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2009 Consumer Packaging Solutions for Barrier Performance Course

Flexible Packaging Printing Processes Overview

Presented by:

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The Clorox Company (GLAD)

8000 B.C. INVENTION OF THE PRINTING PROCESS.

The Basics of Flexible Packaging Printing

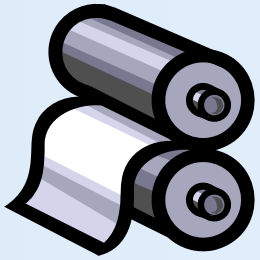
DEFINITION:

Applying ink to a substrate to produce an image or text

PRINTING METHODS:

Flexography and Rotogravure

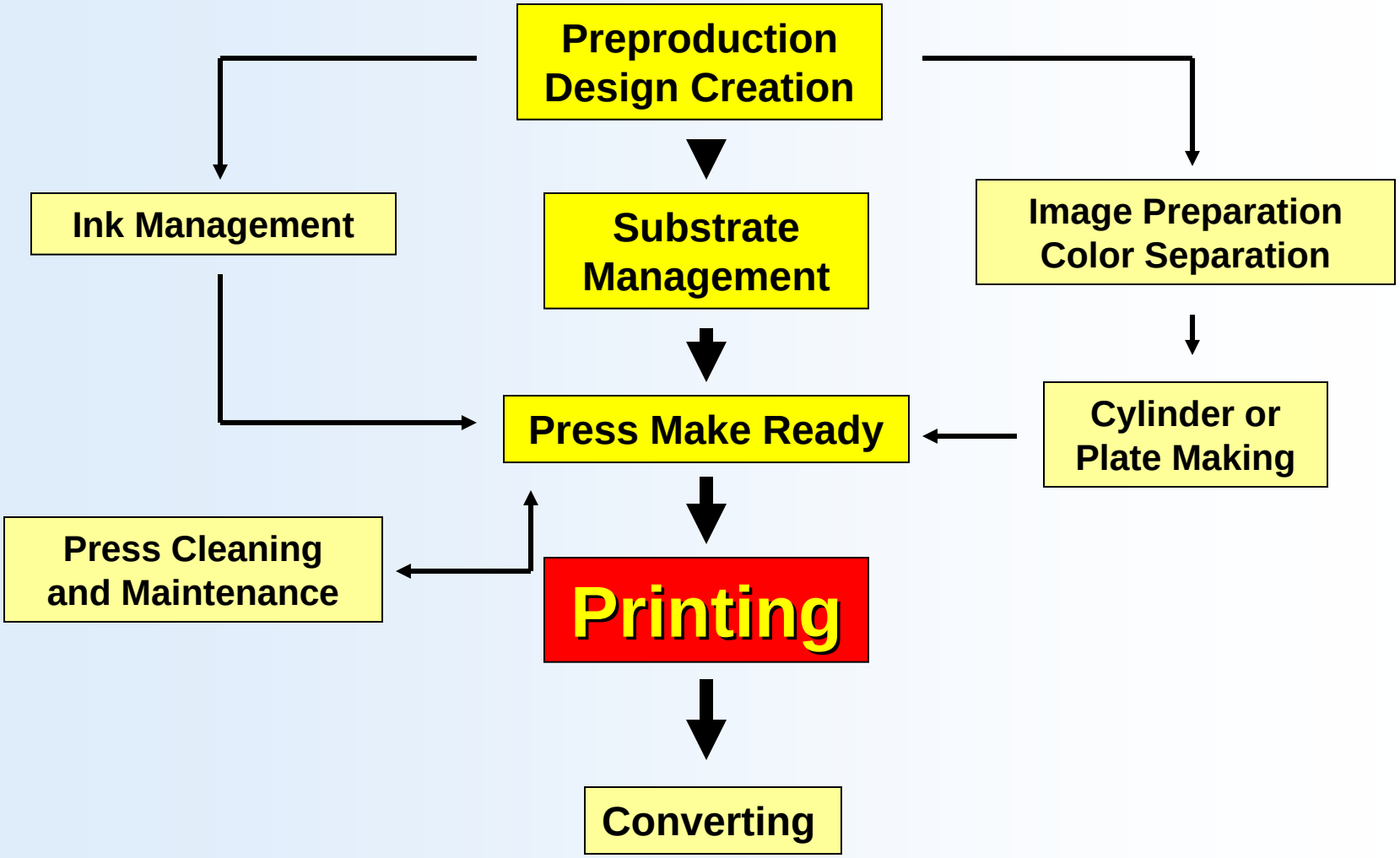
the two most widely utilized methods for Flexible Packaging



