# Reproduction Characteristics of Computer-to-Plate Imaging Systems

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Abstract

A series of press tests were performed at GATF during January 2-6,1995 from plates generated by various computer-to-plate (CTP) systems. The objectives of the study were to evaluate the reproduction characteristics of available platesetters and the printing characteristics of the laser imaged printing plates. The study was undertaken on behalf of the GATF members to inform prospective purchasers of CTP systems of the capabilities and concerns of this new technology. The study also provides methodology and test instruments that can be used in individual evaluation of these systems.

The GATF Digital Test Form was used for this study since it provides a variety of demanding targets that reveal crucial aspects of the CTP systems.

Participants are identified in this report only by code letters. The manufacturers, identified in Table 1, entered into the study with the precondition of anonymity. It would be unfair to pass judgment on a CTP system on the basis of a single test.

Historical Perspective

The ever increasing pace of the technological revolution that is sweeping through the communications industries has many traditional printers in a state of some anxiety. Simultaneous developments in the areas of typesetting, color scanning, computer systems, and software have brought a host of new possibilities to the printing industry. The printer must judicially

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select those technologies that will improve quality and increase profits while avoiding the technologies that will become burdensome. The proprietary typesetting systems of the late 1970's taught many companies a painful lesson. However, completely avoiding emerging technologies will ultimately have a deleterious effect on a company's profitability

Like most seemingly revolutionary technologies, computer-to-plate is actually the outgrowth of steady developments on several fronts. Advances in projection platemaking, laser technology, photo polymer chemistry, and desktop publishing have fostered the development of current CTP systems. There are three approaches being used for plate exposure devices: internal drum, external drum, and flat bed. Each has associated advantages and disadvantages.

Attempts at projection platemaking began 45 years ago, when some success was demonstrated in making paper plates by xerographic processes.[1] In 1954, it was reported that metal lithographic plates prepared with xerography were feasible in laboratory conditions and that such plates would have the resolution necessary to print military topographic maps.[2] During the 1960s, diffusion transfer and silver halide became the preferred methods for making litho plates by projection. By 1984, projection platemaking with Opti-Copy cameras was possible.[3]

In 1961 Theodore Maimin demonstrated the operation of the first ruby laser. This invention gave the industry a light source that could be focused so precisely that it could write individual halftone dots. By the early 1980s, computers were used to control lasers in imaging plates from digital files. The emergence of PostScript and software pagination packages made CTP systems more feasible. However, the photosensitive coatings on aluminum printing plates required long exposures to ultraviolet light. No lasers were powerful enough to expose them in a reasonable amount of time. Better plate coating chemistry (highly sensitive in the blue-green end of the spectrum) eventually provided the answer to this dilemma.

During the 1980s, CTP technology was most popular with small commercial and in-plant printers because short-run polyester plates were the only viable solution. However, there was a growing undercurrent of expressed need for high-quality, aluminum-based, computer-imaged litho plates capable of long-run process color work for general commercial and publication printing.

CTP technology has a number of potential advantages that make it a compelling issue for the graphic communication industry. Eliminating the film stage from the production cycle offers faster turnaround and lower costs for materials, labor, and overhead. It also provides better control over the process because fewer steps are involved. In theory, CTP has advantages for stochastic screening because the troublesome steps of duplicating films and imaging plates are avoided.

The expense of purchasing a platesetter ($200,000–500,000) and training personnel can pose significant drawbacks to obtaining a CTP system. In addition, the need to image color proofs from digital data presents additional concerns. Proofs are needed to predict color appearance on the press; to check the imposition of pages; and to check for moiré patterns, trapping problems, missing pieces, or reverse type. Usually, two different proofs are required: a color proof for customer approval, and a blue line proof to check imposition. It must be determined whether the same RIP will be used for preparing the proof and the plate data. The least expensive solution is to use a soft proof, but for many applications this is not acceptable because it does not provide a document confirming the visual "contract" with the customer. Digital proofers are available using electrophotographic, ink jet, thermal transfer, and dye sublimation methods. They range widely is quality, consistency, cost, and throughput.

With CTP systems, making the plate is the easy part. Information management and integration are more difficult. The requirements of trapping, imposition, networking, and data storage complicate the puzzle. For example, the time needed to run a file through a raster image processor (RIP) can be a bottleneck.[4]

Not all the obstacles to implementing CTP technology are financial or technical. As long as ad agencies persist in sending film-based ads, a hybrid approach incorporating plates that can be exposed partly with films and partly with digital data is a desirable option.[5]

CTP is fueling the efforts toward achieving standards for digital data exchange, with the TIFF/IT format (ANSI IT8.8) being a leading contender.

CTP systems require the exclusive use of digital control bars. There are both advantages and disadvantages to using these on press. The control bar will have the same dot structure, screen ruling, and imaging peculiarities as the live work, but it will no longer be a standard that is consistent from job to job. Instead, as the imagesetter characteristics change, those variations are reflected in the values of the control bar. Also, the color bar cannot contain very high precision patterns that are not able to be generated electronically. This becomes particularly troublesome when the requirements of throughput cause the resolution of the RIP to be at a low setting.

## Test Preparation

Fourteen manufacturers of CTP platesetters and nine manufacturers of direct-imaging printing plates were contacted in fall 1994 and invited to submit plates for this study. The plates were to be made from Encapsulated PostScript (EPS) files supplied by GATF. Press tests were conducted at GATF during January 3-9, 1995. The vendors who participated in the study are listed in Table 1.

One week before the computer-to-plate test, maintenance was performed on the Heidelberg Speedmaster press at GATF. All ink form rollers were checked for contact with the plate cylinders and the oscillator rollers. All other ink transfer rollers were reset to conform with manufacturer's specifications. Dry, wet, and break-away solid tests were performed. The dry solids test confirmed that the press did not demonstrate any inker streaks, the wet solids test showed no signs of dampener

| Participant | Platesetter | Plate | RIP | Software | lpi | Dot shape | Resolution |
|---|---|---|---|---|---|---|---|
| Kodak | Ektron 6447 | Kodak X-919 Lithoplate | Harlequin ScriptWorks | Impostrip | 133 | Euclidian | 1800 |
| Gerber | Gerber Crescent 42 | Polychrome CTX | Harlequin ScriptWorks | QuarkXPress | 200 | elliptical | 2540 |
| Screen | DS PlateRite PI-R1080 | Mitsubishi DiamondPlate LA-1 | TaigaEdge T-RIP700 | TaigaSPACE 2.10 | 150 | square | 4000 |
| Krause | Krause LaserStar 140C | Hoechst N90 | Hyphen P.C. | PIP Star | 150 | elliptical | 2540 |
| Creo | Creo 3244 | Hoechst N90 | Harlequin ScriptWorks | Preps 2.0 | 150 | elliptical | 2400 |
| Creo | Creo 3244 | Agfa Lithostar | Harlequin ScriptWorks | Preps 2.0 | 175 | elliptical | 2400 |
| DuPont | Optronics XLP | DuPont Silverlith | Optronics CAI | INposition | 150 | round | 2000 |
| Optronics | Optronics Aurora | DuPont Silverlith | Harlequin | Preps | 300 | — | 4000 |
| Mitsubishi | Escher-Grad EG-8000 | Mitsubishi DigiPlate | Escher-Grad | PressWise 2.0B | 150 | — | 2400 |
| Agfa SetPrint | Agfa Avantra 44 | Agfa Setprint | Star 800 | — | 150 | elliptical | 2400 |
| Misomex | Misomex 5040 | DuPont Silverlith | Harlequin | Ultimate Imposition | 150 | elliptical | 2000 |

Summary of Participants
Table 1

Repap 80-lb coated stock was used for the press test. After each pressrun, the skid was covered with plastic to maintain proper humidity in the paper.

