I want to present information here to help managers, project coordinators, and end users make informed decisions about graphics hardcopy device acquisitions. This information falls into three categories.

1. Criteria for judging output devices. All these factors should be considered before any purchase is made. Considered here are presentation quality, resolution, number of colors, speed, cost, preview capabilities, media, plot size, required software, and configuration possibilities.

2. The configuration possibilities of various hardcopy devices is a criterion that requires special attention. Can the device you are considering be used in the configuration you want?

3. The wide array of hardcopy technologies available is presented with an evaluation of each of these on the criteria presented in the first part.

**CRITERIA FOR SELECTION AND COMPARISON**

The following criteria should be considered before any graphics hardcopy device is purchased. Determine what your needs are for each item. Does the device you are considering meet these requirements? If not, are there other ways to meet these needs? Don’t lock into a certain feature prematurely, many feature combinations may solve the specific problem or serve a particular need.

It may be helpful to arrange requirements and features into three categories: absolutely essential, features that would be a definite plus, and finally features that don’t make any difference one way or another. Actually having each user or group that will be using (or paying for) the device make up such a list is a good way to determine if everyone is expecting the same thing from graphics hardcopy. If there are disagreements, these lists are a good starting point for compromise or determining that several different devices are actually required to meet all needs.

The following criteria are a good starting point when constructing your needs list.

- **Presentation Quality** - How good does your hardcopy have to look. Who is going to see it and what is it going to be used for? Is the hardcopy for internal use only - "throw away graphics" or does it need to be of "presentation quality"? Most graphics software on the market is capable of producing "presentation quality" graphics. The real limitation is the hardcopy device used. The quality of the picture itself is a combination of many of the hardware features listed below.

- **Resolution** - refers to the discernable line pairs per inch the device can produce. What is usually reported in the device specification sheet is addressable dots per inch (dpi). This resolution specification is misleading. With many devices the "dots" actually overlap. Thus the number of discernable line pairs per inch will be less than the dpi. The smaller the dot overlap the closer dpi will come to describing the actual resolution of the device.

However, if the dots do not overlap, diagonal or curved lines have a pronounced stair-step or jaggy look. The greater the overlap the better these lines will look.

The bottom line is that you need to see actual graphs produced by the device when evaluating resolution quality. Get samples on the media you will be using, as plot quality is often affected by ink bleeding on the paper or other problems specific to the media/ink combination used. As a rule of thumb, pen plotters have excellent line production, as do other devices with a dpi of 240 and higher. A dpi of 150 and greater will produce reasonable line quality. Resolution below 150 will generally produce lines of poor quality.

- **Colors** - Many experts say that the use of more than 5 colors in a graphics presentation is probably excessive. Some applications, however, may make the gradual shading of a bar or background desirable, thus making the availability of 4K or more colors necessary to get good results.

There are other considerations that may be more important than the number of colors. Are the edges of the colors clear and crisp? Is the solid fill really solid or does it have streaks, blobs, or background white showing through? Is the color produced the one you expected? That is, is red, red or is red, orange?
Another factor that makes speed evaluation difficult is rasterization time. To explain, some basics need to be described. All graphs start as vector information. That is, each line necessary to create the graph is described exactly. To get a clear picture, imagine you are trying to tell someone how to draw a plot or graph paper over the phone. The conversation might go something like this:

First put the pen down on the 5,5 coordinate. Now move it to the 5,10 coordinate. Continue the line to 15,10, and then to 15,5, and finally return to the 5,5 coordinate.

You have just described how to draw a rectangle using vector data. If your friend were a bit more sophisticated, you could have said "Draw a rectangle with the lower left corner at 5,5 and the upper right corner at 15,10" and you would have still have been providing vector information. (Most vector devices have these advanced capabilities.)

Most plotters and terminals actually accept this type of information and draw everything in the picture in the same order that you describe it. On many other hardcopy devices, on the other hand, the picture is made up of millions of little dots or pixels that are either on or off. Rasterization is the process of taking vector information that describes a picture and translating it into data that specifies which pixels need to be on to create the picture. Considering that raster devices have 8 to 80 million pixels, this process can be time consuming and CPU intensive.

Rasterization either takes place in the host computer or in a microprocessor attached directly to the hardcopy unit. While the specification sheet may say that the device is capable of delivering 8 copies a minute, the rasterizer it is attached to may only be able to process 1 file every 2 minutes. The amount of time needed to rasterize a file is dependent on the complexity of the graph.