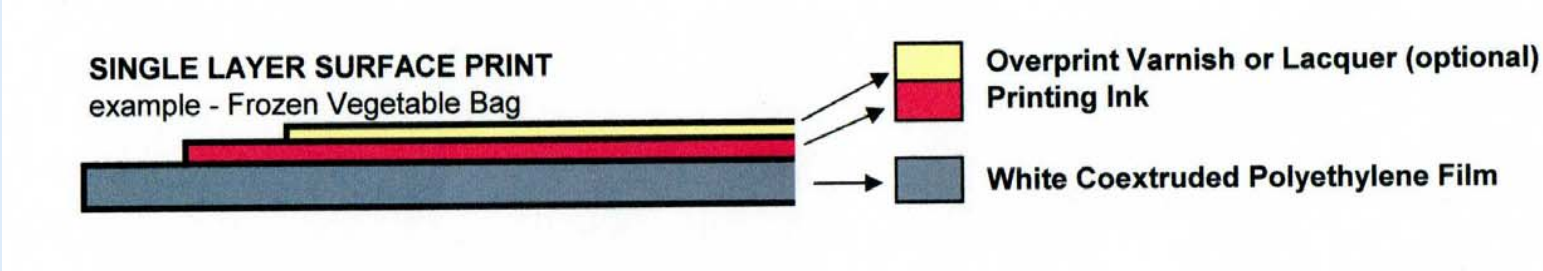
FOCUS:

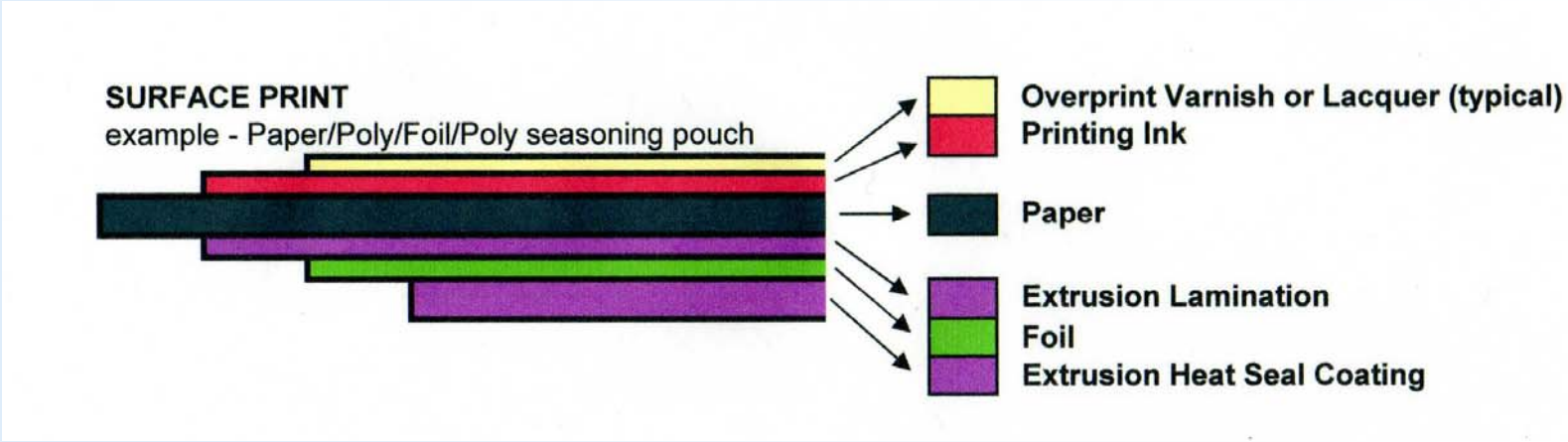
Design to Substrate; the "process" described
Structures and Print location
Understanding Ink
Substrate Surface Preparation
Methods and Equipment in detail
Reproduction Basics; line and process printing