The supplied plates were trimmed (when necessary) coded and punched to fit the press register system.

Test Forms

The test images used in this study were two 8.5 x 11-in. pages from the five-page GATF Digital Test Form. One of the pages was four color and one was black and white. Participants were supplied with the test pages as digital files in EPS format on 44-megabyte removable cartridges. All the participants were able to image plates from the supplied files.

The black-and-white test page (Figure 1) contained two photographic halftones, one of a house with ornate ironwork providing detail and a full tonal range. It was shot in natural light. The second photograph, a portrait of a woman taken in studio light, has a more restricted range of tones and was intended to test the rendition of skin tones.

A press control bar consisting of a repeating pattern of 25, 50, and 75% tints with solids and Star Targets was used to monitor inking density during printing.

A 3.5-in. vignette ranging from 2% to 97% was included to test the ability of the CTP systems to reproduce a smooth transition of subtle density changes without banding.

The test form also contained a type resolution target showing positive and negative type sizes from 1 point to 24 points and positive and negative lines from 0.25 points to 4 points

A GATF Imaging Resolution Target was included to measure the resolution setting of the RIP on the printing plates.

Two large adjacent blocks, one solid coverage and the other a 25% tint, were used to examine the uniformity of the platesetters.

A tone scale, including highlight and shadow dots, was provided to measure dot gain curves.

A dot size comparison chart created in Photoshop provided 10, 25, 50, and 75% tint patches at 85, 133, 150, 175, and 200 lpi. This target provided dot gain curves at several screen rulings. It also tested the ability of the CTP RIP to maintain screen rulings that had been designated in Photoshop.

The four-color test page (Figure 2) contained a variety of test targets, including a color control bar that was used during the pressruns to adjust ink densities and measure dot gain, print contrast, and ink trapping.

A continuous register track around the perimeter of the page was imaged in all four colors. This target was used to evaluate the fit between the four process color plates. An image fit target contained a pattern of geometric elements that were created with no trapping. The target shows all the combinations of cyan, magenta, yellow, and black to evaluate the fit of these colors after printing.

The test page also included Star Targets, which are sensitive to directional effects such as slurring or doubling during imaging or printing.

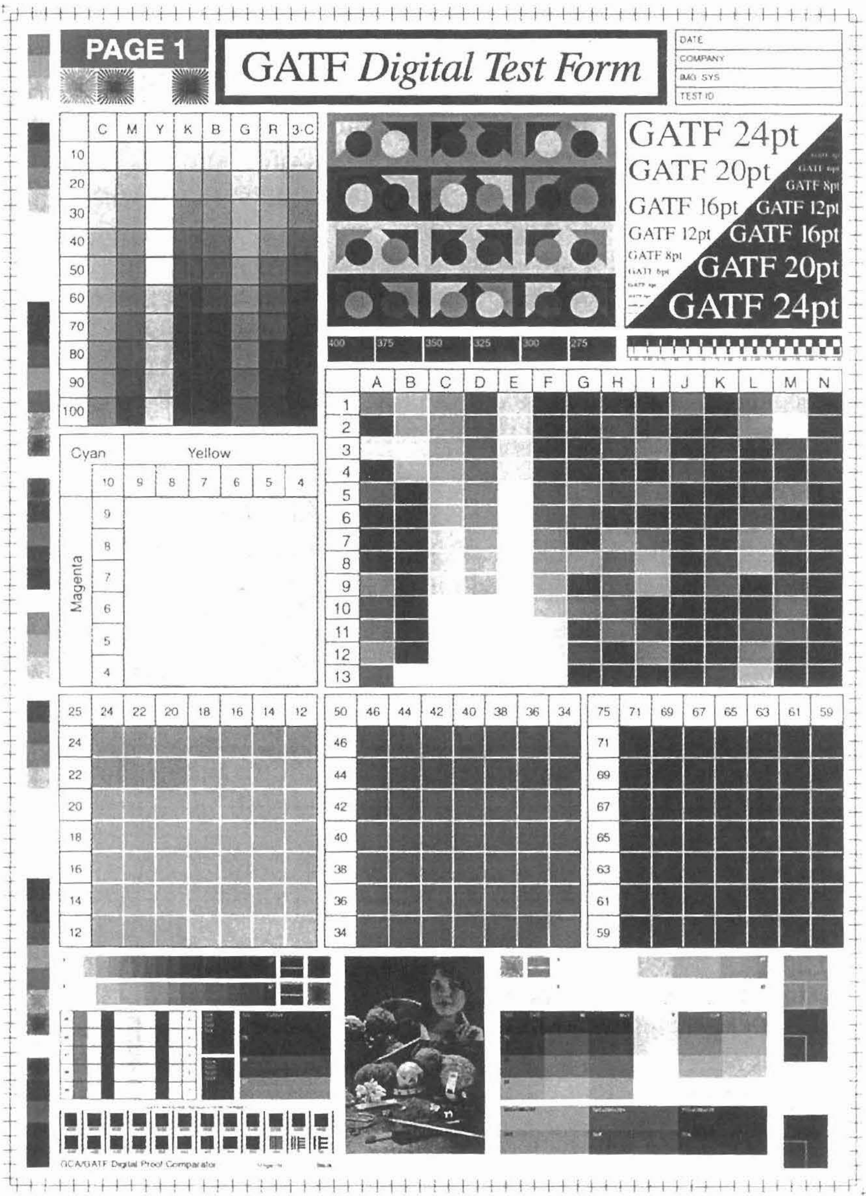
A directional effects target was included to show how the imaging system portrayed straight-line patterns at four different angular orientations. The line spacing in the directional effects target is 150 lines per inch. The line orientations are 0, 45, 90, and 135 degrees.

Tone scales were provided for each of the process colors plus the two- and three-color overprints. These scales can be used to measure the dot gain curves for the process colors and to construct multiple GAF Color Hexagons.

A series of total ink coverage patches showed the range of densities achieved with selected total coverage steps between 275 and 400%.

An IT8.7/3 color field was also included. This standard color field is used to characterize reproduction systems. It is of particular value because it contains a variety of tertiary colors


Black and White Test Page
Figure 1




Color Test Page
Figure 2

that are representative of all the domains in the printing system's color gamut.

A Gray Balance Chart measured the three-color gray balance requirements at the 10, 25, 50, and 75% levels.

