shows times for four of the many other files that were printed in our extended tests. All images listed in these tables are reproduced on pages 13-15. When interpreting this data, remember that there may be variations in processing speeds from CPU to CPU, and from one software product to another. Furthermore, structural differences in image files that produce similar output can result in significant time differences. This table, then, should be used as a general indicator of printer speeds, not as a listing of firm benchmarks. Dashes in lieu of time entries indicate no time was recorded; "N/A" indicates the device was not able to print a particular image, or it isn't an appropriate choice.

P l o t m a s t e r	I B M P C	C o r S c r i p t	T e k t r o n i x 4 6 9 3 D X	T e k t r o n i x 4 6 9 3 D X	C o l o r Q u i c k	H P a i n t J e t	H P

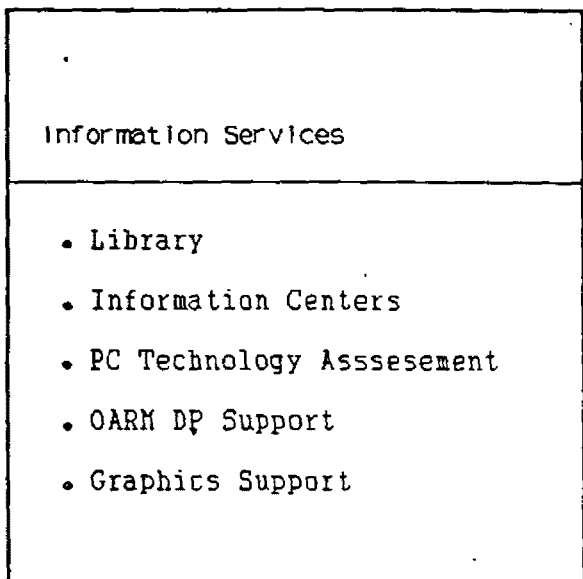
Table #2

Test Image #	P (M)	N/A (M)	P (M)	P (M)	P (M)	P (M)	P (M)	P (M)
Test Image #1	4:15 (M)	N/A (M)	1:40 (M)	2:20 (M)	----	1:40 (M)	4:20 (M)	---- (M)
	---- (P)	9:00 (P)	---- (P)	2:00 (P)	----	N/A (P)	2:37 (P)	1:00 (P)
Test Image #2	4:25 (M)	N/A (M)	4:00 (M)	2:30 (M)	----	1:20 (M)	3:25 (M)	---- (M)
	4:15 (P)	9:00 (P)	---- (P)	---- (P)	----	N/A (P)	2:55 (P)	3:00 (P)
Test Image #3	4:00 (M)	N/A (M)	N/A (M)	2:30 (M)	----	2:00 (M)	3:15 (M)	---- (M)
	---- (P)	10:00 (P)	---- (P)	3:54 (P)	----	N/A (P)	5:03 (P)	22:00 (P)
Test Image #4	7:35 (M)	N/A (M)	3:00 (M)	2:40 (M)	----	2:00 (M)	3:05 (M)	N/A (M)
	---- (P)	13:00 (P)	---- (P)	---- (P)	----	N/A (P)	3:00 (P)	N/A (P)
Test Image #5	6:30 (M)	N/A (M)	N/A (M)	2:48 (M)	----	3:00 (M)	6:20 (M)	N/A (M)
	---- (P)	---- (P)	---- (P)	2:30 (P)	----	N/A (P)	3:49 (P)	N/A (P)

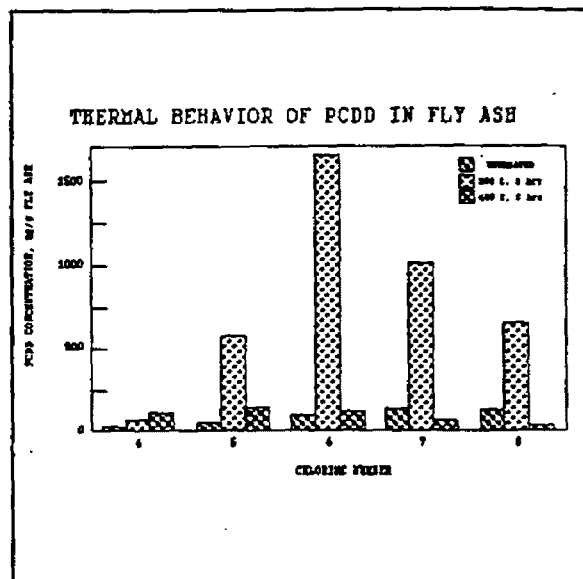
Table #3

Extended Image #1	PC Zenographics image printed on Tektronix 4693DX. Print time: 4 minutes, 20 seconds.
Extended Image #2	Macintosh Aldus Freehand image printed on QMS ColorScript. Time not available.
Extended Image #3	Macintosh MacDraw II image printed on CalComp PlotMaster. Time not available.
Extended Image #4	PC Arts & Letters image printed on Tektronix 4693DX. Print time: 35 minutes.