Design to Substrate

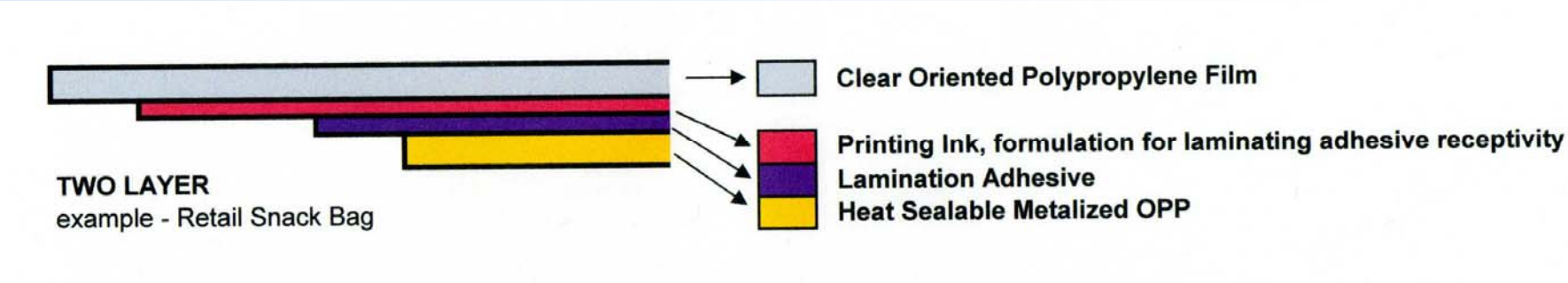


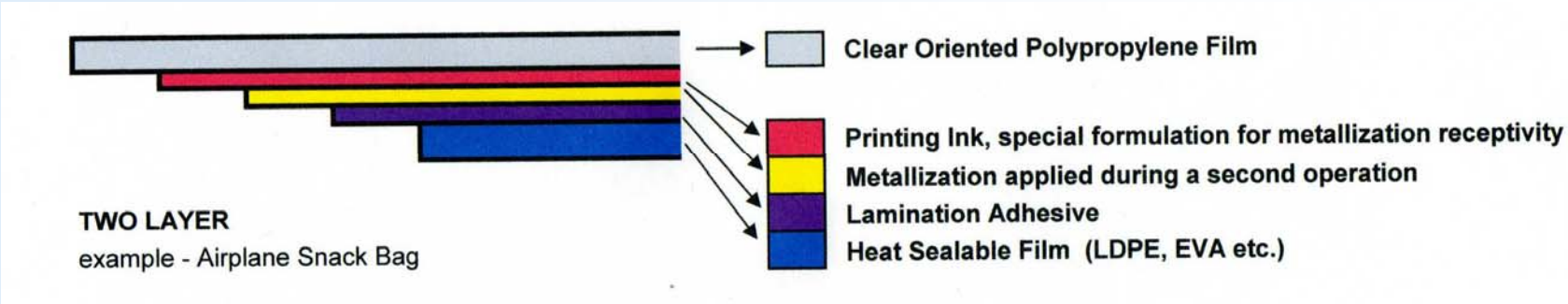
SURFACE Printing



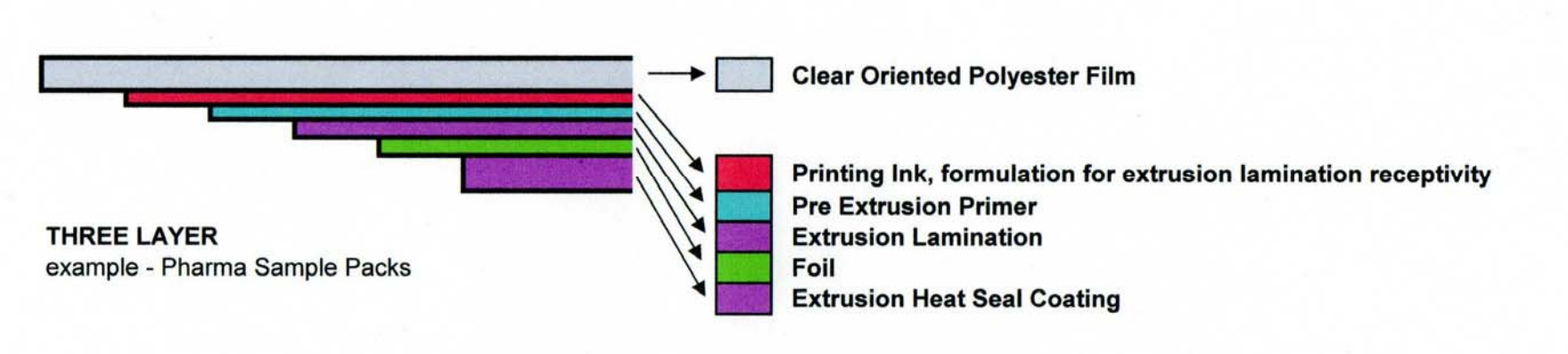


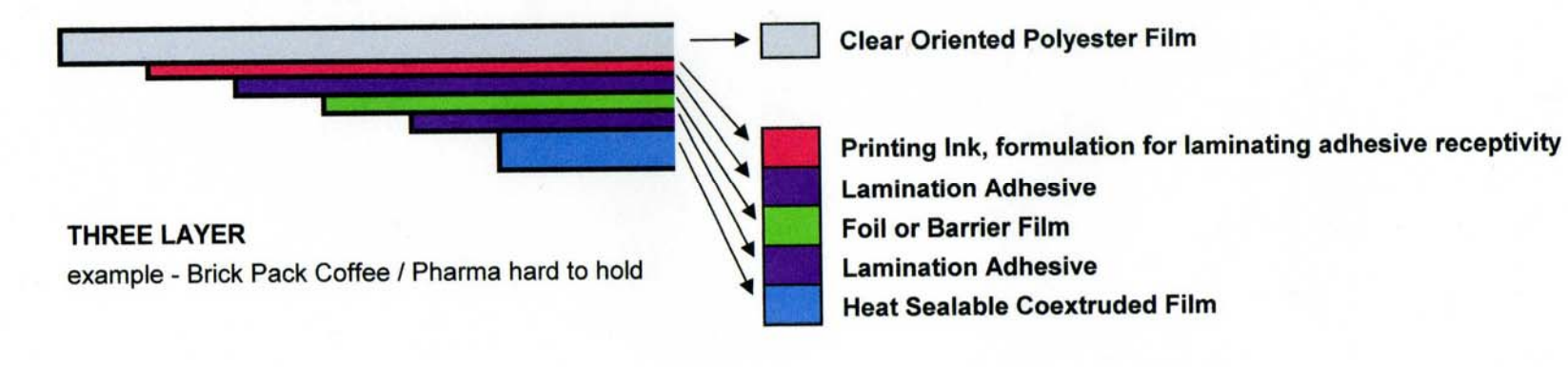
REVERSE Printing 2 Layer Structures





REVERSE Printing 3 Layer Structures





PRINTING INK, form & chemistry

- **Physical form**
  - **Liquid – free flowing**
