Identifying High-Volume Printing Processes Û

by Dr. Malcolm G. Keif & Tom Goglio

Editor's Note: To view the photos in color go to:
http://www.igaea.org/Images/Keif/

Printing professionals frequently examine printing to see how pieces were produced. They break out loupes and look at the dots. Is it offset or gravure? How about flexo? It is important to be able to distinguish among printing processes through examination in order to determine the key variables to control for quality printing. Further, expertise is established and confidence built when a professional can determine how something is printed.

When examining a printed sample to determine how it was printed, one must look with a critical eye and consider several factors. Considerations include the use of the product, the substrate, the expected run length (including versioning), print quality, characteristics of type and line work, and the characteristics of halftones. It is usually easy to determine a product's printing process. However, printing and prepress technologies have seen rapid improvement in recent years, making it more difficult to distinguish one process from another. Many inherent characteristics used to differentiate printing methods in the past are no longer clear determinants. High-volume printing processes are beginning to attain near-perfect line or tone reproduction, particularly when laser imaged printing plates and cylinders are used. This makes identification more challenging.

Identification is also complicated by the increased use of combination printing processes. For example, in flexible packaging, flexo presses often incorporate in-line rotary screen printing. A screen unit lays down opaque white ink upon which process inks are printed using flexo plates—allowing graphics for frozen food bags on clear film. Also common are flexo units at the end of rotogravure retail insert presses for regional versioning. Combination presses are frequently used in the gaming industry, where lottery tickets may use three or more printing processes including flexo, gravure, screen, and digital printing on a single ticket.

Despite the challenges, the astute viewer can usually identify a product's primary printing techniques with a standard 10X loupe or magnifier. This paper focuses on distinctions between three high-volume printing applications: Web Offset, Rotogravure, and Flexography. After reading this paper, the reader will know more about the characteristics of each process and can confidently identify a process through investigation. This paper does not address low-volume processes such as sheetfed offset and digital printing processes.

When individuals examine printing, they should consider the following questions: Does a product's use give any logical hints? Does the type of substrate lend itself to being printed by any one particular process? What is the expected run-length of the product? Does the quality of the printing point to a particular process? Finally, do the type, line-work, and halftones exhibit any revealing characteristics? The characteristics of web offset printing will be covered first. See Table 1.

Web Products	**Typical Printing Process(es)**		
	Offset	**Gravure**	**Flexography**
Commercial Printing	✓		
Magazines	✓	✓	
Catalogs	✓	✓	
Books	✓		
Business Forms	✓		
Envelopes	✓		✓
Newspapers	✓		✓

Table 1 – Common printing processes used for high-volume products **(continued on page 35)**

Web Products	Typical Printing Process(es)		
	Offset	Gravure	Flexography
Flexible Packaging		✓	✓
Folding Cartons	✓	✓	✓
Corrugated Postprint			✓
Corrugated Preprint	✓		✓
Tag and Label (excluding sheetfed)		✓	✓
Giftwrap and continuous-image products		✓	✓

Table 1 – Common printing processes used for high-volume products (continued from page 36)

Web Offset

Web offset is a printing process typically utilizing two printing fluids (ink and fountain solution) and a flat aluminum plate. The ink is transferred via a rubber (or elastomeric) blanket to the substrate. Web offset is popular in many markets and, along with its sheetfed cousin, accounts for about 50% of all printing in the United States.

Uses of Web Offset

Web offset is used for numerous commercial products such as flyers, brochures, general advertisement, business forms, direct mail, publications and catalogs, books, newspapers, and folding cartons. Some of these market segments utilize competing processes—particularly publications and catalogs (gravure), newspapers (flexo), and folding cartons (gravure and flexo).

Substrates

Web offset typically prints on paper with average to high smoothness. Typical papers for publications include 40–100 pound coated and uncoated book papers. Folding cartons use paperboard typically thicker than .018 inches. Web offset does not print well on plastic sheets, films, or foils. Therefore, web offset may be ruled out for most flexible packaging applications. Further, web offset is not typically used for corrugated carton printing. Sometimes, however, a preprinted litho sheet may be laminated to a corrugated medium.