A GCA/GATF Digital Proof Comparator, itself a multi-element device, was placed on the four-color test form to provide a standard means of comparing digital proofing systems with press results. The proof comparator contains a photographic montage; three-color gray balance bars with adjacent black tints; single-color, two-color, and three-color solids and tints; vignettes; Star Targets; total coverage patches; highlight and shadow patches; and imaging resolution targets. For a complete description of the elements of the GCA/GATF Digital Proof Comparator, see the user's guide for the product.

Each participant was instructed to submit five plates to GATF. The black-and-white page was imaged in one of the four quadrants available on a 19 x 25-in. press sheet so that four submissions could be printed in subsequent passes on the same sheet.

The four-color page was imaged in each of the four quadrants of a 19 x 25-in. press form. Four printing plates were submitted for this part of the test (one for each process color). These plates were printed on all four units of the press. Some participants did not submit color plates for the test, and two of the participants submitted color plates with only one of the four quadrants imaged.

GATF control plates were run at the beginning of the press run to act as a baseline. During the pressruns, all inking fountains were set via the Heidelberg CPC-1. This data was saved on cassette tapes and used to duplicate the ink key settings for all the test plates. The ink densities were adjusted to conform with the SWOP Hi/Lo Color References.

Each black-and-white plate was printed on the same unit (#4) of the press. The ink/water balance was optimized for each plate. After the press was judged to be in balance, 600 impressions were made for each plate.

The GATF control plates were made by conventionally outputting film from an Agfa 5000 SelectSet imagesetter, assembling the film on carrier sheets, and imaging 3M Viking plates in a contact frame. For the black-and-white test, a second GATF control plate (a Kodak plate) was run near the end of the test series.

Measuring Dot Sizes on Plates

To determine the press dot gain associated with each of the participant's plates, it was desirable to measure the dot sizes on the printing plates before mounting them on press. All computer-to-plate systems can be linearized to achieve target dot sizes on plates, and some are positive acting, allowing for dot sharpening. Therefore, to isolate press gain, it is necessary to know dot size on the plates.

Two instruments were used to make these measurements: a Betalog Masterplate and an X-Rite 418 reflection densitometer. Using densitometers to measure dot areas on plates is controversial. Therefore, statistics were calculated to estimate the standard deviation of repeated measurements and the correlation coefficient between the readings of the two instruments.

Only the black-and-white plates were measured. Dot area readings were made from the 10, 25, 50, and 75% patches at 85, 150, and 200 lines per inch. The two sets of dot readings are presented in Table 2 for each of the printing plates in the study. Shaded areas show platesetters that did not maintain the Photoshop-designated screen rulings during RIPing. Instead, the screens were all reproduced at the same screen ruling.

The readings from the two instruments correlated well with each other (correlation coefficient 0.95). However, the Betalog densitometer consistently gave slightly higher values than the X-Rite. The values in Table 2 show that some of the platesetters were sharpening dots, others were calibrated to provide dot-for-dot reproduction on the plates, and still others had some dot gain. The dot gain or loss was more pronounced as the screen ruling increased. (Disregard the shaded values in Table 2 when

| | | Beta | | | | X-Rite | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **lpi** | **10%** | **25%** | **50%** | **75%** | **10%** | **25%** | **50%** | **75%** |
| GATF-a | **85** | 14.0 | 30.5 | 58.0 | 81.5 | 14.0 | 30.8 | 57.5 | 80.5 |
| 0.378/0.777 | **150** | 15.0 | 33.5 | 62.5 | 84.5 | 15.9 | 33.2 | 61.5 | 83.5 |
| | **200** | 16.0 | 34.5 | 64.0 | 85.0 | 16.3 | 33.7 | 62.5 | 83.9 |
| GATF-b | **85** | 14.0 | 29.5 | 56.0 | 80.0 | 11.3 | 27.3 | 54.4 | 78.7 |
| 0.319/0.988 | **150** | 13.5 | 30.0 | 58.0 | 82.0 | 11.9 | 29.0 | 56.8 | 81.0 |
| | **200** | 11.5 | 29.5 | 58.5 | 82.5 | 11.6 | 29.2 | 57.9 | 81.4 |
| Code B | **85** | 11.0 | 26.5 | 51.5 | 77.0 | 10.9 | 26.5 | 52.1 | 77.2 |
| 0.423/0.813 | **150** | 12.5 | 30.0 | 56.5 | 81.0 | 12.8 | 30.0 | 57.2 | 81.3 |
| | **200** | 12.5 | 29.5 | 57.0 | 80.0 | 12.4 | 29.7 | 58.0 | 80.7 |
| Code C | **85** | 12.5 | 30.5 | 55.5 | 78.5 | 11.8 | 28.9 | 54.1 | 77.6 |
| 0.293/0.895 | **150** | 11.0 | 29.0 | 54.5 | 81.0 | 9.5 | 27.1 | 52.7 | 79.2 |
| | **200** | 8.5 | 26.0 | 49.0 | 81.5 | 8.1 | 25.1 | 47.0 | 79.6 |
| Code D | **85** | 12.5 | 28.5 | 55.5 | 80.0 | 10.9 | 26.9 | 54.0 | 78.4 |
| 0.266/0.817 | **150** | 10.5 | 27.5 | 57.0 | 81.0 | 9.5 | 26.1 | 55.2 | 79.9 |
| | **200** | 10.0 | 27.0 | 57.5 | 82.0 | 8.3 | 24.9 | 55.4 | 81.0 |
| Code E | **85** | 9.5 | 24.5 | 49.5 | 75.0 | 10.5 | 25.8 | 50.9 | 76.1 |
| 0.541/0.639 | **150** | 9.5 | 24.0 | 49.0 | 75.0 | 10.1 | 26.1 | 51.4 | 76.6 |
| | **200** | 9.0 | 24.0 | 48.5 | 75.0 | 9.9 | 26.3 | 51.3 | 77.0 |
| Code F | **85** | 14.0 | 30.0 | 56.5 | 79.0 | 13.6 | 29.7 | 56.2 | 78.7 |
| 0.311/0.556 | **150** | 15.0 | 32.0 | 58.0 | 81.0 | 14.7 | 31.4 | 57.6 | 80.8 |
| | **200** | 18.0 | 32.5 | 60.5 | 82.0 | 17.9 | 32.1 | 60.4 | 81.4 |
| Code G | **85** | 10.5 | 27.5 | 55.5 | 79.5 | 10.0 | 26.0 | 54.0 | 80.0 |
| | **150** | 10.5 | 30.5 | 56.5 | 82.5 | 11.0 | 29.0 | 55.0 | 82.0 |
| | **200** | 12.0 | 30.5 | 59.0 | 82.0 | 12.0 | 31.0 | 59.0 | 82.0 |
| Code H | **85** | 16.5 | 30.5 | 59.0 | 83.0 | 15.0 | 29.0 | 56.7 | 81.5 |
| 0.300/0.754 | **150** | 15.0 | 30.0 | 57.5 | 83.0 | 13.7 | 28.0 | 55.6 | 81.4 |
| | **200** | 16.5 | 31.5 | 59.0 | 83.0 | 14.0 | 29.5 | 56.2 | 81.3 |
| Code I | **85** | 9.0 | 24.0 | 50.0 | 76.0 | 10.5 | 24.5 | 49.4 | 75.8 |
| 0.306/0.765 | **150** | 8.0 | 23.5 | 49.0 | 76.0 | 10.7 | 25.4 | 49.8 | 75.8 |
| | **200** | 8.0 | 23.0 | 48.5 | 76.0 | 9.3 | 24.1 | 48.8 | 75.3 |
| Code J* | **85** | 10.0 | 22.0 | 46.0 | 67.5 | 9.7 | 22.4 | 46.4 | 68.2 |
| 0.620/0.714 | **150** | 9.5 | 22.5 | 51.0 | 71.5 | 9.2 | 22.8 | 50.6 | 72.2 |
| | **175** | 9.5 | 22.5 | 50.5 | 72.0 | 9.6 | 23.0 | 50.4 | 72.2 |
| Code L | **85** | 12.0 | 32.0 | 60.0 | 82.5 | 14.1 | 32.8 | 60.5 | 83.0 |
| 0.437/0.787 | **150** | 12.5 | 31.5 | 59.5 | 81.0 | 14.0 | 32.4 | 60.5 | 82.2 |
| | **200** | 12.5 | 31.0 | 59.5 | 81.5 | 14.0 | 32.1 | 59.9 | 82.5 |
| Code M | **85** | 4.5 | 24.0 | 50.5 | 76.0 | 5.0 | 23.7 | 49.0 | 74.2 |
| 0.311/0.768 | **150** | 4.5 | 22.5 | 49.0 | 76.0 | 5.8 | 22.7 | 47.4 | 73.8 |
| | **200** | 3.5 | 22.0 | 48.0 | 75.0 | 4.6 | 21.1 | 46.5 | 73.7 |
| correlation | | **0.929** | **0.943** | **0.961** | **0.962** | | | | |