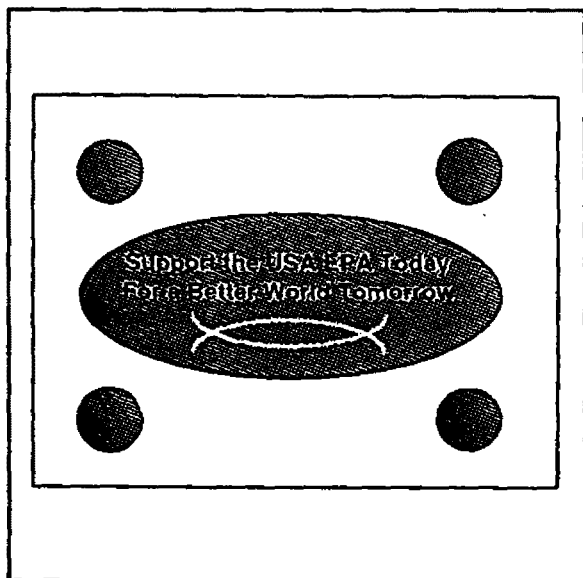
Color Output Tests: Standard Images



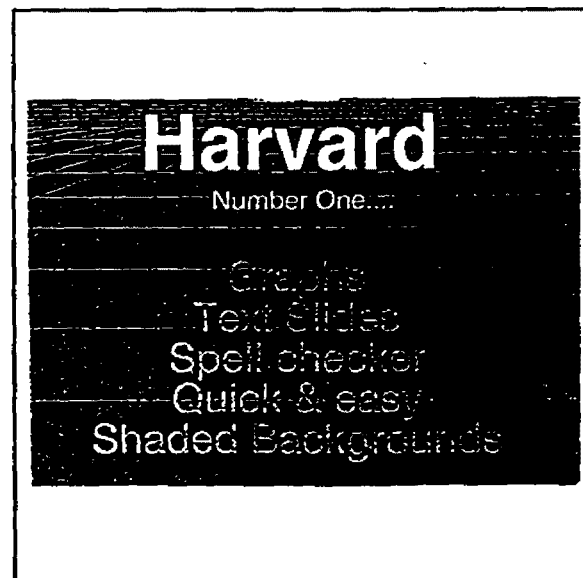
Test Image #1 (Mac & PC)



Test Image #2 (Mac & PC)

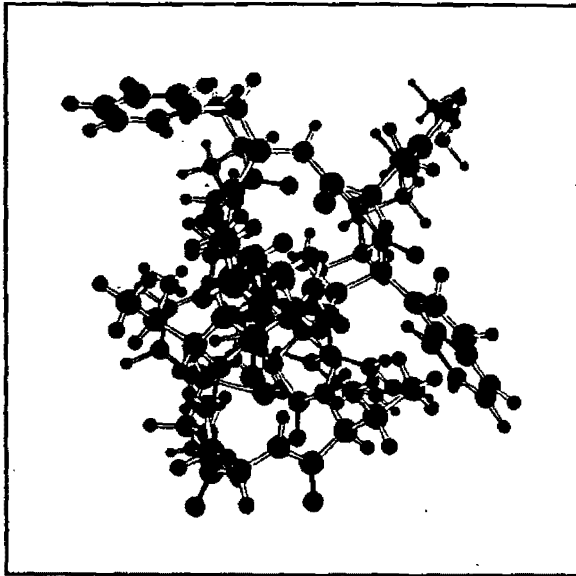


Test Image #3 (Mac)

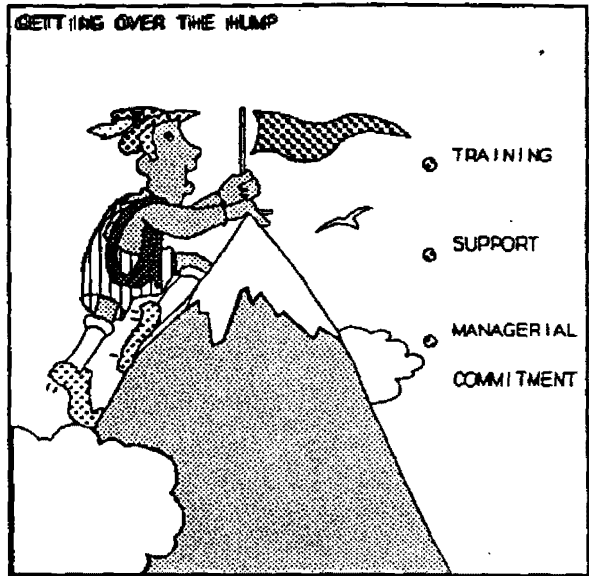


Test Image #3 (PC)