  - **30% to 60% solids and 100% solids UV/EB**
  - **Relatively low viscosity**
    (closer to water than heavy syrup)
- **Chemistry**
  - **Solvent based – gravure, flexographic**
  - **Water based – flexographic, (gravure)**
  - **Radiation (UV/EB) cured– flexo, (gravure)**

RESINS Used in Packaging Printing Inks

- **Common**
  - **Nitrocellulose – Cellulose (cotton linters)**
  - **Polyamide – Rosin (crude tall oil)**
  - **Acrylic – Petrochemical (styrene and acrylic acid)**
  - **Phenolic – Rosin (gum derived)**

- **Specialty**
  - **Acrylate – used in UV/EB inks & coatings**
  - **Epoxy – used in UV/EB inks & coatings**
  - **Urethane – used in solvent and UV/EB inks and coating**

Typical PIGMENTS in Packaging Inks

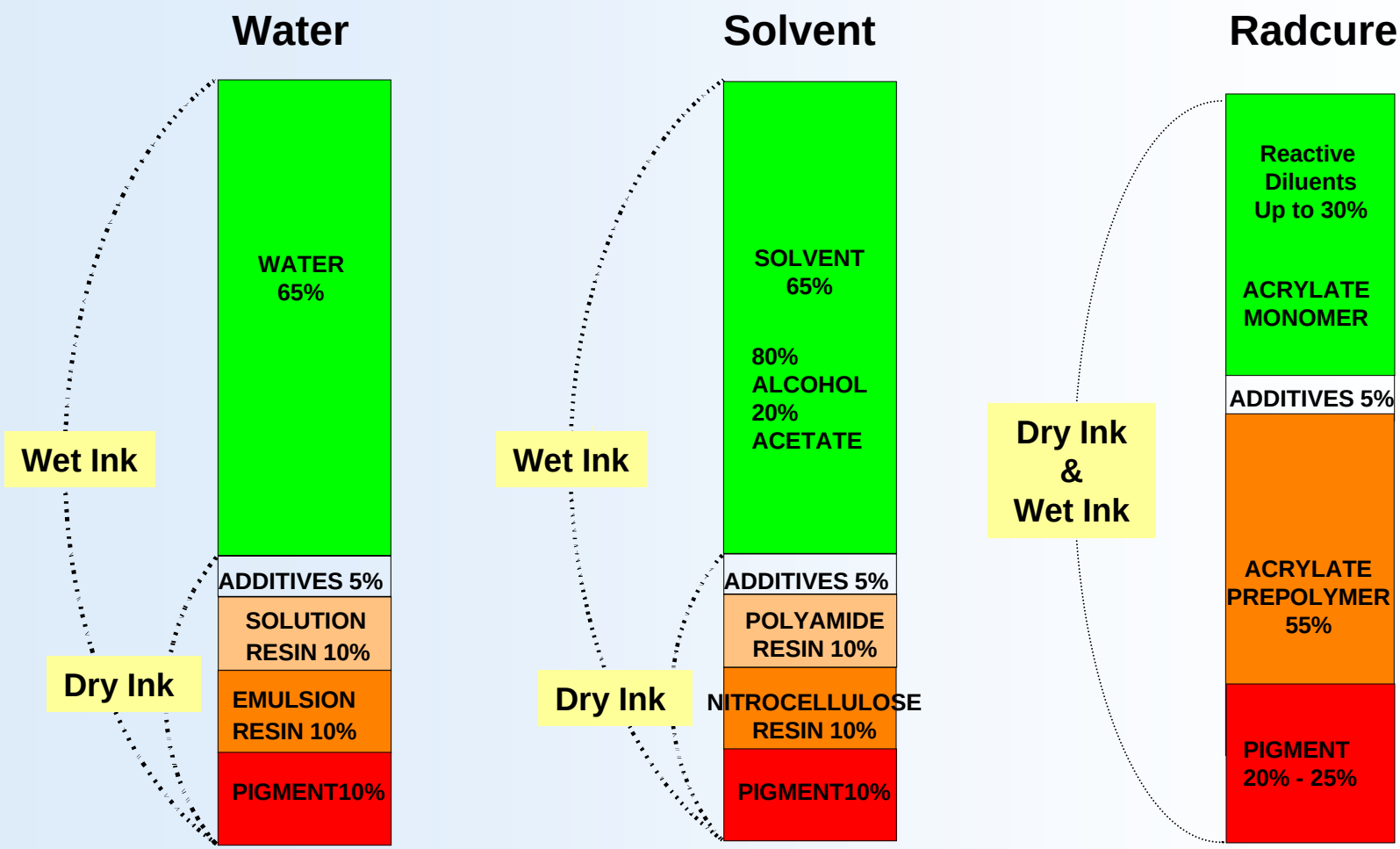
Organics:

