Comparison of Mainframe Hardcopy Devices Compatible with SAS/GRAPH

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Abstract and Introduction

Mainframe hardcopy devices compatible with SAS/GRAPH are compared. Devices in the Appendix are ones I support at my site. There is also discussion of devices and/or technology under study or evaluation, and of post-processing technology to leverage the use of SAS/GRAPH hardcopy; in most cases, I do not mention brands and models—so as to not slight any specific product, especially for technology available from multiple vendors. Ink-jet printers and electrostatic plotters are not discussed.

Some Evaluation Criteria

Some evaluation criteria to consider are:

• Computer connectivity, software compatibility, ease of interfaceability
• Speed
• Quality
• Reliability
• Critical special features, if any
• Ease of use and customer-provided maintenance (i.e., convenience)
• Arrangements for vendor-provided maintenance
• Computer and network resource requirements (CPU time, memory, print file size)

Easily quantifiable costs (consult the vendor) are:

• Acquisition (And can you afford a second one for backup?)
• Vendor-provided maintenance and repair
• Per-page charges, if any
• Supplies (traditional), as well as parts which are known to require periodic replacement, whether by vendor or customer

The Quest for Economy

To assert that backup can be provided by a pre-existing (or new) alternative device type is understandable optimism. However, the ultimate user of one's graph may insist, with short notice, on what only the primary device can deliver. At best, the creator will have to go through unwanted, time-consuming rigmarole to revise the program (and maybe even redesign the graph) for the alternate device type.

There is no such thing as a device-independent program, unless you don't really care what the result looks like. Even if result-constancy across device types is unimportant, device-independent programming is probably undesirable, if not infeasible. Replaying a catalogued graph through a color map—assuming you want to bother—can succeed only if the palette of the alternate device is larger or equal in size to that of the preferred device. And, if one relies on hardware characters (typically fixed-width) to reduce print times and computer resource requirements, then what fits across the page on the preferred device may be too wide for the alternate, requiring SAS/GRAPH to draw the text with its default scalable software characters—unattractive in the result, inefficient on the computer, and slow at the hardcopy device.

Technology Background

Dot-matrix Printers

If high resolution and color are not needed, then dot-matrix print is acceptable.

Color is available on dot-matrix printers. But the best use of color is solid fill. And dot-matrix printers do a poor job on solid fill. Their fill is not really solid—instead it is mottled and/or banded. (This is true even for an exceptional 720 dot-per-inch, high-resolution dot-matrix printer.) Furthermore, the paper gets rippled from the beating by the print head. And since the printers with a palette of eight or more colors actually rely on multiple passes for blending with different primaries from a four-color ribbon, not only does the rippling increase, but also the second (or third) pass to color one area lets the ribbon brush across the high spots on adjacent areas, producing discolored islands there.

The use of a ribbon is a guarantee that print quality gets progressively worse as more and more ink comes off the ribbon. The increasing faintness is especially apparent on a color printer.

Dot-matrix printers are not fussy, and allow the user to feed them with a box of, as many as, 2700 sheets of continuous-form pin-feed paper, needing no
attention until that runs out, or the ribbon quality finally becomes intolerable.

Dot-matrix printing is best suited to black-and-white analytical graphs, not color presentation graphs.

**Pen Plotters**

Pen plotters offer the ultimate in resolution, and (if pens are in good condition) produce excellent solid fill. But they are not without limitations.

The more solid fill, the more text, and the more line drawing, the longer the plot takes. Plot times for anything complex range from minutes to (for the extremely complex) hours.

Plotter pens wear out unpredictably. Since, except for a recently announced one, plotters do not monitor pen condition, the result can be an unexpected pile of scrap—unless the plotter is at one’s desk, or one first runs an area-fill pen test. The more colors, the more pens. Every pen presents the threat of a random commencement of scrap production.

The quality of result can be a strong function of paper choice. Glossy paper gives the best result. Unfortunately, the glossing agent gradually cakes up on the wheels of an autofeed mechanism, which require cleaning to prevent or cure paper jams.

Despite the drawbacks of such technology, pen plotters from Hewlett-Packard are the most widely installed equipment for presentation-grade color graphs. HPGL (Hewlett-Packard Graphics Language) is a de facto industry-standard graphics data stream protocol.

Manufacturers of graphic hardcopy devices, whether pen plotters or not, typically provide HPGL compatibility. The SAS/GRAPH HPGL drivers can bridge one’s graphs to a device for which there is no “native” SAS/GRAPH driver.

(PostScript is a new industry standard for graphic, and publishing, data streams. But it has been reported that a representative graph may produce a PostScript print file five times the size of the corresponding HPGL print file.)

**How to Avoid Smearing on Plotter Area Fills**

Pen plotter ink, depending on the medium, may dry slowly. If you lay down black ink first, a lighter-colored pen which touches the black area (or boundary) while filling an adjacent area may pick up black ink and smear it across the lighter area. To avoid this, define BLACK last in your GOPTIONS COLORS=list, and load the black pen in the last position of the pen holder.

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**Thermal Wax Printers**

Thermal wax printers (a.k.a. thermal transfer printers) technology yield flashy output, but are the antithesis of plain-paper technology.