Numbers under codes are solid/background densities from plates.
Shaded areas indicatet plates output at a single lpi regardless of the Photoshop designation
Screen ruling on code J was altered to 85-, 133-, and 175-lpi

Plate Dot Area Measurements
Table 2

making this comparison since they represent no change in screen ruling.)

To test the repeatability of measurements, the same 50% patches at three different screen ruling were read 30 times by each instrument on both a plate (the GATF control plate) and a printed sheet. For each reading, the instruments were re calibrated to the background and a solid area. Table 3 contains the average, high, and low readings, as well as the standard deviations of the measurements. Note that the standard deviations are quite low. In some cases the instruments' readings on paper show greater variability than those on the plate.

| | | lpi | mean | low | high | std. dev. |
|---|---|---|---|---|---|---|
| plate | Beta | **85** | 58.30 | 58.0 | 58.5 | 0.25 |
| | | **150** | 62.40 | 62.0 | 63.0 | 0.28 |
| | | **200** | 63.65 | 63.0 | 64.0 | 0.27 |
| | X-Rite | **85** | 56.86 | 56.2 | 57.5 | 0.29 |
| | | **150** | 60.91 | 60.4 | 61.4 | 0.26 |
| | | **200** | 62.37 | 61.8 | 62.8 | 0.26 |
| Paper | Beta | **85** | 68.53 | 68.0 | 69.0 | 0.18 |
| | | **150** | 77.15 | 76.5 | 77.5 | 0.33 |
| | | **200** | 79.80 | 79.5 | 80.0 | 0.25 |
| | X-Rite | **85** | 65.50 | 65.1 | 66.6 | 0.35 |
| | | **150** | 73.89 | 73.4 | 74.8 | 0.31 |
| | | **200** | 76.78 | 76.2 | 77.6 | 0.41 |

Variability of Dot Measurements
Table 3

## Black-and-White Pressrun

Observations made from the black and white press run are given in Table 4. Additional pressroom observations of some exceptional conditions follow:

| Code | Min/Max | Vignette | Large solid | Large tint | Star Targets |
|---|---|---|---|---|---|
| GATF | 1/96 | good with slight shadow banding | good | slightly blotchy | too full, no directional effect |
| B | 2/98 | severe banding at several tone levels | good | grainy but no pattern | too full, no directional effect |
| D | 3/95 | severe midtone banding | good | slight graininess | sharp, no directional effects |
| E | 2/95 | grainy with plugging at the three quarter tone | good | blotchy | slightly full, slight effect in the direction of travel |
| F | 3/99 | moderate banding at two levels | good | smooth | very sharp, no direction effects |
| G | 1/97 | smooth and even | good | slight graininess | sharp, no directional effects |
| H | 1/97 | banding at several tone points | good | slightly mottled with banding | sharp, slight directional effect in the direction of travel |
| I | 1/97 | moderate banding | good | exceptionally free of grain | sharp, no directional effect |
| J | 1/90 | severe banding at highlights and other tone steps | good | grainy | severe distortion across the form |
| L | 2/90 | slight banding but overall grainy appearance | good | very grainy | sharp, no directional effects |
| M | 10/99 | highlights missing but free of banding | good | smooth | very sharp, no directional effect |

| Code | Pos/Neg type | Halftone scales | Portrait photo | Outdoor photo |
|---|---|---|---|---|
| GATF | 1 pt./ 2 pt. | slightly blotchy | too full | good detail, good tone reproduction |
| B | 2 pt./2 pt. | grainy | skin appears blotchy | good detail |
| D | 1 pt./1 pt. | good | highlight detail lost; overall tone reproduction too dark | good detail, overall dark, missing highlights |
| E | 1 pt./ 2 pt. | slightly graininess in the finer screen rulings | dark, flat , slightly grainy | good detail, slightly flat |
| F | 2 pt./1 pt. | good | flat, losing highlights | good detail, flat |
| G | 1pt./1 pt. | extreme patterns in 175 and 200-line scales | excellent | good detail, good tone reproduction |
| H | 2 pt./2 pt. | slight mottle | mottled with banding | detail very good, slightly flat |
| I | 1 pt./1 pt. | good | flat | good detail, good tone reproduction |
| J | 1 pt./ 3 pt. | grainy | mottled and full | detail soft, overall too dark |
| L | 1 pt./1 pt. | grainy | too dark overall | good detail |
| M | 2 pt./1 pt. | good | flat with highlights missing | good detail, highlights missing |

Black and White Test Results
Table 4

The first plates run were the GATF/3M Viking control plates. Once the press was adjusted to SWOP densities, the midtone dot gain ranged 24–27%. This amount was high for a sheet that contacted only one printing blanket (18–20% was considered more reasonable). Efforts were made to reduce dot gain on this control plate by mixing fresh fountain solution, cleaning the press rollers, making a new plate, changing blankets, changing inks, changing print sequence, substituting a different fountain solution, and changing the ratio of the press packing to 0.006 in. over bearers for the plate and 0.0 over bearers for the blanket. Despite these efforts, dot gain did not improve.

Densitometric measurements of the original film and the UGRA scale used to control platemaking showed both films to be within 0.5% of 50% dots. Measurements of the printing plate showed 10% dot gain from film to plate (an unacceptably high level) for the GATF halftone film, but only 5% dot gain for the UGRA scale. The plate exposure was reduced to produce 3% dot gain for the UGRA scale (resulting in 7% for the GATF film). Microscopic examination under darkfield illumination showed a distinctive imaging pattern on the GATF film that might be associated with the increased dot gain. Investigation into this phenomenon is continuing.