- Carbon — black
- Diarylide — yellow
- Pyrazolene — orange / red
- Disazo — green shade yellow, red, orange
- Naphthol — red, brown, violets
- Pthalocyanine — green, blue
- Quinacridone — red

Inorganics:

- Titanium Dioxide — white
- Iron Oxides — yellow, red, brown
- Metallic (Aluminum) — silver, gold
- Clay — green, red, yellow, brown

Basic INK Formulation Examples



PRINTING INK, viscosity measurement

CENTISTOKE is the unit of reference in all viscosity cup measurements
SECONDS (time) is the Operator press side measurement

POISE is the fundamental unit of viscosity defined as the resistance of a liquid to flow where gravity is not a factor. **100 CENTIPOISE = 1 POISE.**
Gravity is the driving force causing liquid in a viscosity cup to flow through the orifice so a high density material will flow from a cup in a shorter time than a low density material of the same viscosity.
STOKE is defined as the POISE divided by density. 100 CENTISTOKES = 1 STOKE.

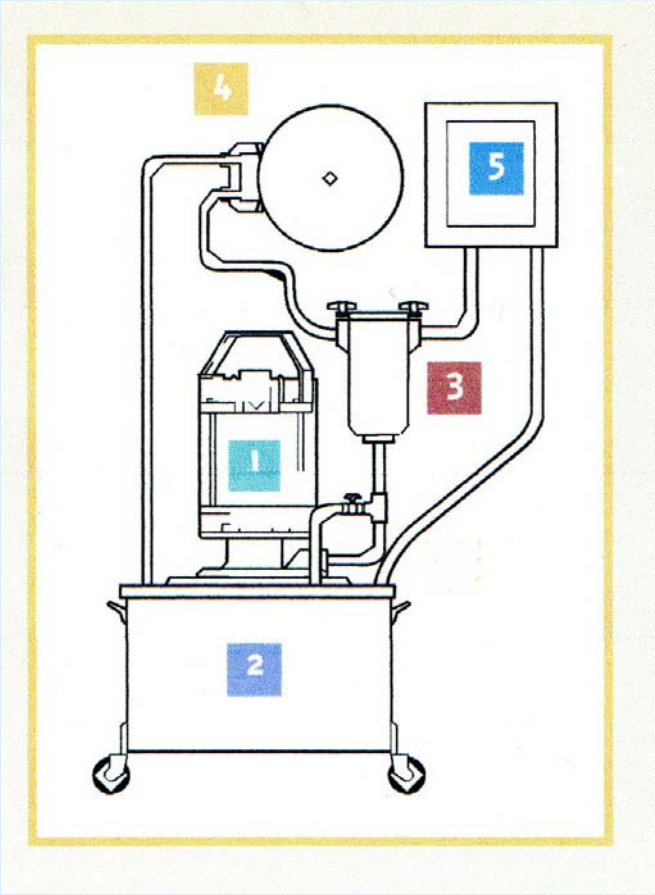
ZAHN Cup

ZAHN Cup conversions

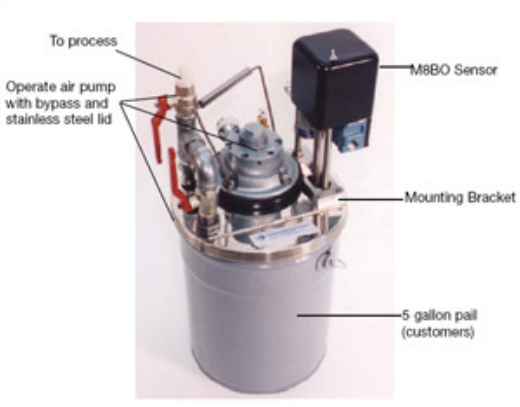
Cup Number	Seconds Efflux Time	Centistokes Range	
1	40-60	10-36	
2	20-60	19 to 156	
3	12-60	64 to 596	
4	10-60	79-784	
5	10-60	161-1401	

SHELL Cup

PRESS SIDE Ink Management



1) PUMP & MOTOR
2) INK TANK
3) FILTER
4) PRINTING STATION
5) AUTOMATIC VISCOSITY CONTROL



TREATMENT - Substrate Surface Preparation

Most plastics such as polyethylene, polypropylene and polyester have chemically inert and nonporous surfaces with low surface tensions causing them to be non-receptive to bonding with printing inks, coatings and adhesives.

Surface Treatment Systems increase surface energy to promote adhesion for printing, coating, laminating and other converting processes.

Most all substrates including paper and foil will exhibit increased adhesion to inks, adhesives and extrusion coatings after surface treatment.

CORONA Treatment

An electrical process that uses ionized air to increase the surface tension of substrates.

Typically, corona treating systems operate at an electrical voltage of 10 kV.

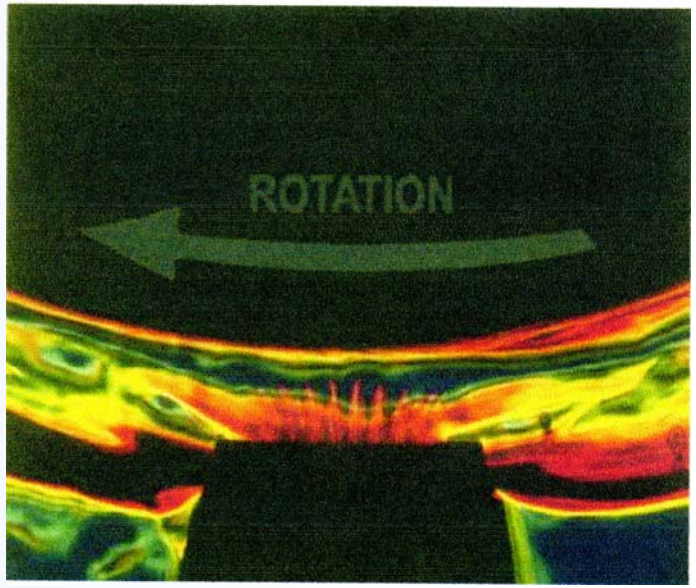
The high voltage is applied across an electrode which ionizes the air in the electrode/web gap, creating a highly energized corona.

PLASMA Treatment

Like corona, plasma is the electrical ionization of a gas. Unlike corona, plasma is created at much lower voltage levels and the rate at which electron bombardment occurs is up to 100 times greater. Plasma facilitates the use of chemical gases which can produce controlled chemical reactions to functionalize surfaces.

FLAME Treatment

The process of burning away surface contaminants by forcibly spraying a flame onto a substrate surface. This is accomplished by burning an ultra-lean gas mixture, whose excess oxygen is rendered reactive by the high temperature.



TREATMENT - determining the treatment level

DYNE Test

- Solutions of various percentages of Ethyl Cellosolve, Formamide and Water
- Dyne solution levels range from 30 to 60+
- The "treatment level" is based upon the specific solution number that wets out the surface vs. the next level up that beads up
- Easy and cheap test method well suited for use on the shop floor
- Procedure can be subjective but is reasonably accurate if adequate care is taken and the solutions are kept fresh