The paper is flimsy and wrinkle-prone, and tends to curl. The wax image can be damaged. It can even lift off paper lying (pressed) on top of the original.

Confidentiality, if a concern, can be compromised if one forgets that thermal transfer printers retain a roll of negative images of what they have printed.

Most of these printers leave big margins.

Thermal wax printers are probably best suited for transparencies—which are not expected to be sturdy, plain-paper, or bound in reports.

**Black-and-white Laser Printers**

Laser printers (and akin technology, e.g., LED printers) are the standard for presentation-grade and publication-grade black-and-white graphic hardcopy.

Industry-standard resolution is 300 dots per inch (dpi). For IBM, which has finally announced at least one device at 300 dpi, the standard is 240 dpi. However, with the enhancement that some IBM printers do, it is claimed that 240 dpi can be as good as, if not better than, 300 dpi. Other vendors are now enhancing 300 dpi.

(The charm of 240 dpi is that such a graph will take less CPU time to create it, less disk space or memory to store it on the computer, less time to transmit it, less memory to hold it in the printer’s buffer, and maybe less time to print it.)

As an aside, it should be mentioned that some laser printers—especially ones with complex internal paper handling—are subject to jamming if the paper type or condition is wrong. And, though laser printers are “plain-paper” devices, paper choice does—as with every technology—affect appearance of result.

Laser printers are the fastest technology, but, for graphic output, one cannot expect them to perform at their nominal print rate.

The commonest deficiency, if present, is inadequate memory in the printer. The circumventions are undesirable: a full-page image at reduced resolution, or a partial page at full resolution. Either alternative may be acceptable for an analytical graph.

**Color Laser Printers**

There are only three in the USA. Two are LED electrophotographic, one is truly laser. (Some persons
refer to, e.g., even thermal transfer printers as "laser printers". I do not.) The nominal print speeds are meaningless—they exclude time to transmit and rasterize the image, before actual printing begins. Prices start at $30,000.

Only the most expensive printer was designed expressly for mainframe attachment. Also, it is HPGL-compatible. Under restricted sale for 2-3 years as a "market probe", it's no longer available.

For the other two printers, the customer must find a communications interface for the mainframe; the vendors don't provide one. The mid-priced printer is compatible with PostScript. HPGL and PCL are promised additional options for the least expensive.

Some industry watchers were predicting imminent color laser printing for at least three years, but vendors have been reluctant to make my idea of a serious effort in the USA. There is talk: some mentioning imperfect technology, other lamenting the fact--probably the real reason for bashfulness to enter the market—that no one would be able to sell lots of them at present high prices (so they won't try to sell any). Now predictions (not mine) are that widespread color laser printing is years away.

Continuous-tone Printers

Many of these are thermal dye sublimation (not to be confused with thermal wax or thermal transfer) printers. One of the others uses laser-addressed liquid crystal light valve (LCLV) imaging. They give photograph-like results, and are marketed to attach to PCs, workstations, or video sources. Presumably some could be interfaced to a mainframe somehow. However, they tend to be costly, take 2.5 to 5 minutes per page, require thick (photo-like) paper, and—in many cases—yield an image as small as 4 X 5. The LCLV printer can produce 8-1/2 X 11 hardcopy, 35 mm slides, and stiff transparencies.

Other Technology

So far implemented only as a color copier (i.e., with no computer interface to its printer phase)—is CANON's bubble-jet technology. It can do output as big as 22" X 33", and even as big as 22" X 33", assembleable from 22" X 33" paper tiles.

Copiers for Post-processing

If high-quality color graphs are required in high multiples (e.g., 10 to 200 or more of each graph), high-resolution, comparatively fast color copiers make it feasible to rely on a comparatively cheap pen plotter to produce the originals only. The slow rate of plotting is less a concern, and multiples done on a copier do not wear out plotter pens.

One can also convert thermal wax output to plain paper with such a copier.

With a Varitronics PosterPrinter black-and-white copier, one can magnify the 7 X 10 center of an 8-1/2 X 11 original into a 23 X 33 copy.

Specific Evaluation

SAS/GRAPH-compatible mainframe hardcopy devices include:

- Hewlett-Packard 7550A Plotter
- Xerox 4045 Laser CP Printer
- IBM 3812 Model 2 Pageprinter
- IBM 3820 Page Printer
- IBM 4224 Model 2C2 Printer

All attach to a mainframe computer’s network in a standard manner. A summary comparison is given in the Appendix. See the author to view sample output.

Interface Systems, Inc. offers substitutes (not evaluated) for the IBM 3812-2 and IBM 4224-2C2.

Notices

*SAS/GRAPH is a registered trademark of SAS Institute Inc., Cary, NC, USA.

Release 5.18 was used for benchmarks and samples.

My remarks are intended neither as endorsement, nor as criticism. Nor as substitute for your own investigation and evaluation.

A March 1990 list of SAS/GRAPH-compatible hardcopy devices is in System Requirements, SAS System for MVS, Release 6.06, published by SAS Institute Inc., Cary, NC, USA. Equipment not listed may be useable with a SAS/GRAPH driver, if the output graphic data stream (e.g., HPGL, PostScript, etc.) is compatible with the device. The Institute says, "We strongly suggest a trial period be secured from the hardware vendor to confirm compatibility."