Overall, the CTP plates were successful on press. The press crew had little difficulty running most plates. The polyester plates were more sensitive to ink/water balance than the aluminum plates.

Plate C failed to clean up on press. After several attempts, the effort was deemed a failure, and no good prints were produced from this plate.

The code D plate, a positive-acting plate, had a pronounced midtone band in the vignette. The range of reproduced dots was only 3–95% causing some highlight detail to drop out of the photograph.

The code E plate toned the paper in the other three nonprinting quadrants. This prevented any other plate from being printed on that same sheet of paper.

Prints from the code G plate had distracting patterns (artifacts from the platesetter) in the 175- and 200-line scales. The 175-line pattern had a checkerboard effect, and the 200-line pattern consisted of tiny horizontal stripes.

The vignette from the code G plate was judged to be the most smooth and even of all CTP samples, superior even to the GATF control plate.

The code I plate was sensitive to plugging. It held a dot scale from 1 to 97%. The vignette was judged to have slight to moderate banding.

The code M plate ran reasonably well except that the lead edge color bar had a tendency to go blind. Reducing the water improved the situation, but the image began to plug before the control bar was completely clean.

Dot Gain. The results of the measurements from the dot-size comparators for the black-and-white prints are contained in Table 5. The 85-, 133-, 150-, and 175- and 200-lpi scales were all measured at the 10, 25, 50, and 75% levels.

Of the ten computer-to-plate systems that were successfully tested, four of them did not maintain the dot size distinction that was built into the file. In three of the cases (plates H, I, and L), all the scales on the dot size comparator were imaged at the same screen ruling (150 lpi). In another case (plate J), the file was deliberately altered to make a progression of line screen rulings of 85, 100, 133, 150, and 175 lpi because the platesetter was not intended to image 200-line screens. Therefore, in examining the data in Table 5, it should be noted that in the instances mentioned above, the dot gains between the various screen rulings should all be the same.

The dot gains generally followed a predictable pattern, with finer screen rulings resulting in higher levels of dot gain. Plates where halftone dots were sharpened by positive platemaking exhibited consistently lower dot gains than their negative-acting counterparts. The GATF dot gain was higher than the CTP participants, who fell within a 10–20% range in most cases.

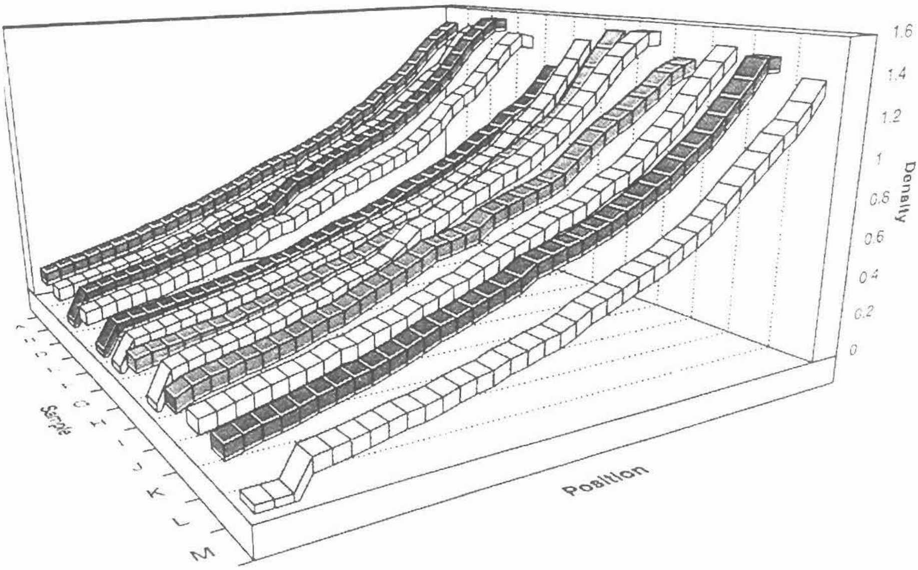
| | | 10% | 25% | 50% | 75% |
|---|---|---|---|---|---|
| GATF-a | 85 | 17.2 | 37.5 | 66.3 | 85.2 |
| | 133 | 21.0 | 40.7 | 71.7 | 89.0 |
| | 150 | 22.3 | 42.5 | 74.8 | 91.2 |
| | 175 | 24.9 | 45.7 | 75.9 | 92.1 |
| | 200 | 24.8 | 46.3 | 77.2 | 92.8 |
| | | | | | |
| GATF-b | 85 | 10.2 | 32.2 | 61.4 | 82.4 |
| | 133 | 14.2 | 33.6 | 65.1 | 85.6 |
| | 150 | 15.7 | 37.3 | 67.1 | 86.8 |
| | 175 | 17.9 | 38.4 | 68.5 | 87.8 |
| | 200 | 18.1 | 38.5 | 69.8 | 88.2 |
| | | | | | |
| code B | 85 | 10.6 | 28.6 | 57.8 | 82.0 |
| | 133 | 11.7 | 30.9 | 62.1 | 84.5 |
| | 150 | 11.7 | 32.8 | 65.5 | 87.9 |
| | 175 | 11.2 | 33.9 | 65.2 | 86.9 |
| | 200 | 12.5 | 33.2 | 66.3 | 89.8 |
| | | | | | |
| code D | 85 | 12.7 | 30.9 | 61.8 | 82.6 |
| | 133 | 13.1 | 34.1 | 65.8 | 85.4 |
| | 150 | 14.8 | 35.8 | 69.5 | 87.9 |
| | 175 | 15.2 | 36.4 | 68.7 | 88.5 |
| | 200 | 16.6 | 37.0 | 72.7 | 91.5 |
| | | | | | |
| code E | 85 | 14.8 | 34.3 | 64.4 | 84.8 |
| | 133 | 16.1 | 36.7 | 67.2 | 87.6 |
| | 150 | 17.4 | 39.4 | 70.3 | 89.1 |
| | 175 | 17.5 | 41.0 | 72.7 | 90.9 |
| | 200 | 17.5 | 40.8 | 73.4 | 90.4 |
| | | | | | |
| code F | 85 | 9.4 | 28.1 | 55.0 | 78.7 |
| | 133 | 12.0 | 28.6 | 55.5 | 81.1 |
| | 150 | 11.3 | 28.5 | 57.2 | 82.9 |
| | 175 | 12.1 | 28.2 | 57.1 | 81.6 |
| | 200 | 9.3 | 24.2 | 58.4 | 84.6 |