	Untreated	Treated
LDPE	31	38-45
OPP	31	38-45
PET	42	50+

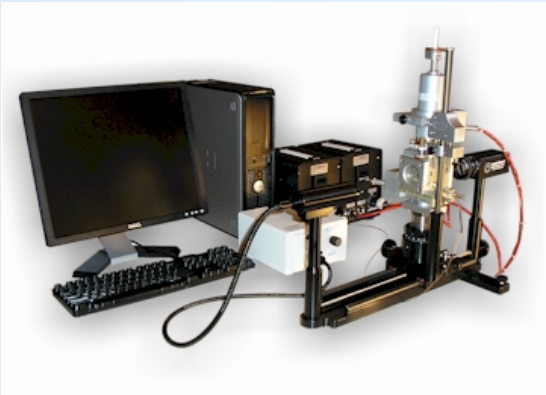
Reference ASTM D2578

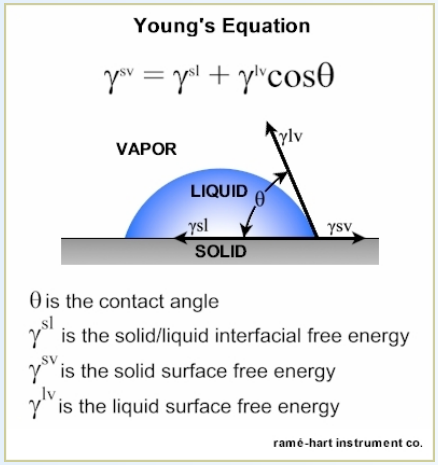
TREATMENT - determining the treatment level

CONTACT ANGLE

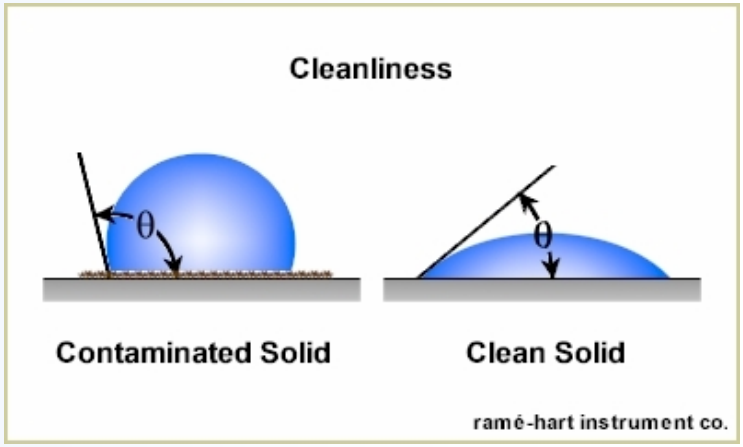
- **Contact angle is the angle formed by a liquid at the three phase boundary where a liquid, gas and solid (substrate) intersect**
- **Very precise measurement with high repeatability**
- **Requires a relatively expensive test instrument that is not well suited for shop floor use**
- **The lower the contact angle, the higher the treatment level**