Expected Run Length

Web offset is economical for run lengths as low as 10,000, or into the millions. Web offset may compete with sheetfed offset for short runs and with gravure for long runs, depending on the product. Offset offers easy and inexpensive plate changes, making it well-suited for versioning. Some long-run magazines have offset covers and advertising sections with gravure editorial pages. Examples include *National Geographic* and *Good Housekeeping*. Be careful to examine both advertising and editorial sections before drawing conclusions.

Quality of the Printing

Due to its high quality and image richness, it is sometimes difficult to differentiate offset litho from gravure or flexo. Historically, ink/water imbalance, resulting in color variation throughout a press run, has been the enemy of the offset printer. As more closed-loop color controls have been installed on web presses, ink variation has decreased, offering consistency that rivals gravure. However, if color does vary across a run or even across a spread, it may be web offset.

Web offset produces a broad tonal range and is often superior in its highlight and shadow detail. Gradations generally look very smooth even in extreme highlights (0–10%). Vignettes show no drop-off and images can be produced near photographic quality.

Offset news inks dry incompletely (by absorption) and darken one's hands as a newspaper is handled. In contrast, flexo newspapers use ink with through drying agents. So, offset printing may be suspected if ink rubs off a newspaper onto one's hands or discolors skin (see Photo 1).

Type and Line Work

Web offset offers relatively smooth type and line work. Under high magnification (50X), you will see some raggedness on the edges. This is usually a result of the

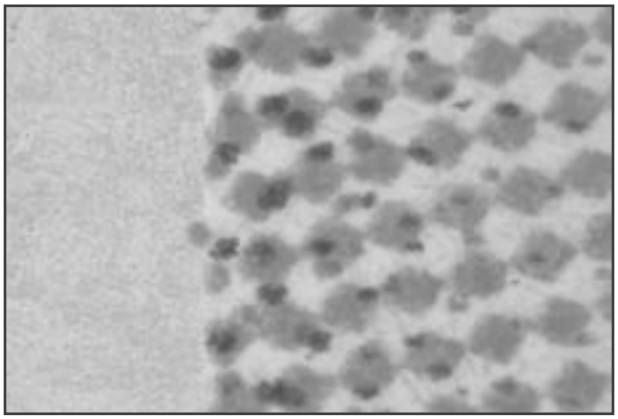

Photo 1 – This offset printed magazine shows relatively consistent halftone images and a smooth gradation in the black.

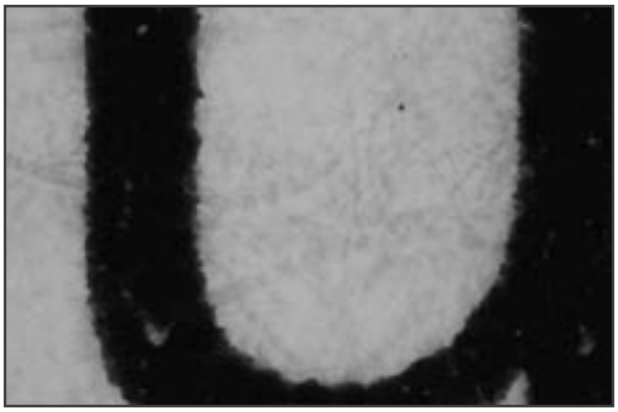

Photo 2 – Relatively smooth edges on the type and no halos leads to identifying this as offset lithographic printing.

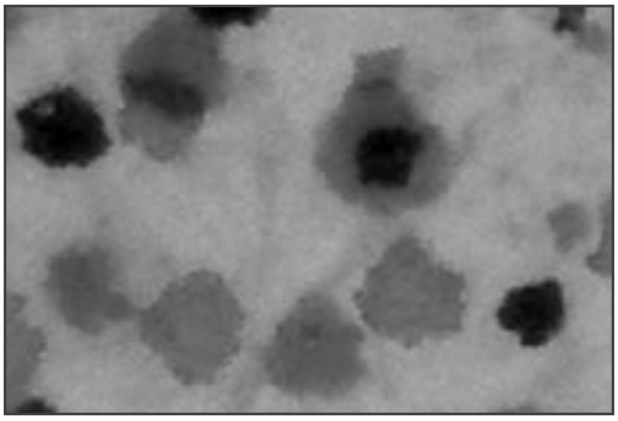

Photo 3 – These litho dots show good uniformity and no doughnuts. The inconsistent shapes are likely a result of substrate absorption.

substrate roughness in combination with the grain of the litho plate. These ragged edges should not to be confused with gravure printing, where the "jaggies" (resulting from the engraved cells) are quite visible. See the gravure section for samples of gravure type (see Photo 2).