| | | 10% | 25% | 50% | 75% |
|---|---|---|---|---|---|
| code G | 85 | 14.7 | 32.6 | 61.8 | 82.5 |
| | 133 | 17.9 | 37.3 | 66.7 | 86.4 |
| | 150 | 19.9 | 39.5 | 66.8 | 87.4 |
| | 175 | 18.8 | 40.1 | 69.4 | 88.5 |
| | 200 | 23.1 | 45.6 | 73.5 | 91.6 |
| | | | | | |
| code H | 85 | 17.8 | 34.8 | 63.6 | 85.5 |
| | 133 | 17.9 | 34.9 | 64.2 | 86.2 |
| | 150 | 18.2 | 33.7 | 63.2 | 85.8 |
| | 175 | 18.4 | 33.9 | 63.1 | 85.4 |
| | 200 | 19.6 | 32.4 | 63.0 | 84.8 |
| | | | | | |
| code I | 85 | 15.9 | 34.7 | 61.8 | 84.9 |
| | 133 | 15.4 | 34.1 | 62.9 | 84.2 |
| | 150 | 15.3 | 34.0 | 62.4 | 84.5 |
| | 175 | 13.9 | 33.1 | 62.2 | 85.1 |
| | 200 | 14.8 | 33.5 | 61.5 | 85.8 |
| | | | | | |
| code J | 85 | 20.1 | 37.1 | 66.6 | 84.5 |
| | 133 | 20.3 | 37.9 | 69.1 | 86.2 |
| | 150 | 20.9 | 41.1 | 72.5 | 88.7 |
| | 175 | 21.8 | 42.6 | 75.3 | 90.1 |
| | 200 | 22.6 | 43.0 | 76.9 | 91.6 |
| | | | | | |
| code L | 85 | 22.4 | 42.5 | 71.2 | 89.2 |
| | 133 | 22.1 | 43.8 | 70.2 | 89.3 |
| | 150 | 21.7 | 42.5 | 71.4 | 89.3 |
| | 175 | 20.1 | 42.3 | 70.8 | 89.1 |
| | 200 | 18.7 | 41.5 | 70.6 | 88.9 |
| | | | | | |
| code M | 85 | 8.8 | 27.5 | 55.3 | 78.9 |
| | 133 | 6.2 | 26.6 | 53.9 | 79.8 |
| | 150 | 5.8 | 25.5 | 53.7 | 80.8 |
| | 175 | 7.5 | 25.3 | 53.3 | 80.3 |
| | 200 | 5.8 | 24.7 | 54.0 | 79.9 |

Dot Gain Measurements
Table 5

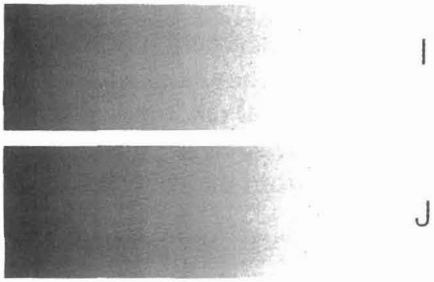
The differences of dot gain between the plates was high. At 200 lpi the range was nearly 25%; at 150 lpi the range was almost 20%. This indicates that it is not safe to send a file to a CTP system with the assumption that a fixed level of dot gain will be obtained. The dot size will depend on the calibration settings of the platesetter. Thus, characterizing the printing press and calibrating the platesetter to meet the requirements of that press are necessary with CTP.

The black and white test page contained a 3.5-inch vignette that graduated in dot size from 2 to 97%. An X-Rite X-Scan densitometer was programmed to measure the density values on the printed vignettes every 0.1 inch over the entire length of the target. These measurements resulted in 36 density readings for each target. A three-dimensional graph (Figure 3) was plotted to depict the density values plotted against the location of the density reading on the target for each supplied plate.

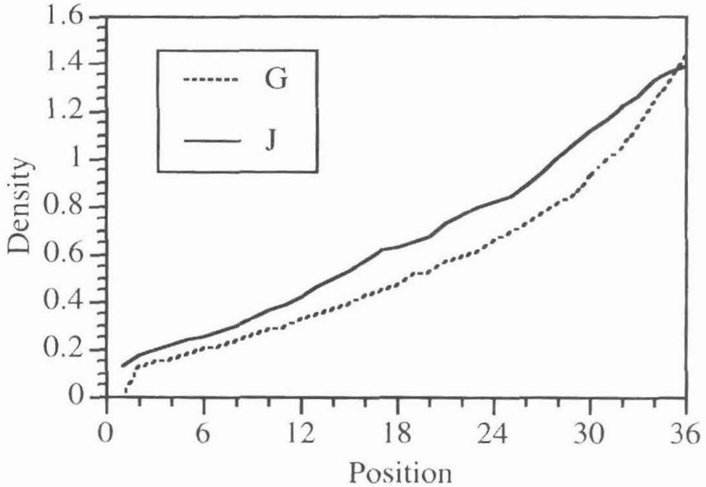



Graph of Vignettes
Figure 3

Banding on the supplied plates was more frequent and more severe than anticipated. Figure 4 shows a photograph of the vignette targets from plates I and J, both of which were judged to show pronounced banding. The density measurements from plates G and J are plotted on a two-dimensional graph in Figure 5. Plate G was judged to have the smoothest vignette, and plate J had among the worst vignettes. The curve for plate G is smooth and free of characteristics that would indicate sudden shifts in density (visible to the observer as banding). The graph for code J, on the other hand, has noticeable (and visible) peaks at reading locations 17 and 21.




Photograph of Vignettes
Figure 4




Graph of Vignettes G and J
Figure 5

## Pressrun Consistency

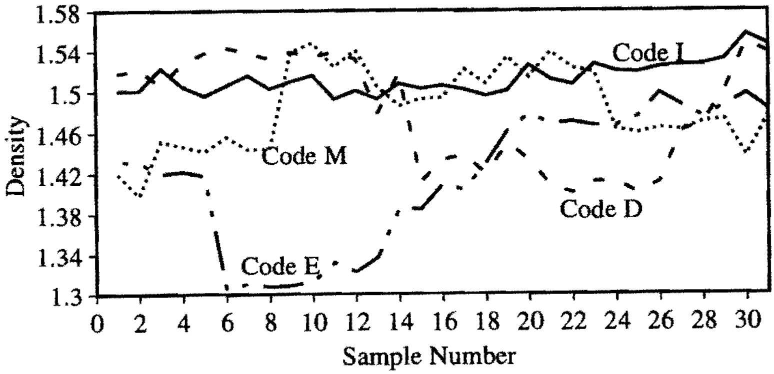
Table 6 shows the summary statistics from the black-and-white pressrun data. For each plate, approximately 600 sheets were run once the press was considered to be at equilibrium. The range and variability of the pressrun through the 600 sheets were examined to compare the stability of printing conditions with various printing plates. Note: All deviations during the pressrun are not caused by the characteristics of the printing plate; potential sources for variations in the readings include fluctuations of the machine, intervention of press operators, and changes in the environmental conditions of the pressroom. In compiling the data in Table 6, 30 randomly selected sheets for each plate were read using the X-Scan densitometer. A single solid ink patch was chosen from the color bar to measure variability.

| | **mean** | **std. dev.** | **max.** | **min.** | **range** |
|---|---|---|---|---|---|
| **GATF** | 1.481 | 0.019 | 1.519 | 1.432 | 0.087 |
| **B** | 1.512 | 0.016 | 1.538 | 1.482 | 0.056 |
| **D** | 1.481 | 0.055 | 1.548 | 1.401 | 0.147 |
| **E** | 1.415 | 0.068 | 1.499 | 1.305 | 0.194 |
| **F** | 1.481 | 0.019 | 1.519 | 1.432 | 0.087 |
| **G** | 1.499 | 0.017 | 1.542 | 1.464 | 0.078 |
| **H** | 1.486 | 0.015 | 1.519 | 1.463 | 0.056 |
| **I** | 1.513 | 0.015 | 1.556 | 1.493 | 0.063 |
| **J** | 1.453 | 0.020 | 1.512 | 1.426 | 0.086 |
| **L** | 1.493 | 0.031 | 1.552 | 1.447 | 0.105 |
| **M** | 1.484 | 0.040 | 1.548 | 1.398 | 0.150 |

Consistency of Black and White Press Runs
Table 6

The mean values for the solid densities show the levels at which the press was balanced for each plate. The minimum and maximum values show the range of densities achieved during the run.