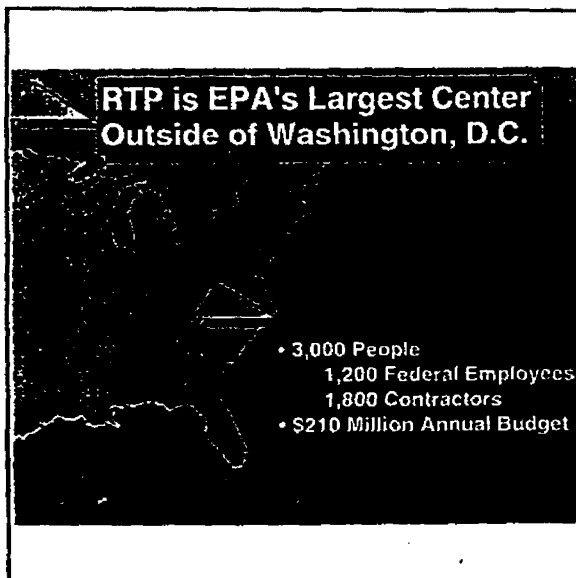
Color Output Tests: Standard Images



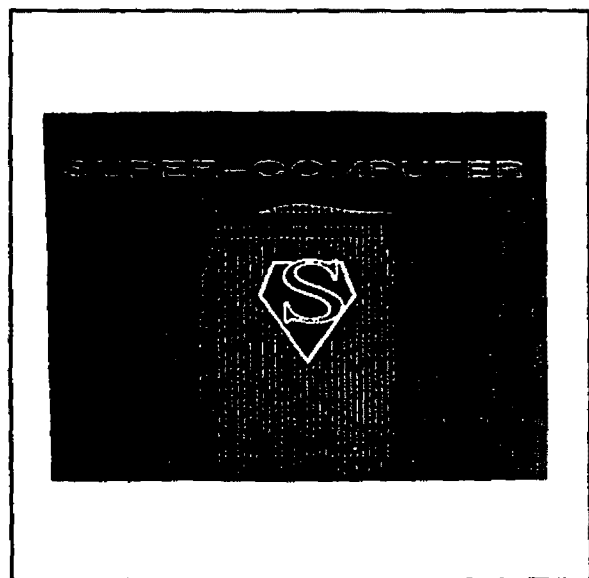
Test Image #4 (Mac)



Test Image #4 (PC)

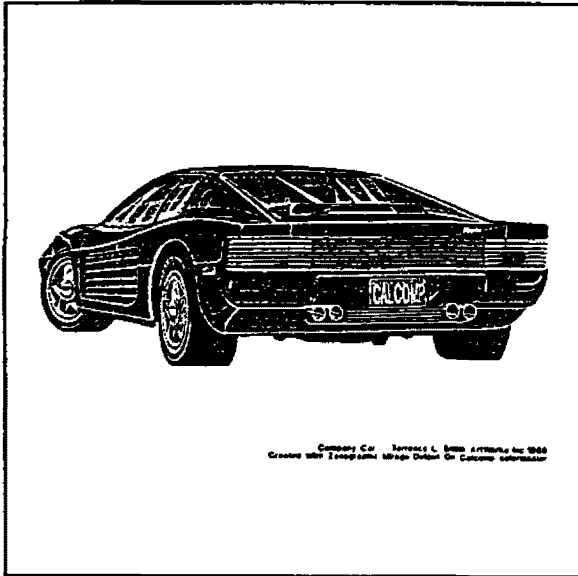


Test Image #5 (Mac)

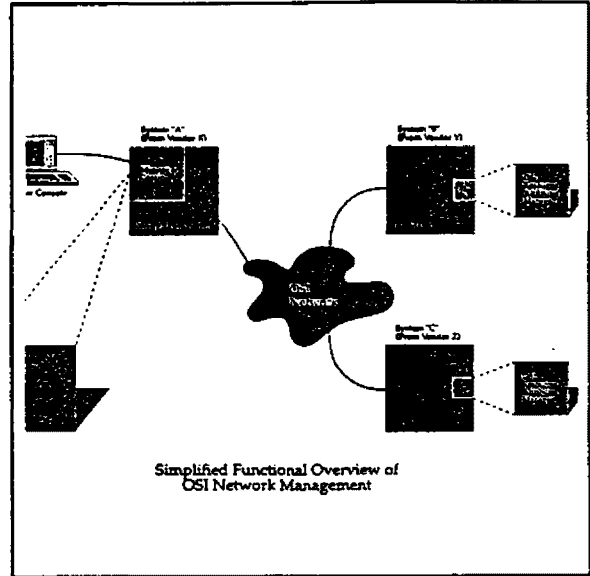


Test Image #5 (PC)