Other factors that affect the speed of hardcopy output are the built-in hardware capabilities of the device. For example, many devices can produce a solid polygon, like a bar in a bar chart, from a single command that describes the lower left and upper right coordinate. This means that the amount of data that must be transmitted to the device is much less than if the solid polygon had to be described by hundreds of individual vectors.

To summarize, the speed of hardcopy output can be broken into three factors. First the creation of the vector data. This time is directly related to the complexity of the graph and is fairly consistent across devices. The more graphics primitives (ability to do hardware fills, polygon generation, circle drawing, and the like without needing to have all the vector supplied) the device has, the shorter this time and the shorter the data stream that is produced.

Secondly is the time required to transmit the data to the device. This time is directly related to the amount of data to be transmitted and the speed of the communications line. If the vector data is rasterized on the host computer, this datastream will be quite long compared to vector data sent to a rasterizer or a vector data driven device.

Finally, there is production time, the amount of time it actually takes to draw the picture. This is the time that is generally reported on the device specification sheet. As you can see, because of differences in other speed factors, this time isn’t always a good yardstick for comparison of devices.
Small errors or adjustments can be made easily on the terminal. If you must wait for your hardcopy before determining if the graph is correct, you are going to waste lots of time and resources. Optimally, you need a terminal capable of producing a picture as close to the hardcopy resolution and color as possible. The larger this discrepancy the more you will actually be using the hardcopy as a preview device and the more time you will waste.

- **Multiple copy capabilities** - How easy will it be to produce multiple copies? This aspect of hardcopy is often overlooked and can be a costly mistake. There are several options listed from the most efficient to the least. 1) A color photo copier. 2) Some rasterizers can produce multiple copies with time-consuming re-rasterization. 3) The system spooling system can be used to direct the graphics data to the device may have the capabilities to direct multiple copies of the same data. 4) Software on a PC or host computer can be used to replay saved graphics command data sets. 5) The graphic procedure can be run multiple times.

- **Media** - Do you need graphics produced on transparencies or 35mm slides? It may not be necessary to have the graphics output produced directly on all media you need. There is other hardware that may serve your needs that can make the transparencies or slides. Or you may choose to have your slides made by a service bureau. Some of these can take either data or hardcopy for slide production. Also be aware of the cost and availability of the media used by the hardcopy device. Some media may not be available or very expensive. For example, a box of clay-coated paper for an ink-jet printer may cost $60 while a laser printer may be able to use ordinary copier paper.

- **Plot size** - Do you need large scale plotting capabilities. Some plotters are capable of producing graphs 48 inches wide with a virtually unlimited length. Most of the other hardcopy devices are limited to 17x11 or 8.5x11 inches but there are exceptions. If you need large scale plots it will be possible to eliminate many devices on this criteria alone.

- **Software support** - Do your graphics packages support the device? If they do, do they also support all of the features of the device you want to use? Do they support your device in the configuration you want to use? If you are planning to use a protocol converter make sure it is supported for the configuration you are planning to use.

Your graphics package may support a particular device but it may not work on your system without additional hardware or software. When you talk with your systems support staff be specific about the configuration you will be using.

Graphics data is often (usually) very different from the data you are used to transmitting. Often systems are not equipped to transmit this type of data. Users then find themselves with plot data that is perfect on disk but with no means of getting uncorrupted data to the device.

- **Configuration Possibilities** - Do you need the device to be in a remote configuration and available to multiple users or in a workstation where the hardcopy device is tied to a single terminal. Some devices are more suited for one of these configurations. Others can only work in one configuration. Before making a purchase make sure the device will work in the desired configuration. This means you must have the appropriate system software, possible additional hardware, and that your graphic package supports the configuration. Some specific configurations are discussed in the final section of the presentation.

**OVERVIEW - EVALUATION OF CATEGORY OF DEVICE WITH SPECIFIC EXAMPLES**

- **Pen plotters in eavesdrop mode** (figure 1) In this configuration the hardcopy device, usually a plotter, is attached directly to the host computer. A second cable then attaches the plotter to the user's terminal. The graphics job is run interactively and any graphics data that are created are sent directly back to the terminal. The plotter is listening in (eavesdropping) on the line and recognizes commands intended for it. So when the graphics procedure starts sending data the plotter starts plotting. The users terminal is disabled while the graph is being produced.
An advantage to this mode of operation is that the device can be monitored directly by the user who gets immediate feedback. The disadvantage is that the device cannot be easily shared by multiple users and if the graph is complex the user's terminal can be tied up for a long time while the plot is completed.