Halftones

Web offset halftone dots may exhibit ragged edges under high magnification. Litho dots are not typically uniform, though the imaging technology can impact the shape of the dot. Computer-to-plate (CTP) devices will often produce sharper and more uniform formation than traditional platemaking methods. The grain structure of the actual plate may further impact the dot uniformity. In addition, paper surface will have a significant effect on dot roughness. Coated stocks result in better ink holdout and provide a more uniform dot shape than uncoated papers (see Photo 3).

Although some recent work has been done in both flexo and gravure using frequency modulated (FM or stochastic) screening, this is usually an indication of lithography. Hybrid screening (a combination of amplitude modulated (AM) and FM screening) is more common in flexographic printing, where the unique benefits of FM screening for highlights and shadows can be incorporated with the smooth rendition of traditional screening in the quarter-tone through three-quarter tone areas.

Gravure

Like offset, gravure is a high quality printing system. It utilizes an engraved cylinder with a recessed (intaglio) image area. Everything to be printed is engraved into the cylinder—halftones, line work, and type. This is an important feature in the identification of gravure. While there are specialty engraving processes that may not have jagged type, a typical characteristic of gravure printing is the serrated edges around type. Gravure accounts for about 16% of all printing revenues in the United States.

Uses of Gravure

Gravure is used for a number of different products including long-run publications, catalogs, retail inserts, folding cartons, and flexible packaging. In addition, gravure is often used for many continuous-image products like gift wrap, vinyl floor covering, and wallpaper, where there is no defined beginning or end to the image.

As mentioned earlier, gravure has competition in many product segments—namely publications (offset), folding cartons (offset and flexo), flexible packaging (flexo), and specialty products (offset, flexo, and even screen printing).

Continuous-image products are usually printed gravure, as the cylinder can be easily engraved with a seamless repeating pattern (in some cases flexo can also be used for continuous-image products). Many simulated wood grains are produced in this manner taking advantage of the seamless repeated pattern. Offset is usually incapable of producing continuous-image products.

Substrates

Gravure prints well on paper, films, and foils, as well as laminated materials. In general, gravure requires smoother substrates than either offset or flexography. If the substrate is highly textured, it is not likely to be printed by gravure (although some gravure products may be embossed or textured as a separate finishing process). The substrate's surface must contact each and every gravure cell for complete ink transfer. For this reason, paper and paperboard are frequently coated or calendared for gravure printing. While flexo and litho easily print on rough surfaces, the substrate must be smooth for gravure. Publication gravure also frequently prints on much thinner papers than litho. This is another tell-tale indicator of process.

Expected Run Length

Gravure is known for being most cost-effective at long run lengths or for repeat work. Although much is being done to reduce cylinder costs—with an eye toward shorter runs—gravure cylinders are still more expensive than offset or flexographic plates. This fixed-cost must be offset by one of gravure printing's many strengths—low variable costs, rich shadow detail, consistency, continuous-image printing, and variable repeat. Gravure packaging printers occasionally print 50,000 pieces or less, but typically print much higher quantities or produce multiple short repeat runs from the same cylinder. Since packaging graphics don't change as frequently as magazines, they can be printed, stored, and rerun many times.

Publication gravure printers prefer run-lengths over 1/2 million impressions. Gravure magazines often have covers and regional or targeted advertising sections that are printed via web offset. Circulation is one determining factor of whether a magazine is a candidate for gravure.

Photo 4 – Two gravure printed catalogs.

Runs under 500,000 are usually offset, while runs over one million are often printed by gravure. Publications requiring runs between 500,000 and one million can be printed by either offset or gravure. Of course, time-compression may play a role—most weeklies are printed web offset regardless of circulation (see Photo 5).