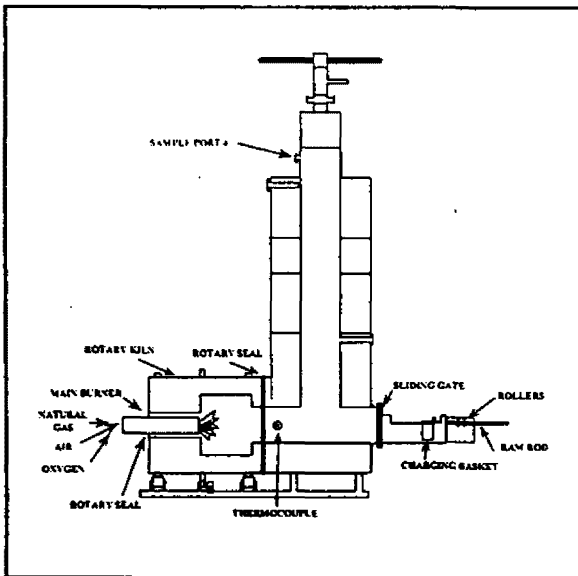
Color Output Tests: Extended Images



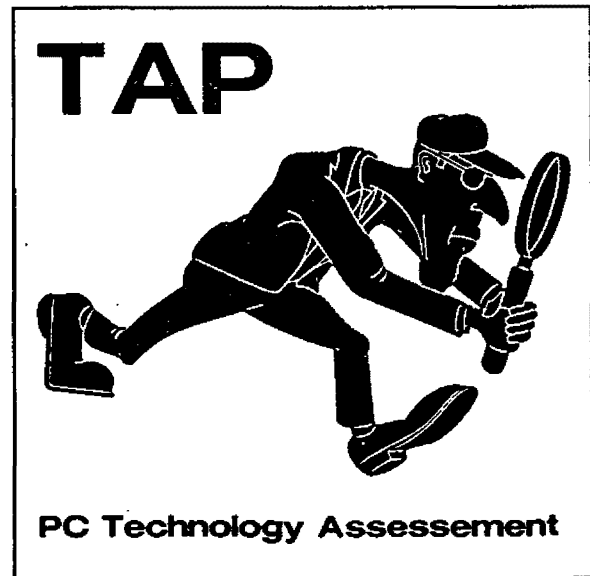
Extended Image #1



Extended Image #2



Extended Image #3



Extended Image #4

Product Review: Color Copier

To round out our study we looked at the Canon Color Laser Copier. Color photocopiers have become quite sophisticated, and along with their benefits come a number of problems. For example, because they're so powerful these machines are considered to be *photocomposers*. In simple terms, this means you're potentially in the printing business. Just as the GM commercial says "this is NOT your father's Oldsmobile," today's color reproduction unit is more than just an office copier.

Because of the cost of color reproduction, the Government has strict rules about its use. A key consideration is that the use of color must contribute "demonstrable value toward achieving a greater fulfillment of the ultimate end-purpose of whatever printed item in which it is included." If that contribution of demonstrable value comes into question, the burden of proof falls on the person authorizing the use of color. Examples of "demonstrably valuable multicolor printing" include maps and technical diagrams where use of color is necessary for clarity; object identification in medical specimens, plants, flags, etc.; and safety programs. Specifically excluded are printed items wherein additional color is used primarily for decorative effect; use of color in lieu of layout and design; and excessive use of color (like using four colors where two would provide sufficient contrast). Finally, it is strictly illegal to copy certain government documents, among which are paper money, passports, food stamps, postage stamps, and a number of other "official" documents. Users of high-quality reproduction equipment should familiarize themselves with laws and regulations concerning these devices. It seems the use of color could be justified under the "necessary for clarity" criterion in many of the graphic images created in conjunction with EPA scientific applications.