The standard deviations show the variability of density during the pressruns. Most values are quite low, however, for plates D, E, and M the standard deviations were higher than normal. Trend graphs (Figure 3) show densities through time for plates D, E, M, and I, (where plate I is included as an example of stable press operating conditions). It is seen that the high standard deviations are caused by directional trends instead of random variations. This indicates that the high standard deviations of these press runs are due to changes made by the operators, and are not attributable to the characteristics of the printing plates.




Trend Graphs
Figure 6

## Four Color Tests

The press was adjusted to the SWOP Hi/Lo Color References (black 1.60, magenta 1.35, cyan 1.30, and yellow 1.00). The press operators fit the images as well as possible in one of the four quadrants and printed approximately 600 sheets. The lead press operator noted that the aluminum four-color plates were far easier to fit than the polyester ones. Also, the ink/water balance was more difficult to maintain with polyester plates.

Some observations made during the printing of the color plates were that the code B plates registered very well; however, the lines around the test form title block (themselves a directional effects target) were broken and partially missing.

The code E plates were sensitive to toning during startup, but ink/water balance was achieved soon after the press was running. Also, internal register was considered to be inaccurate.

The code G plates did not have the four-color page imaged in all four quadrants. The yellow plate was difficult to fit because the image was cocked. The vendor reported that no pin system was used when the code G plates were imaged. The magenta plate skipped during exposure, preventing the image from fitting.

The register on the code H plates was very good, but a pattern was noted in the directional effects target. These plates were judged to be slightly sensitive to ink/water balance during printing.

Satisfactory fit was never achieved on the code I plates. The cyan unit almost reached its maximum adjustment when the best compromise was found. . The code I plates did not successfully image the 1, 2, or 3% dots. These plates became damaged during cleaning and were subsequently blinded. It should not be assumed that this an inherent weakness in the plate system; it is more likely that a special plate cleaner may be required for these plates.

The fit of the code J plates was moderately poor. It took several impressions to clean the non-image area during start up. The Star Targets were found to have severe distortion indicating that a pronounced directional effect that was induced during the images of the plates.

Code M four-color plates were not submitted.

Solid ink density, dot gains, print contrast, and ink trapping were measured for all four colors. The mean, minimum, maximum, and ranges for each attribute were compiled. This data was gathered from 10 randomly selected sheets from the pressrun.

The 25, 50, and 75% dot gain values for each of the plates are shown in Table 7. (Plate I has unrealistic dot gain numbers because the plate was not successfully printed.) It is encouraging that the dot gains are not excessive, but situations where there are substantial imbalances between the dot gains of the four different colors are causes for concern. For example, plate B showed a black dot gain of 14, magenta of 11, and yellow of 10, but a cyan dot gain of only 5%. This would distort the gray

| | Black | | | Cyan | | |
|---|---|---|---|---|---|---|
| | **25%** | **50%** | **75%** | **25%** | **50%** | **75%** |
| **GATF** | 22.8 | 25.8 | 16.9 | 18.4 | 24.3 | 15.4 |
| **B** | 9.0 | 17.9 | 12.6 | 7.6 | 12.2 | 10.8 |
| **D** | 11.0 | 15.5 | 10.8 | 5.7 | 8.6 | 7.4 |
| **E** | 14.1 | 19.6 | 13.6 | 10.6 | 16.0 | 11.3 |
| **F** | 4.3 | 7.8 | 7.5 | 3.2 | 8.1 | 8.4 |
| **G** | 7.6 | 11.7 | 8.3 | 8.0 | 12.3 | 8.1 |
| **H** | 6.7 | 11.3 | 10.2 | 6.2 | 9.7 | 8.3 |
| **I** | -1.7 | -1.5 | 2.5 | - | - | - |
| **J** | 16.5 | 20.7 | 14.3 | 13.2 | 18.9 | 11.4 |
| **L** | 12.1 | 16.6 | 11.9 | 13.1 | 17.0 | 12.4 |

| | Magenta | | | Yellow | | |
|---|---|---|---|---|---|---|
| | **25%** | **50%** | **75%** | **25%** | **50%** | **75%** |
| **GATF** | 18.2 | 24.9 | 16.2 | 16.4 | 24.1 | 15.3 |
| **B** | 8.3 | 14.7 | 11.9 | 6.7 | 10.5 | 10.2 |
| **D** | 6.6 | 9.8 | 8.8 | 4.8 | 8.3 | 7.6 |
| **E** | 8.8 | 14.2 | 10.1 | 11.5 | 17.5 | 12.6 |
| **F** | -0.6 | 4.9 | 6.1 | -0.7 | 5.1 | 5.5 |
| **G** | 6.1 | 10.3 | 7.0 | 6.4 | 9.0 | 7.7 |
| **H** | 5.4 | 10.2 | 9.0 | 5.3 | 9.3 | 8.4 |
| **I** | -4.1 | -4.8 | 1.4 | -3.2 | -4.4 | 1.1 |
| **J** | 11.8 | 18.6 | 12.8 | 14.4 | 21.5 | 13.5 |
| **L** | 11.6 | 15.8 | 11.5 | 10.6 | 15.2 | 10.4 |

Color Dot Gains
Table 7

balance and seriously hamper the color reproduction from a job sent to this platesetter. A similar situation was found with plate D, where the range for 50% dot gain went from 12 for black to 4 for cyan. A much better situation was seen with plate G, where the dot gains were within 2% of each other, with yellow being the lowest and black the highest.

The print contrast values in Table 8 show large differences obtained with different printing plates. However, these differences should be interpreted in relation to plate dot sizes. In this instance it is more valuable to analyze the three-quartertone dot gain than the print contrast.

| | **black** | **cyan** | **magenta** | **yellow** |
|---|---|---|---|---|
| **GATF** | 32.7 | 29.1 | 30.5 | 22.6 |
| **B** | 41.3 | 40.2 | 38.7 | 34.1 |
| **D** | 43.9 | 41.5 | 42.9 | 35.1 |
| **E** | 40.3 | 35.8 | 33.5 | 26.7 |
| **F** | 48.8 | 44.2 | 46.3 | 38.5 |
| **G** | 45.6 | 43.5 | 44.5 | 35.8 |
| **H** | 45.6 | 43.8 | 44.6 | 36.6 |
| **I** | 55.8 | 52.9 | 55.3 | 46.4 |
| **J** | 37.5 | 37.4 | 36.4 | 28.9 |
| **L** | 41.0 | 35.1 | 36.5 | 30.0 |

Print Contrasts
Table 8

Table 9 shows the trapping results for blue, green, and red for all the plates. Since trapping represents a solid ink transfer characteristic, large differences in the trapping values might be attributed to the oleophilic properties of the printing plates. However, large differences were not found between the plates in this study.