Quality of the Printing

Gravure printing has long been considered the Cadillac printing process. Its hallmarks are its very high-quality, rich vibrant colors, and great shadow detail. This is particularly true of photographs and other tonal work. Gravure's ability to lay down a thick three-dimensional ink film—altering not only the width of the dot but also the depth—produces brilliant color (see Photo 6).

This is easily noticeable when looking at black ink areas. Gravure can usually produce a richer black than other processes. For example, a noticeable distinction will be apparent in the black-ink areas of a foreign language edition of a *National Geographic* magazine compared to the same edition circulated in the U.S. Since U.S. editions of *National Geographic* are printed with gravure, and most foreign editions are produced using web offset, the U.S. version will have darker richer blacks because gravure lays a dense thick film on the substrate.

Type and Line Work

While gravure excels in image quality, many criticize its inferior type and rendition of line work. Gravure printing is usually characterized by its serrated edges on type and line work. This serration is due to electromechanical cylinder engraving methods that screen not only tones, but also type. Under magnification, this is quite

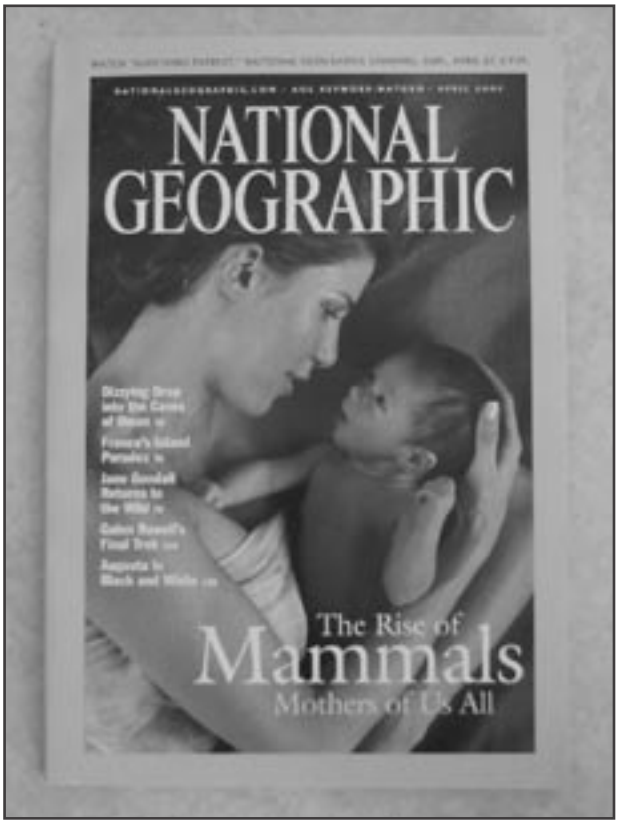

Photo 5 – The US edition of National Geographic magazine has a web offset cover and some advertisements, and gravure editorial sections. An interesting comparison is to acquire a foreign language version to compare with the US version. Foreign language versions are mostly offset.

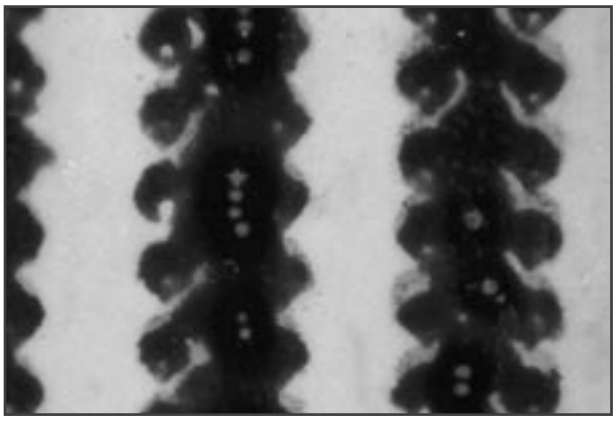

Photo 6 – This barcode from a beverage carton shows the variable ink-film thickness capable of gravure printing.

noticeable. Care should be taken, however, to not confuse a process screen mix with gravure's serrated edges. Examine solid black type rather than a screen build or reverse, which can be misleading.