The Canon Color Laser makes full-color copies with a resolution of 16 dots per millimeter and more than 64 shades for each color. The zoom feature lets you reduce or enlarge originals from 50% to 400% in increments of 1%, and to reduce or enlarge in only one of two directions--vertically or horizontally. An "image composition" capability allows you to select a rectangular area within one image (like a block of space within a page of text), and to insert another image (a picture, for instance) in that space. It's also possible to selectively alter the colors on an image during the copying process. For example, you can insert a single original and output multiple copies, each of which has a different color mix--that is, one could be red, white, and blue; another green, orange, and yellow. There even is a paint feature that allows you to add to an image while copying it, or to "white out" portions you don't want! There's also an optional film projector available that can make full color copies from 35mm slide or negative film.

We copied originals from the high-end CalComp PlotMaster and the low-end Tektronix ColorQuick on the Canon Color Laser. The copied images are very true to the originals, but most medium-to-light colors are slightly lighter in the copies than in the originals. Dark colors, on the other hand, became darker. Where color contrast is sharp in the originals, however, it was retained in the copies. There was also a slight thickening of text characters. These subtle differences are not noticeable unless you compare the copies carefully with the originals; in some cases, the copies are better looking than the originals. With some practice, it's obvious that top-quality results could be achieved with the Color Laser.

One final factor that should be carefully weighed when considering a color photocopier is cost. You should compare the cost of the machine itself, along with the cost-per-copy for making photocopies, with the cost of running out multiple originals on a suitable color output device. Of course, frequency-of-use and number-of-copies would also be significant factors in the equation. The table on the next page provides more detailed cost information.

We had the Canon Color Laser on site for about six weeks. Frequent breakdowns occurred during this period. Because of its power, complexity, operating cost, and the need for security, this machine should be placed in a limited-access area under the charge of a trained operator.

Cost Data--Canon Color Laser Copier

The purchase price of the Color Laser with the optional 35mm slide projector, the first quarter's maintenance fee, and initial supplies of toner, starter, silicon oil, and transparency material, is \$36,089.40. The per-copy costs listed below include paper, maintenance, and all the supplies previously listed.

Copies per month	1,000	2,000	3,000	4,000	5,000	6,000
Cost per copy (to nearest penny)	.85	.56	.46	.39	.36	.34
Total cost per month (to nearest dollar)	\$848	\$1123	\$1380	\$1575	\$1797	\$2021

Summary

In this report we have tried to capture the key issues in a wide and diverse subject area, and to present a readable synopsis of an extensive study. We have attempted to provide enough information to allow you to draw some reasonable conclusions about the products we studied, while at the same time trying not to overwhelm you with too much detail.

When you're considering the use of color output, we think it's important to know your working environment and to keep in mind that different software products, each with their own drivers, yield different results with a given device. So before you invest in a color printer, make sure that good results are possible with *your* application software and *your* printer or plotter. Just because somebody else got beautiful output off a particular printer with PageMaker or Cricket Graph doesn't necessarily mean you can duplicate it on a different printer with Windows or Aldus Persuasion.

Which device should you buy? That depends on what you're going to use it for and how much money you have to spend. The bad news is that the high-end devices tend to be expensive; the good news is that some of the low-end devices do a very respectable job of producing good-looking color output. Ink-jet color doesn't compare with thermal color transfer, but it's probably fine for many applications. The question revolves around how demanding one is, and that's subjective. In the rankings that follow, the PlotMaster and the ColorQuick rank 3rd and 4th, respectively, in color hardcopy quality. When you consider that you can buy four PlotMasters or five and a half ColorQuicks for roughly the cost of one ColorScript or one and a half Tektronix 4693DXs, the question takes on a whole new perspective.

The Eyes Have It

Beauty, it's said, is in the eye of the beholder. To complete our color output study, we put output from the devices we tested on public display at the Environmental Research Center in RTP, and we invited the public to vote for the most attractive products. For each device, we displayed Test Images 1 and 2, a color chart, and two additional images that we felt were among the best we got from each device. In the following lists, the paper copies and transparencies are listed from most attractive to least attractive, starting at the top of each list. Because our Tektronix 4696 output wasn't comparable to that from the other devices, it was not included in the judging. Transparencies were judged from only five devices.

Paper Copies

Tektronix 4693DX
QMS ColorScript
CalComp PlotMaster
Tektronix ColorQuick
HP PaintJet
HP 7550A Plotter
IBM PC Printer

Transparencies

Calcomp PlotMaster
Tektronix 4693DX
QMS ColorScript
Tektronix ColorQuick
HP PaintJet

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We would also like to acknowledge these companies who generously loaned us printers for use in our assessment project:

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Technology Assessment Around EPA

As you probably are all well aware, PC TAP isn't the only group in EPA that's involved in technology assessment. We promised that when we learned about other in-progress technology assessment activities, we'd pass that information along to our readers. Here's a list of those that crossed our desk recently.