- **Other hardcopy slaved off a PC (figure 2)** - As PC workstations have become more popular and small desktop plotters less expensive this mode of operation has become more popular. In its simplest form the graphics file is created on the host computer and written to disk. The file is then downloaded to a diskette on the PC. A program, running on the PC, reads the diskette and writes it to the plotter port on the PC handling any handshaking requirements the plotter has to prevent a buffer overrun.

- **IBM PC/G, PC/GX, and 3179G terminals (figure 4)** - These terminals are a class by themselves because they allow you to attach an ASCII plotter or printer to an SDLC terminal. Copy can be sent directly to the hardcopy device or created as a screen dump. This configuration requires release 4 of GDDM and the terminal is tied up while the plot is produced.

- **ASCII Pen plotters in spooled mode (figure 5)** - Many ASCII pen plotters can be attached to a protocol converter (minicomputers can spool directly to the device without a protocol converter) and receive graphics data directly from the system spooling facility (not provided by SAS Institute). Pen plotters can theoretically work in this mode, but, in practice, are not worth the trouble. To be practical the device should, at very least, have an autofeed capability. This allows the plotter to produce several copies without any operator intervention. The plotter should also have supported. This is often an attractive configuration because if you can get a picture on the terminal screen there is no need for additional software or hardware.
the pen capabilities to provide the necessary colors for your output without operator intervention. Finally the plotter, if it is to receive much use, should be fairly fast so that it isn’t easily bogged down.

These criteria eliminate many plotters that are designed primarily for eavesdrop mode. Devices that work well in this configuration include most plotters marketed by Nicolet and CalComp. In addition, the HP7220T and HP7550A plotters work well in this mode.

Nicolet offers a line of plotters with built-in protocol converters. These plotters can be attached directly to your control unit as an IBM 3287 printer.

- Raster devices in a spooled mode (figure 6) - Most raster devices are also used in a spooled mode. The expense of these devices make tying them to a single work station impractical. The most common setup has the hardcopy device attached to a rasterizer which is in turn attached to a protocol converter. Since the rasterizing is the bottleneck in the process, some devices can be attached to several rasterizers. This enables the device to produce output continuously rather than spending most of the time waiting on the rasterizer to finish.

Tektronix has just announced the 4510 CX rasterizer that can be attached directly to your control unit without the need for a protocol converter. Their 4681 or 4692 ink-jet printers can be attached to this rasterizing unit.

PC Rasterizers (figure 7) - There are rasterizers for some device installed on a board that can be fitted in a PC. A program can be run on the PC that receives the vector data from the host computer. The rasterization is then done on the PC and the raster data is sent to the hardcopy device that is attached to the printer or IEEE port of the PC. This option is less expensive than the standalone rasterizer if the cost of the PC isn’t included, i.e. you have a spare PC that can be tied up when ever the hardcopy device is in use.

Host to PC communication is accomplished through a 3270 board in the PC, or a protocol converter, or downloading via ASCII lines. With the appropriate software on the PC this can be an automatic process requiring no operator intervention for the PC to communicate with the host spooling facility.

Some terminal emulator programs, programs run on a PC to make them the functional equivalent of a terminal, have built in rasterizing capabilities. SAS/RTERMTM is one of these, providing raster data for Tektronix ink-jet printers.

Introduction to Graphics Hardcopy Technology

This section will provide a brief introduction to the types of hardcopy available and a brief discription of the technology involved. We will cover five general categories of devices: pen plotters, electrostatic printers, ink-jet printers, laser printers, cameras, and thermal transfer printers.
PEN PLOTTERS

Plotters are electro-mechanical devices that drag a pen across paper to produce a plot. Plots are drawn directly from vector input. Line widths can be changed by changing pens. There are two main types of pen plotters. Flatbed plotter pens are pulled in two directions across a fixed plotting surface. The largest of these draw up to 66x47 inches. Drum plotter pens move in one direction only while the paper rolls back and forth in the other direction. This means the plotter is capable of creating plots of unlimited length in one dimension. These plotters generally take up less floor space.

General Info

- Resolution - Plotters have an addressability that ranges from 200 to 1000 lines per inch. The actual resolution is limited by how narrow a line the pen can draw. Plotters, since they actually draw a line directly between two points, have the best line production of all devices.