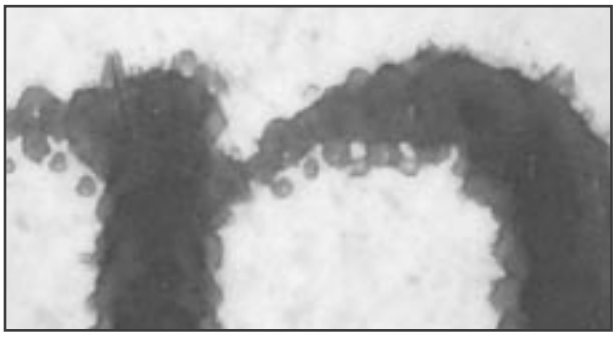

Photo 7 - The serrated edges around the type are a sure sign that this is a gravure printed product.

Recent advances in cylinder engraving technologies have seen dramatic improvements in type and line reproduction. Direct laser engraving, as well as other new technologies (such as Xtreme engraving or Transcribe), minimize serrated type.

Halftones

As previously noted, gravure printing involves pulling ink out of recessed cells. The most common shape of these miniature cells resembles an inverted pyramid. The tip of the pyramid (the bottom of the cell), does not readily release ink. This, in combination with the ink's surface tension, often results in non-uniform ink coverage. The resulting dot often resembles a "doughnut." Flexo printing also exhibits hollow-centered doughnut tones.

The release of ink from these problem areas is aided by an electrostatic charge, known as electrostatic assist

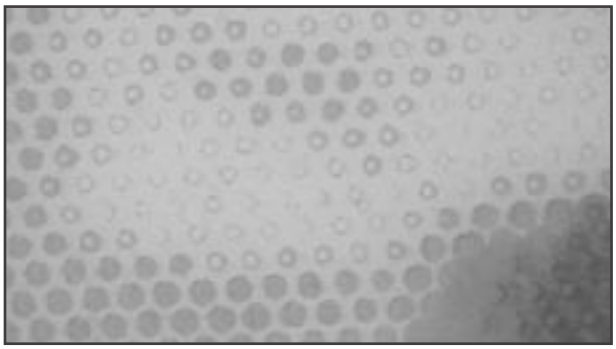

Photo 8 – These tones show the doughnut center typical of gravure printing. This sample used laser engraved cylinders.

(ESA). This process incorporates a static charge at the cylinder nip, attracting the ink to the substrate. However, this often results in a residual static charge in the substrate. Open a magazine or catalog and if you notice significant static, it is quite likely a gravure product.

While the predominant process of gravure engraving is electro-mechanical via a diamond stylus, laser engraving technologies have seen limited market penetration. Laser engraved dots exhibit slightly different print characteristics. The cell shape resembles a round-bottom cup rather than the inverted pyramid. The resulting ink release characteristics are quite different and the doughnut pattern is reduced.

Flexography

Flexography is a printing process using a raised polymer or elastomeric plate to transfer ink to a substrate. It has historically been a lower quality process than either offset or gravure. However, over the last decade, flexo print characteristics have improved so that it is now a high-quality process. This increase in quality is related to research and development in anilox rolls, plate technology, and inks. Computer-to-plate flexo is now common and energy curable ink technology in narrow-web applications is quite advanced. Flexography accounts for approximately 20% of the US printing market.

Uses of Flexo

Flexography is used for a number of different products, but is dominant in the packaging arena. Flexography can print on a number of different substrates, including very rough surfaces. Flexo products include folding cartons, flexible packaging, corrugated cartons, shrink sleeves, and pressure sensitive labels. Flexo is also used on a limited basis in the newspaper industry. Flexo competes against other printing process in some of these niches—namely folding cartons (gravure and offset), flexible packaging (gravure), and newspapers (offset). Additionally, pressure-sensitive labels receive competition from the sheetfed glue-applied technologies and, to a lesser degree, gravure and intermittent web offset presses. While continuous-image jobs can be printed by flexography, they are more commonly printed by rotogravure (see Photo 9).