The **National Enforcement Investigations Center** at the Denver Federal Center has established an Office Automation Workgroup. They're looking into forms generation, electronic signatures, system capabilities and future possibilities regarding reduced paper flow (the "paperless office"), and other office automation issues. They're also participating in the Agency's Forms Task Force, whose goal it is to attack the issue of forms usage and control in the context of the latest technology.

The National Data Processing Division's **Architectural Management and Planning Branch** is preparing to begin an evaluation of Microsoft Windows 286, Microsoft Windows 386, OS/2, OS/2 Extended Edition, and AIX as alternatives to EPA's current Intel-based personal computer workstations.

LANSYS, NDPD's **LAN Systems Group**, recently completed an evaluation of tape systems for backing up LANs. Two products, Maynard Electronics' MaynStream 2200HS and The FileSafe Series 2100 from Mountain Computer Inc., were studied. A number of test criteria were established, including compatibility with existing EPA LAN hardware and software and the ability to perform unattended backups. Upon conclusion of the test program, LANSYS recommended the Maynard MaynStream 2200HS be used in EPA LANs. For more details, contact the LAN Systems Group at the EPA National Computer Center, MD 90, RTP, NC 27711 (EMAIL LANSYS).

Several state-of-the-art tools are being used in a 35-node token ring local area network in the offices of the **EPA Administrator and Deputy Administrator**. Through the use of *disk mirroring* (requires a special version of Novell Advanced Netware), saved files are automatically copied to two hard disk drives, so a current backup is always available for files created or updated on a workstation. *PS/2 Model 30* workstations offer IBM PC-AT compatibility and speed. Although they were quite new in the Agency at the time they were ordered for this installation, these workstations are now available, without the hard disk drives, through EPA's Desktop Publishing/LAN contract with SMA. *WordPerfect Office* is a desktop tool that provides users with automated calendaring, interoffice electronic mail, and scheduling options for both human and physical resources. Last, but not least, *Lotus Agenda* is a project management tool that provides a number of capabilities, including project tracking, scheduling, and costing. (For more information about Agenda, see *PC TAP Consumer Report #1--Ed.*).

Open Forum

Open Forum provides an opportunity for users to share with others their own innovations, or the results of their own technology assessments. The PC Technology Assessment Program neither verifies nor endorses the contents of *Open Forum* items, but we are pleased to offer them as a service to users.

PC/AT SYSTEM BOARD UPGRADE TO 386

This article was submitted by Floyd O'Hara, Region V. It describes his experience installing and using a PC 386 upgrade board in an IBM PC/AT. We're grateful to Floyd for sharing this with our readers.

When I began feeling limited by aging technology and slow processing in my PC/AT, I started investigating the alternatives. One was an expensive (\$2,500) IBM replacement system board. Further investigation turned up less expensive AT replacement system boards (\$1,600, now down to \$1,100) with faster processor/memory chips (30386, 16-33 Mhz). When I began looking at upgrade options (August 88) there were few 386 boards in the market. Based on what was available at the time, I decided to order Hauppauge Computer Works' 386 16-Mhz board to evaluate.

The Hauppauge board is a little bit smaller than the IBM AT system board. Installing it in the AT chassis was real easy. Of course, you have to take out the old board first; here are the steps:

- Remove the keyboard cable and detach all cables from the back of the PC
- Remove PC cover
- Remove I/O cards
- Remove the power supply connectors
- Remove the speaker connector
- Remove the two screws holding down the existing board
- Grasp the board and slide it out of position to the left and then up
- Take the plastic stands (a long nose pliers helps) off the old board and install them on the new 386 board

To install the new board, reverse the order of the removal steps. But before you install the new board, set the display jumper switch to match your primary display adaptor type. Also, the old battery should be replaced by the battery pack (a plastic pack that accepts 4 AA alkaline type batteries) that came with the board. Before reinstalling all the I/O cards, test the board by turning on the power. You should hear a sequence of beeps: LONG SHORT SHORT. This indicates that the board is okay and that it's waiting for all the cards to be installed. Don't forget the keylock/power LED connector. This connector is keyed, so it can only be plugged in one way.

When everything is installed and the cover has been replaced, setup should be run. When the power is turned on, the system will display the BIOS (Award) and the version, and its CMOS checksum. Pressing Ctrl-Alt-Esc invokes the ROM-resident setup utility. Set the time and date, floppy and hard drive types (Seagate ST251 40 MB is type 44), base memory and extended memory.

After the SETUP procedure is done, the system should boot up normally. The only difference that you will be able to notice in comparison to the old system board is the speed at which DOS commands and programs executed. All EPA standard software runs properly, and I have not encountered any hardware failure or any software incompatibility problems up to this point.