- Ink - use fiber tip, roller ball, or liquid ink pens. Some plotters have self capping pens. Others tend to dry out if left unused in a plotter for several hours.

- Colors - Number of colors are only limited by the availability of pens. Plotters generally hold from 1 to 8 pens. Additional colors are achieved by changing pens in the middle of graph production (this doesn’t work well for batch environments).

- Speed - slowest of high resolution devices. The speed depends on acceleration (average 3g), top speed (average 20 in/sec), pen up/down cycle (average 12 microseconds/cycle), internal buffer size, and efficiency of plotting language. 3-10 minutes per 8.5x11 page.

- Cost - relatively inexpensive in initial cost, per copy cost, and maintenance cost.

- Media - most can draw directly on paper or acetate with the appropriate pens. If you need transparencies make sure this media is available for the plotter you have in mind.

Also be aware of any special paper needs. Does the plotter require special paper? If it uses continuous feed roll or fan fold paper, is the paper generally available, or does it need to be special ordered?

- Configuration - Most of the smaller flat bed plotters are designed primarily for use in an online, interactive mode. This means the plotter is attached to and used from a single terminal. Others can be used in a batch mode and shared by multiple users. To be useful in a batch mode the plotter must have automatic feed capabilities.

- Strengths - best production of line drawings.

- Weakness - slow solid fill.

IMPACT PRINTERS

Tiny hammers strike an ink impregnated ribbon against the paper to produce a dot or actually a matrix of dots. The paper moves up while the hammer head moves across much like a typewriter.

General Info

- Resolution - around 100x100 dots per inch, somewhat higher for some black and white devices.

- Ink - ink impregnated ribbon.

- Colors - multiple colors are achieved by using a four-color ribbon or by actually changing the entire ribbon. Some models provide up to 8 colors by dithering the three colors on the color ribbon.

- Speed - all graphs take about the same time as the print head always makes a complete pass across the page. Per copy times vary by machine from around 3 to 6 minutes per page.

- Cost - per copy cost runs from about 15 cents to 40 cents and the device runs from about $4000 to $10,000.

- Media - Paper only, most use continuous feed fan fold paper.

- Plot size - 8.5x11 to 11x14.

- Configuration - primarily used in a batch environment.

- Strengths - much faster text and solid fill production than a pen plotter.

- Weaknesses - ribbons get chewed up; color intensity deteriorates as the ribbon is used; on printers that allow overstriking of colors, the ribbon colors can become contaminated; the resolution of line drawings is poor and the solid fill is often not that solid.

ELECTROSTATIC PRINTERS

These devices use raster or pixel information rather than vector input. A long plotting head that extends across the width of the paper is embedded with as many as 21,760 tiny styluses. As the paper rolls past this head, these styluses...
produce tiny electrostatic dots at the appropriate points. The paper is then processed in liquid toners to produce the permanent image.

Color processing requires that the paper be rewound and an additional pass made for each color. Color processing is, of course, a bit slower than black and white.

General Info

- Resolution - ranges from 100 dpi to 508 dpi. At higher resolutions lines look almost as good as those produced on a plotter.
- Colors - Until the last couple of years these were black and white devices. New models from Versatec, Benson, and Calcomp can produce a full range of color from 3 primaries and black using a dithering process.
- Speed - These, and laser printers, are the fastest of all hardcopy devices after they receive the rasterized data. For black and white plots up to 8 per minute is possible, but 2 per minute is more likely. Color requires about 4 to 5 times as long to print. The bottleneck in this process is the rasterizing of the data that can slow the process down. This is done either on the host or at a controller connected to the device.
- Cost - b/w at about 10 cents a copy, color runs a bit more. These devices are expensive, running around $100,000.
- Plot size - Many new models handle up to E size paper in roll or sheet feed.
- Configuration - batch output.
- Strong points - speed, no pens or jets to wear out.
- Weak points - generally higher maintenance cost.

INK-JET

This raster device shoots tiny droplets of ink onto the paper. Two major technological differences seen in these hardcopy devices are continuous stream vs. drop on demand ink delivery systems. Continuous delivery systems consist of a stream of ink that is electronically diverted to the paper when the print head is at the appropriate location. When not going to the paper, the ink flows into a gutter that returns the ink to the reservoir. Drop on demand systems only deliver ink when the print head passes over the appropriate spot on the paper.

Another difference between ink-jet devices is the movement of the print head. On some, the head passes over the paper like the type ball of a typewriter. These often make a separate pass for each color. On others the paper is attached to a spinning drum while the print head scans across the paper in the axis of the drum.