Substrates

Flexography is one of the most versatile processes when it comes to substrate selection. Flexo prints on films, oils, paper, paperboard, and other materials. Because of its resilience, the flexo plate compresses and fills voids in the substrate surface, allowing it to print on both smooth and rough substrates. That is why the majority of corrugated boxes are printed by flexography. The rougher the substrate, the more likely it is printed by flexography. Screen printing is also excellent at rough substrates but is used for only limited high-volume applications.

Expected Run Length

Like offset, flexography prints both short-run and long-run jobs. Plate life is quite long and, like gravure, flexo plates are often cleaned and saved for future work. However, flexo plates usually last less than one million impressions. Therefore, plate changes are required for run lengths over one million impressions (see Table 2).

Quality of the Printing

In years past, flexo was easily identifiable due to inferior print quality. Historically, flexo was noticeable with the naked eye, possessing a strong "halo" pattern where the ink was squeezed at the edges of the print. This characteristic may still be noticeable under magnification. However, flexo has improved. Presses and press operators are more sophisticated in applying impression, "kissing" the plate to the substrate. So, quality no longer easily distinguishes flexo from other processes.

Vignettes are still challenging in flexo. There is commonly a drop-off near the highlight area of the gradation. Somewhere around 10% (the actual percent varies), the gradation will simply drop-off, resulting in a dramatic loss of highlight detail.

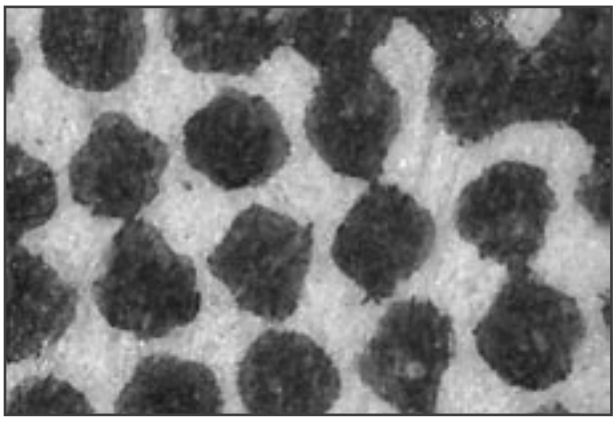

Photo 9 – This flexo newspaper shows very slight doughnuts in the halftones. The ink will not rub off as easily as an offset newspaper.

	Web offset	Gravure	Flexography
Substrates	Paper or paperboard only	Smooth substrates only – paper, film, or foil	Most substrates including very rough substrates
Run-length	Short-runs and long-runs possible. Plate changes may be required	Most economical for long-runs or repeat jobs	Short-runs and long-runs possible. Plates last longer than offset but not as long as gravure cylinders.
Quality characteristics	Color inconsistency over long run or spreads may be apparent. Good highlights and gradations.	Rich blacks and deep colors. Thicker ink film gives more vibrant color. May be weak in highlights and gradations.	Often quality expectations are lower for flexo. Weak highlights and drop-off in gradations. Registration may be inferior.
Type and line work	Few noticeable defects.	Serrated edges on type unless advanced engraving technique used.	Halo around type, particularly on films and foils.
Halftones	Few noticeable defects. Generally fairly smooth.	Noticeable doughnut effect on non-absorbent stocks	Noticeable doughnut effect on non-absorbent stocks.

Table 2 – Common characteristics of high-volume print processes

Because flexo plates are usually mounted without pin-registration, there may be slight register issues. Although registration techniques are improving, flexography is most likely to have looser registration tolerances.

Type and Line Work

As mentioned previously, under close examination, a "halo" effect may be seen on type and line work produced using flexographic printing. Factors that have contributed to the diminishing of this effect include harder durometer plates and more precise pressure controls on press (see Photo 10).

Halftones

Flexo halftones resemble gravure halftones. Hollow-centered (doughnut) dots are a result of non-uniformed ink distribution on the plate surface, in part due to the surface energy of the plates. Plate capping or advanced screening technologies may improve this characteristic (see Photo 11).