I installed Microsoft Windows 386 without any glitch. Pagemaker, Designer, and WordPerfect were run concurrently (one active and two in the background) without any problem. Changing from one program to another was a breeze, although you can't use the cut and paste option of Windows in WordPerfect. It's important to note that memory is an important consideration with this process. I would recommend a minimum of three to four megs of RAM. Intel Above Board or AST Rampage Boards could be used, although system throughput decreases a bit due to the 16-bit bus that these boards are designed to use. A faster way is buying the Hauppauge 32-bit memory cards.

The Hauppauge 386 system board comes with a diskette that contains nine different programs. Two are used to increase the overall processing speed of the system. One, called 386BOOST.EXE., is the Hauppauge version of a disk cache. The other, TURBOEGA.EXE, is useful if you have a system with EGA OR VGA. It relocates your EGA or VGA Adapter BIOS to the high speed 32-bit RAM on your system board.

Today there are more 386 replacement boards on the market compared to a year ago. Your choices range from 16 Mhz to 33 Mhz, with or without onboard memory cache controller. Some come with RAM on the system board and others on 32-bit memory cards. Memory chips also come in different varieties and sizes. From 256K DRAM or SIMM to 1MEG DRAM or SIMM chips. Deciding on which chips to use will depend on how much memory you want on the system.

Most of these boards are made in Taiwan, but a few of them are made in Korea and the USA. Among others, they are available from Hawk Computers, San Jose, CA; C2 Micro Systems, Inc., Fremont, CA; Artek Computer Systems, San Jose, CA; Copo Systems, San Jose, CA; Micronics Computers, Inc., Sunnyvale, CA; and Mylex, San Jose, CA.

Our region has ordered 386/25Mhz replacement boards from Hawk Computers to upgrade two IBM AT PCs in our Water Division. I'll be glad to share with you anything more we might learn on this subject.

§ § §

This article describes another Hauppauge 386 installation in Kansas City's Region VII office. Our thanks to Craig Patterson for this contribution.

The Hauppauge 386 motherboard is advertised as an inexpensive way to upgrade older PCs. The basic idea is to remove the original system board and install the 386 motherboard in it's place. All existing peripherals, software, and other equipment will work as before, only much faster. We chose to upgrade in order to improve performance of an IBM PC/AT in our graphics department. The machine is used heavily for graphics image processing using several computation-intensive software packages. It was felt that the motherboard replacement would provide the best combination of price and performance without our having to procure a whole new machine.

The Hauppauge 386/16 is a 16-mhz 80386 board that contains 1 megabyte of memory and an 80387 math coprocessor. We installed it in a 6-mhz IBM PC/AT, along with these peripherals:

- 2mb Aparat RAM expansion board
- TARGA.16 graphics card
- Hercules compatible graphics card
- Roland high resolution monitor
- Monochrome TTL monitor
- Microsoft bus mouse
- Summa Summasketch digitizing pad
- IEEE-488 GPIB card
- 2 serial RS-232 ports
- 2 centronics parallel ports
- 40mb hard disk drive
- 1.2mb and 360K floppy disk drives

When undertaking a task like this, the first rule should be *make sure you know what you are doing*. It is extremely important to know how the system was configured and how it operated before the upgrade was done. You also should be aware of any changes in configuration or power requirements that the upgrade might necessitate. Read all the documentation **BEFORE** you start, and keep the technical support phone number *within reach*. Finally, be prepared for a lengthy downtime while the upgrade is being done. Observing these guidelines should help you in your upgrade project.

Although reviews have placed the Hauppauge 386/16 at the top of the motherboard upgrade class, we found the package to have few merits. Documentation is sparse, incomplete, and poorly translated, and none of it is designed to aid in an actual upgrade. Technical support staff have been courteous and responsive, but they have not been very knowledgeable about specific PC configurations. Unless you are upgrading a standard office-type PC, plan on providing your own technical support.

We encountered several problems that may show up in any such upgrade. The original IBM power supply is not large enough to provide power for all 8 of the 386/16 expansion slots. The 275-watt power supply we bought to overcome this problem wouldn't fit in the machine, so we had to obtain a "tower" style case. The motherboard had a tendency to short out against the PC case; this problem was intermittent and required repair from the vendor. Configuring a large number of peripheral cards to prevent interrupt and memory conflicts proved to be a major task.

We feel that the motherboard upgrade option should be attempted only after careful consideration, and only if you are willing to work through the potential problems. Choose the motherboard carefully with consideration for the vendor, and above all be prepared for the worst.