General Info

- Resolution - ranges from 120 to 180 dpi. This allows reasonably good production of lines and very good solid fill.
- Colors - The first of these devices were black and white only. Now there are many full-color devices. Generally these have three primary colors plus black and achieve a wide array of colors using dithering to generate from 125 to 256 colors with its internal hardware. Many of these can be attached to rasterizers that can increase the number of colors that can actually be produced upwards to more than 150,000 colors.
- Speed - copies in 1.5 to 3.5 minutes. Again since this is a raster device, raster time can reduce actual throughput.
- Cost - $1600 for the Tek 4695 to $17,000 for the Benson Color Scan. Per copy cost range from about 7 cents per page to 15 cents.
- Plot size - 8.5x11 to 11x17. Some are sheet feed and others are fed from a continuous roll.
- Configuration - There are two common configurations for this type of device. The first, and most simple, is attached to a terminal or PC's printer port. Firmware in the terminal or a program in the PC can do a screen dump to produce a graphics hardcopy of a plot displayed on the screen. Some of these configurations are able to produce hardcopy with higher resolution and more colors than the display screen.

In the second configuration, the printer is attached to a rasterizer (and protocol converter on IBM systems) and vector data is spooled to the rasterizer. When all of the data is received, it is rasterized and sent to the printer for hardcopy.

- Strengths - Works very well as a local screen copy device for both graphics and text. Though for some, the terminal is disabled while the hardcopy is produced. Solid fill is good and copy is faster than most pen plotters (much faster if there is alot of solid fill). As a batch device, ink jet printers require little intervention. These devices are the quietest (except for perhaps cameras) hardcopy device around.

- Weakness - Some of the earlier models were plagued with clogged ink jets. Most newer models have solved this problem with various flushing mechanisms. Some devices leave some narrow empty spaces in solid fills, be sure you get to see several examples plots with solid fill.
LASER PRINTERS These are perhaps the fastest high-resolution hardcopy devices on the market. Most of these are designed around the engine of existing office copiers. Laser beams generate the image on a photoconductor drum. The drum picks up toner which is transferred to paper and fixed with heat and pressure. For color, this process is repeated three times, once for each subtractive color. 

General Info 
- Resolution - from 100 dpi to 300 dpi. 
- Colors - Currently most of these device are black and white. The one exception, the Xerox 6500, can produce a total of seven colors using a combination of three colors. 
- Speed - IBM claims you can get 215 pages a minute on an IBM3800 model 8 which makes this the fastest (and one of the most expensive) graphics hardcopy device on the market. Most of the other printers can give you a page every 5 to 10 seconds from rasterized data. To get color on the Xerox 6580 takes about 20 seconds a copy. 
- Cost - Top end devices (IBM3800 and Xerox 9700) run between $300,000 and $400,000 and can produce a copy for about 4 cents. The mid-range printers (based on the Xerox 2700 engine) run around $10,000 to $21,000 and produce copies for about 5 cents. For color, the Xerox will cost about $30,000 and produce copies for 6 cents (it will also provide color copy capabilities). 
- Plot size - most can take either 8.5x11 or 8.5x14 sheets. 
- Configuration - Because of the cost of these devices they are almost always used in a batch mode. Many have a built in rasterizer so that vector data is spooled to the device via a protocol converter and then rasterized. For others the rasterization is done in the host computer, increasing host resources and transmission times used. 
- Strengths - Speed, high quality black and white, these devices are good for graph/text combination applications. 
- Weakness - Generally higher maintenance cost. Most people have some feeling about maintenance on a Xerox copier, one would guess that these are at least slightly worse. An IBM3800, at 215 pages a minute could keep an operator pretty busy. 

CAMERAS There are several different ways to produce graphics output on slide or print film. The first way and simplest technically is to photograph the screen of a display terminal. This is actually how some of the graphic displays were created for some of the older SAS/GRAPH® flyers at the Institute. To achieve the best results the camera should be on a tripod and the picture taken at a relatively slow shutter speed. 

The room should be dark. Using a telephoto lens at least 135 mm. long will help reduce some of the screen curvature from distorting the picture. Obviously this setup can only be used in a rather limited production environment. 

The second method requires a graphics camera that takes as input the RGB output from a terminal. These devices have an internal monochrome screen where the red, green, and blue components are displayed one at a time through the appropriate color filter. Resolution is limited to that of the terminal the display is created on. 