The smallest and largest printable dots from the four-color test runs are shown in Table 10. Several of the plates were able to hold a nearly full range of dot values: plate J (2-98%), plate H (1-97%), and plate G (1-97%). Other plates had a more modest

| | Blue | Green | Red |
|---|---|---|---|
| GATF | 77.3 | 90.1 | 74.1 |
| B | 75.1 | 87.9 | 71.3 |
| D | 76.7 | 90.0 | 76.6 |
| E | 73.3 | 86.5 | 78.9 |
| F | 74.9 | 87.6 | 73.3 |
| G | 74.8 | 88.7 | 74.0 |
| H | 77.0 | 89.4 | 74.4 |
| I | 80.3 | 91.1 | 73.0 |
| J | 74.3 | 89.3 | 74.5 |
| L | 74.9 | 87.3 | 75.2 |

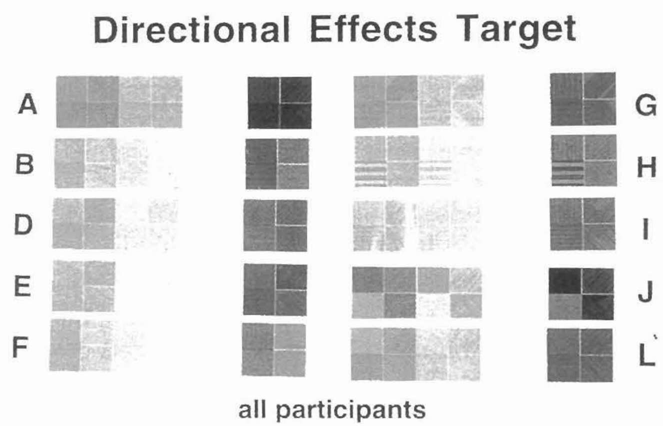
Ink Trapping
Table 9

range of printable dot-sizes. Plate D, for example, was limited to 3-97%, while plate E was not able to print shadow dots beyond 95%. Plate F could print 99% shadow dots but no highlight dot lighter than 4%. To make pleasing reproductions, it is more important to print highlight dots than shadow dots because the human observer is particularly sensitive to deviations in light values.

| | Minimum dots | | | | Maximum dots | | | |
|---|---|---|---|---|---|---|---|---|
| | **K** | **C** | **M** | **Y** | **K** | **C** | **M** | **Y** |
| **GATF-a** | 1 | 1 | 1 | 1 | 96 | 96 | 96 | 96 |
| **B** | 2 | 2 | 2 | 2 | 98 | 98 | 98 | 98 |
| **D** | 3 | 4 | 3 | 4 | 97 | 97 | 97 | 97 |
| **E** | 2 | 2 | 2 | 2 | 95 | 95 | 95 | 95 |
| **F** | 4 | 5 | 4 | 5 | 99 | 99 | 99 | 99 |
| **G** | 1 | 1 | 1 | 1 | 97 | 97 | 97 | 97 |
| **H** | 1 | 1 | 1 | 1 | 97 | 97 | 97 | 97 |
| **I** | 2 | 6 | 4 | 6 | 99 | 99 | 99 | 99 |
| **J** | 2 | 2 | 2 | 2 | 98 | 98 | 98 | 98 |
| **L** | 1 | 1 | 1 | 1 | 96 | 96 | 96 | 96 |

Smallest and Largest Printable Dots
Table 10

One of the most pronounced difficulties for CTP systems is imaging the Directional Effects Target. Figure 7 shows the printed targets from all the plates in this study. The best imaging systems are the ones that image the target as uniformly as possible in all four quadrants (codes B and F). Note from the GATF control sample that even film imagesetters do not image this target perfectly. Of the plates in this test, codes G, H, and J were judged to be unacceptable with regard to this target.




Directional Effects Target
Figure 7

The four-color prints were evaluated to determine whether the images fit in all four quadrants. The continuous register track and the image fit target were used to judge the success of image fit. The press operators brought one quadrant into register. Since the other three quadrants were imaged by the platesetter stepping the same film three more times, the register in the four quadrants was expected to be the same. The aluminum plates were found to fit better as a whole than the polyester plates. But even some aluminum plates (notably, Code D) were judged to be unacceptable for commercial printing.

The visual appearance of the Gray Balance Chart is very sensitive to slight shifts in dot size of any of the process colors.

The Gray Balance Charts that printed in line with each other both on the left and right sides of the sheet were measured with an X-Rite spectrophotometer. Delta E values were calculated to judge color match (Table 11). In one instance (code H) a pronounced shift in hue was detected between two in-line charts. This indicates that the platesetter was not consistent in exposing the same file in two adjacent portions on the same plate.

| | Left<br>**10** | Right<br>**10** | Left<br>**25** | Right<br>**25** | Left<br>**50** | Right<br>**50** | Left<br>**75** | Right<br>**75** |
|---|---|---|---|---|---|---|---|---|
| GATF | **1.01** | **0.35** | **1.54** | **0.66** | **1.41** | **2.17** | **1.33** | **3.18** |
| Code B | 0.57 | 0.67 | 0.65 | 1.42 | 0.14 | 0.48 | 2.35 | 1.69 |
| Code D | 0.33 | 0.46 | 0.69 | 0.38 | 1.03 | 1.94 | 1.40 | 3.78 |
| Code E | 0.44 | 0.86 | 0.96 | 0.85 | 0.96 | 0.68 | 1.14 | 1.29 |
| Code F | 0.28 | 0.43 | 0.57 | 0.74 | 0.52 | 0.61 | 1.43 | 1.17 |
| Code H | **1.36** | **1.22** | **3.38** | **1.15** | **8.24** | **4.11** | **12.55** | **6.90** |
| Code J | 0.59 | 0.57 | 0.67 | 0.74 | 0.92 | 1.07 | 1.33 | 5.36 |
| Code L | 0.36 | 0.14 | 0.94 | 0.49 | 1.11 | 1.57 | 1.47 | 2.84 |

In-Line Delta E Values
Table 11

## Conclusion

This study found technical problems on some of the submitted plates. The potential purchaser of a CTP system should gain assurances that the system in question does well in terms of the aspects examined in this paper. Plates for a four-color job must register consistently and have matched dot gain values. The imaging system should be free of directional effects and provide high resolution. Vignettes should be free of noticeable banding. Tone reproduction should be full range and predictable. Color balance when successive plate are exposed should be consistent. The GATF Digital Test Form is a useful tool for testing these attributes.

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Thanks also go to the many other GATF staff members who assisted in this effort.

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