§ § §

Mark Tolton, Manager of the RTP Information Centers, wrote this account of another 386 upgrade option, the Intel Inboard.

In the RTP Information Centers we have been testing an Intel Inboard 386 as a potential upgrade alternative for our original IBM AT 6Mhz and 8Mhz machines. The Intel Inboard is just one of the alternatives we are considering. The Inboard is not cheap. When you add 3 megs of memory and a

387 math coprocessor the total cost--including board, piggyback memory, cabling kit, and math coprocessor--comes to \$2500. For that amount of money you can buy another system unit as an alternative to multi-tasking.

Installing the board, chips, straps, etc., is no easy task. Allow approximately 2 hours for the task, and attempt it only if you have the eyesight and the steady hand of a fighter pilot. Do not attempt this installation just before lunch. There are 5 major steps to installing the board and software. The manual strongly recommends that you let your dealer do the installation unless you are experienced working with electronics. Here are the 5 steps:

1. Install memory on boards. Special tools are available for this task.
2. Set the board's dip switches.
3. Put the board into computer. This involves removing the 80286 chip, the 287 coprocessor, and the disk controller.
4. Run the setup program.
5. Install the Inboard 386 software.

After completing these five steps, when you reboot your system you have a 386/16Mhz machine capable of multitasking. The board comes with software utilities for caching, turning extended memory into expanded, and swapping slow memory for fast memory. So far our board has performed well with the standard DOS programs, and we have observed a speed increase of about 30% for most applications. This is especially important if you are a heavy graphics user. Occasionally, for no apparent reason, the machine locks up and we must reboot the system.

To test the Inboard's multitasking performance, we installed DESQVIEW 386. We have had reasonable success running programs in the background for printing and downloading files, while concurrently running one other application in the foreground. Memory seems to be the critical factor in multitasking. At least 4 megs of available memory is recommended; if you're rich, get 8 megs.

Based on our testing, we would recommend the Inboard only if increased speed is a significant factor in running your applications software. Otherwise, save your money and buy a true 386 machine when you can afford one.

§ § §

This item came to us from Theresa Rhyne, an information center consultant in Research Triangle Park. Theresa is our Macintosh expert.

Symantic Tools is a group of utilities for Macintosh computers, similar to the Norton Utilities for IBM PCs and compatibles. We recently had the opportunity in our information center to test these tools under live conditions.

When the Tektronix ColorQuick was improperly connected to the Macintosh II during our color hardcopy output testing, a crashed hard disk on the Macintosh II resulted. To recover, the Symantec Tools for the Macintosh were used, along with a Macintosh Bernoulli 44 cartridge. Symantec Tools provides a menu that allows the user to select a storage medium to which the crashed files will be restored. We selected the Bernoulli cartridge as the intermediate medium, then copied the restored files to the Mac's hard disk. This method allowed us to efficiently recover most of the files that were lost when the disk crash occurred. We can now with good conscience recommend Symantec Tools for Macintosh users.

How to Submit Items for *Open Forum*

In keeping with the PC Technology Assessment Program's objective to have the user community actively involved in TAP projects, users are encouraged to submit items for inclusion in future *PC TAP Consumer Reports*. If you have independently investigated the capabilities of a software product or a hardware component, we would like to hear from you. We'd also like you to share with others your solutions to any problems you may have encountered with a particular application or device, and about tricks, shortcuts, or unique applications you have devised. Although we can't promise to publish every contribution, we will evaluate them all in terms of their potential interest to our readers and their conformance to the spirit and intent of PC TAP.

There are no additional rules for *Open Forum* contributions, but here are some guidelines:

1. Contributions must be typed. Our first preference is that they be submitted on a floppy disk in WordPerfect format. If that isn't possible, the next best method is to EMAIL the text to DAVE.TAYLOR, EPA3099. The least preferable method, but still acceptable, is to mail a typewritten article to TAP at the address on the cover of this publication.
2. The length of your contribution will be determined somewhat by its complexity. However, keep in mind that we're primarily interested in the purpose of your study project and how pleased you were with the results, not in the nitty-gritty details of how you did it. We will publish your name, address, and phone number for those who want more details. Two to three pages is probably a reasonable maximum length. On the other hand, a paragraph containing a nugget that may be useful to others would be equally welcome.
3. All material submitted by users is subject to our editing, and you will not be given an opportunity to review the final manuscript before publication. Sorry, you'll just have to trust us. If we have questions or don't understand any part of your text, we'll contact you for clarification.

We hope you enjoy *PC TAP Consumer Reports*, and we look forward to hearing from individuals who have insights or discoveries to share with others. Thanks for your interest and your participation in the PC Technology Assessment Program.