With the third type of graphics camera the picture is created directly on a high resolution monochrome screen in the device. These are raster devices, and like the camera above, the film is exposed through filters to achieve a wide array of colors. Unlike the camera above, the resolution is not dependent on any other device. The raster data is produced specifically for the camera device. This produces the highest resolution of any graphics output device. 

Finally, Hewlett Packard has introduced a vector graphics camera. Like the other devices, it has a monochrome screen and the film is exposed through filters to achieve different colors. The difference is that rather than producing the entire picture on the monitor and then exposing it or turning on a pixel at a time while the film is exposed the graph is actually drawn on the screen a vector at a time. This technology has some drawbacks but is much lower in price than the raster devices. 

General Info 
- Resolution - The resolution of the terminal driven devices is, of course, tied to the resolution of the parent terminal. The directly driven camera have resolutions ranging from 4096x2732 up to 32Kx32K. At these resolutions line reproduction is as good as a plotter. This makes for perfect graphs. 
- Colors - This depends on the technology. For the first two types the number of colors is dependent on the parent display terminal. The other can generally produce over 17 million colors. (Of course it is doubtful that you can distinguish all these colors.) 
- Speed - varies from about 4 per hour to 15 per hour. On the direct driven devices, as the resolution increases the speed decreases. On the plotter camera, the speed decreases with the complexity of the graph and the amount of solid fill. 
- Cost - When calculating the cost of a camera system it is necessary to consider all the components. The terminal driven cameras run from $6,000 to $25,000. The rasterizer driven camera run from $2,000 to $25,000
dollars for the camera and an additional $3,000 to $7,000 for the rasterizer. The plotter camera is priced at about $13,000. Don't forget the cost of the protocol converter at about $2,000.

- Media - Cameras are available that use regular 35mm film for prints or slides or Polaroid film.

- Configuration - Terminal driven cameras are attached to existing terminals, no additional system software is required.

The standalone versions are generally setup in a batch mode with the rasterizer attached to a protocol converter that emulates a 3287. The camera is then attached to the rasterizer. Some rasterizers can be attached to an ASCII terminal in an eavesdrop mode, but this ties the camera to a single workstation and thus it cannot have output routed to it from multiple users.

Some cameras come with a rasterizer that is actually a board that can be installed in a PC. The graphics file is downloaded to the PC. It is rasterized on the PC and printed on the camera. This configuration can be automated so there is no operator intervention required on the PC. The PC, however, is unavailable for general use.

The final type camera can be set up just like an ASCII plotter in eavesdrop mode or attached to a protocol converter so the output can be spooled to it.

- Strengths - You have never made such pretty pictures. With close to perfect resolution and unlimited colors the direct driver cameras are the definition of presentation quality. The terminal driven cameras really are not in the same league.

- Weaknesses - Turn around is slow. Unless you have inhouse film processing the minimum turnaround is a day. Sometimes there will be problems with the film, the developing, the colors might not be exactly right, or your design might need a minor adjustment requiring that a graph be taken several times before you get it just like you want it. This can be time consuming. For best results, a high resolution preview device capable of producing 4K or more colors is almost a requirement. Per copy price is high as is the equipment. If an inhouse system is not feasible, you might consider a service bureau that can produce the slides from computer generated data.

THERMAL TRANSFER These raster devices use sheets of material impregnated with a low-melting point wax transfer ink. The print head melts the wax binder to transfer the ink to the paper.

General Info

- Resolution - from 100 dpi to 240 dpi.
- Colors - Either b/w or can produce from 3 to 8 colors. Three passes of the paper is required for color processing, using a combination of three colors.
- Speed - 1 to 2 copies per minute, a little longer for color. This does not include raster time.
- Cost - Purchase cost runs from $4500 to $11,000 and copies can be produced for 5 to 25 cents.
- Plot size - 8.5x11.
- Configuration - These devices are either used in a batch mode attached to a rasterizer or as a screen dump device.
- Strengths - Low initial cost and reliability. Solids are very solid and the colors don't fade.
- Weakness - limited colors support.

Summary

1. Decide what you need in terms of colors, media, resolution, configuration, and speed.
2. Determine which devices and configurations will fit those needs.
3. Compare output and costs of possible devices. Discuss these devices with those who have actually used them.
4. Determine what additional hardware and software will be needed.
5. Contact the vendor to arrange a short term loan of the device or about the possibility for a trial period.