The edges of flexo halftones may not be uniform. Unless laser imaged, flexo plates will likely exhibit significant variation among the dots. Highlights, in particular, may suffer in flexo. As a rule of thumb, if there are no tones smaller than 10%, the job may have been printed using flexo.

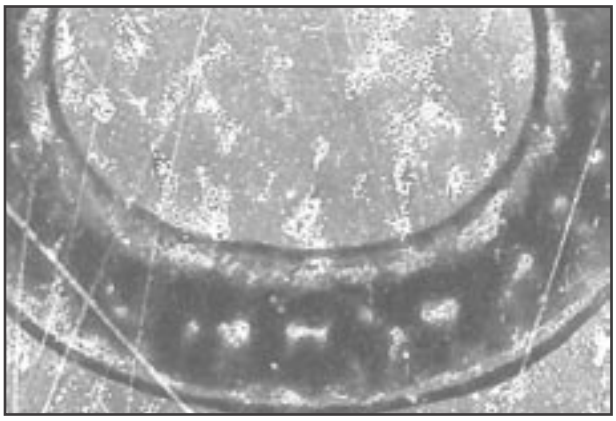

Photo 10 - This letter "O" printed on foil shows a very distinguishable halo around the edges, a clear sign of flexography.

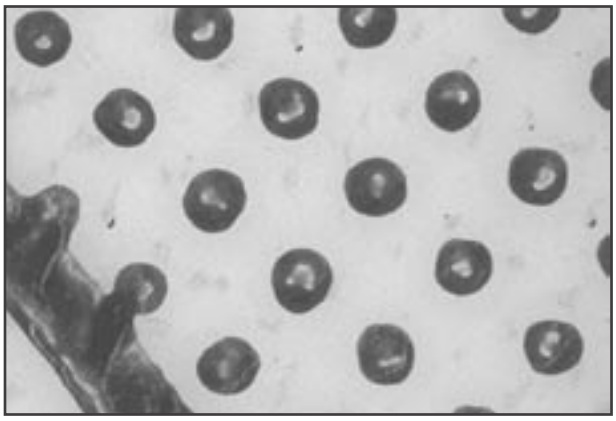

Photo 11 - The doughnut tones, combined with the halo on the type makes one suspect this is a flexo sample.

Combination Printing

Combination printing is gaining in popularity to take advantage of the benefits of different processes. It also significantly complicates the diagnostic process of identifying printing processes because the characteristics of more than one process are inherent in any given sheet. One common application of combination presses involves the use of screen printing units to lay down a thick, opaque white layer on clear film before flexo or gravure printing is applied. Combination printing can also be used to "version" a high-volume print job. For example, the name and address of a local retailer can be imprinted onto a high-volume advertisement printed by offset, gravure, or flexo. Versioning units, which may be flexo, offset, or digital, may be incorporated into any high volume printing press.

Conclusion

While identifying high-volume printing process can be very challenging, with careful examination and logical deduction, one can usually come up with a good guess on which primary printing method was used. Begin by considering the use of the product. Next, examine the substrate and expected run-length of the product. Finally, examine the overall quality of the product as well as the specific appearance of the type, line work, and halftones. These steps make identifying high-volume printing processes easy.

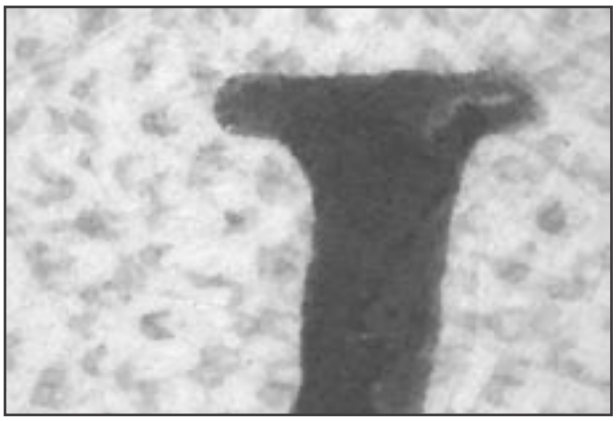

Photo 12 – This Sunday Magazine is printed gravure but uses flexo to imprint the newspaper's name on the front.

Biographical Information

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