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### Appendix - Five SAS/GRAPH-compatible Mainframe Hardcopy Devices*

<table>
<thead>
<tr>
<th></th>
<th>HP 7550A</th>
<th>Xerox 4045</th>
<th>IBM 3812 Model 2**</th>
<th>IBM 3820***</th>
<th>IBM 4224 Model 2C2**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology</strong></td>
<td>pen plotter</td>
<td>laser</td>
<td>LED</td>
<td>laser</td>
<td>dot-matrix</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>highest</td>
<td>higher</td>
<td>high; fainter than other BW; best BW fill</td>
<td>high</td>
<td>medium-low</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>smoothest</td>
<td>300 dots/inch</td>
<td>240 dots/inch</td>
<td>240 dots/inch</td>
<td>144 dots/inch</td>
</tr>
<tr>
<td><strong>Special Concerns, Ease of Use, Etc.</strong></td>
<td>pens wear out unpredictably; vendor forbids glossy paper (needed for best quality result) in autofeed mode (needed for remote sharing)</td>
<td>not fuzzy; paper jams (rarely occur) easily cleared; SAS/GRAPH fills V = L2, V = X2, &amp; V = R2 are indistinguishable</td>
<td>extreme care needed when replenishing supplies other than paper</td>
<td>paper type or condition is important; extreme care needed when replenishing other supplies; big (floor, not tabletop)</td>
<td>flexible part of ribbon carrier may need manual adjustment to avoid snagging edge of paper; highest noise level; vibrates</td>
</tr>
<tr>
<td><strong>Colors</strong></td>
<td>8 colors</td>
<td>black &amp; white</td>
<td>7 colors (6 are greys)</td>
<td>greys, depending on software</td>
<td>8 colors</td>
</tr>
<tr>
<td><strong>Media</strong></td>
<td>8-1/2 X 11 (or 11 X 17); special paper; transparencies</td>
<td>8-1/2 X 11 plain paper</td>
<td>8-1/2 X 11 plain paper</td>
<td>8-1/2 X 11 plain paper</td>
<td>8-1/2 X 11 (or 11 X 17) continuous-form pin-feed paper</td>
</tr>
<tr>
<td><strong>Media Input Capacity</strong></td>
<td>100-150 sheets</td>
<td>depends on model</td>
<td>550 sheets, but 250 job separators</td>
<td>1100 sheets, but 250 job separators</td>
<td>limited by box size, usually 2700 sheets</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>low</td>
<td>low</td>
<td>medium</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td><strong>Supplies</strong></td>
<td>pens</td>
<td>toner; vendor-replenish developer</td>
<td>expensive: toner, fuser, developer, photoconductor</td>
<td>toner, fuser oil; vendor-replenish developer</td>
<td>8-color (4-color multi-pass) ribbon</td>
</tr>
<tr>
<td><strong>Duty Cycle</strong></td>
<td>25,000 pages per month</td>
<td>18,000 pages per month</td>
<td>100,000 pages per month</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>&quot;BY processing&quot;</strong></td>
<td>too slow; &amp; pens may wear out</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td><strong>Other Uses</strong></td>
<td>PC attachment</td>
<td>may need Xerox software</td>
<td>PC networks</td>
<td>typographic text; text with graphs</td>
<td></td>
</tr>
<tr>
<td><strong>Special Reqs.</strong></td>
<td>protocol converter</td>
<td>XGRAPH cartridge; extra memory</td>
<td>none</td>
<td>none</td>
<td>front panel initialization</td>
</tr>
<tr>
<td><strong>CPU Time</strong></td>
<td>1.12 X base</td>
<td>1.00 X base</td>
<td>1.49 X base</td>
<td>1.61 X base</td>
<td>1.49 X base</td>
</tr>
<tr>
<td><strong>CPU Memory</strong></td>
<td>1.01 X base</td>
<td>1.00 X base</td>
<td>1.14 X base</td>
<td>1.15 X base</td>
<td>1.14 X base</td>
</tr>
<tr>
<td><strong>Print Time</strong></td>
<td>116 sec.</td>
<td>29 sec.</td>
<td>58 sec.</td>
<td>16 sec.</td>
<td>96 sec.</td>
</tr>
<tr>
<td></td>
<td>71-166 sec.</td>
<td>27-34 sec.</td>
<td>52-62 sec.</td>
<td>8-30 sec.</td>
<td>92-99 sec.</td>
</tr>
</tbody>
</table>

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*Comparison of print times and computer resource requirements is based on a representative sample set, consisting of a line graph, a bar chart, a pie chart, and a choropleth map. Print times can be a function of, besides specifics of the application, environmental factors (computer, network, print queue, etc.), which differ from site to site, and change over time at each site. Because print files for some of the devices use variable-length records, file-size comparison is impossible.

**For Version 5 of SAS/GRAPH, I used the GDML8 driver for both the IBM 3812-2 and the IBM 4224-2C2.