Goniometer



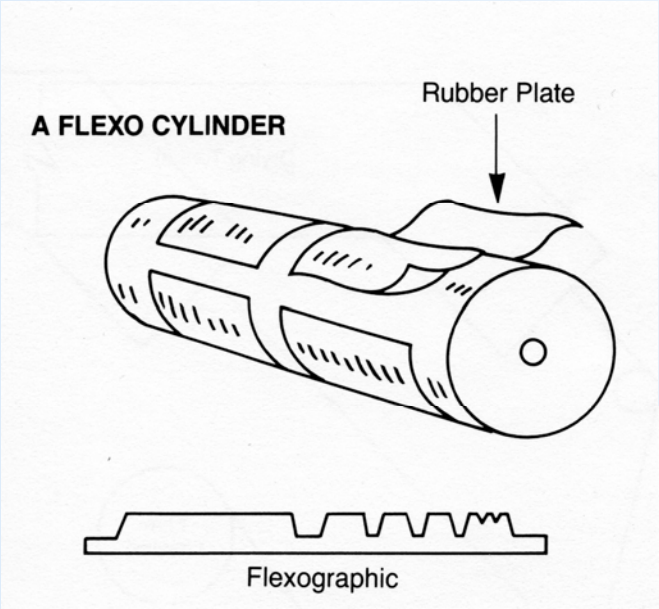


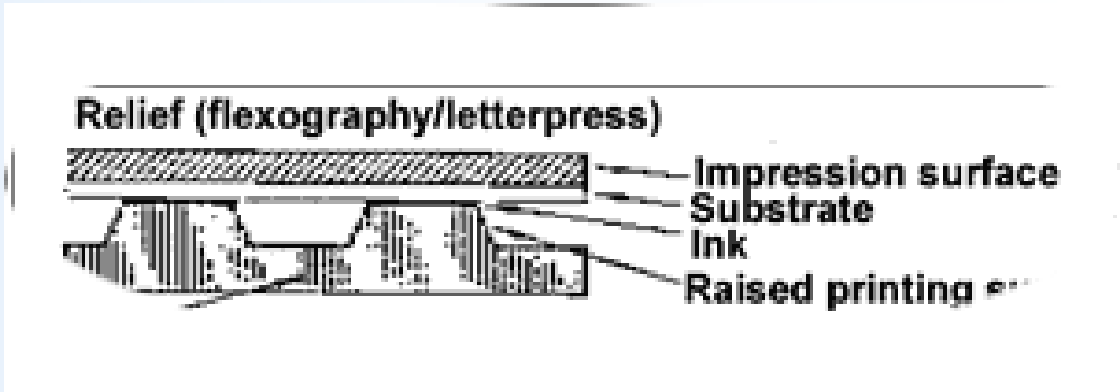
Reference ASTM D5946-04



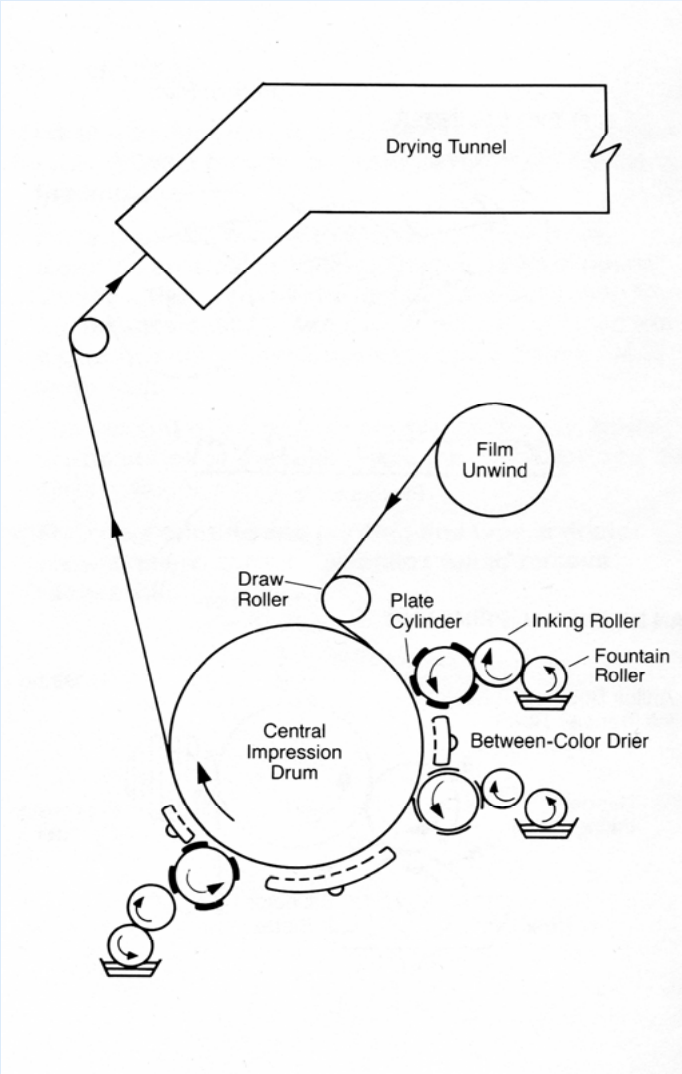
FLEXOGRAPHY Printing

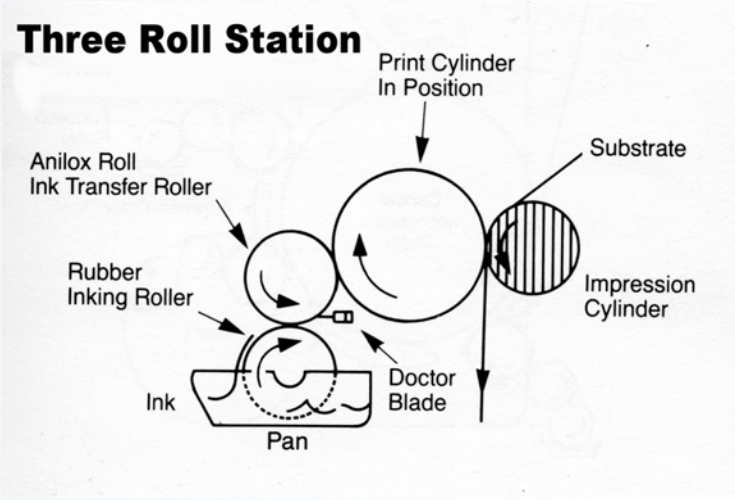
Flexography: (often abbreviated to Flexo)
A form of relief printing where ink is applied to a rubber or polymer plate on which the printing image is raised above the rest of the surface as a 3-D positive mirrored relief.

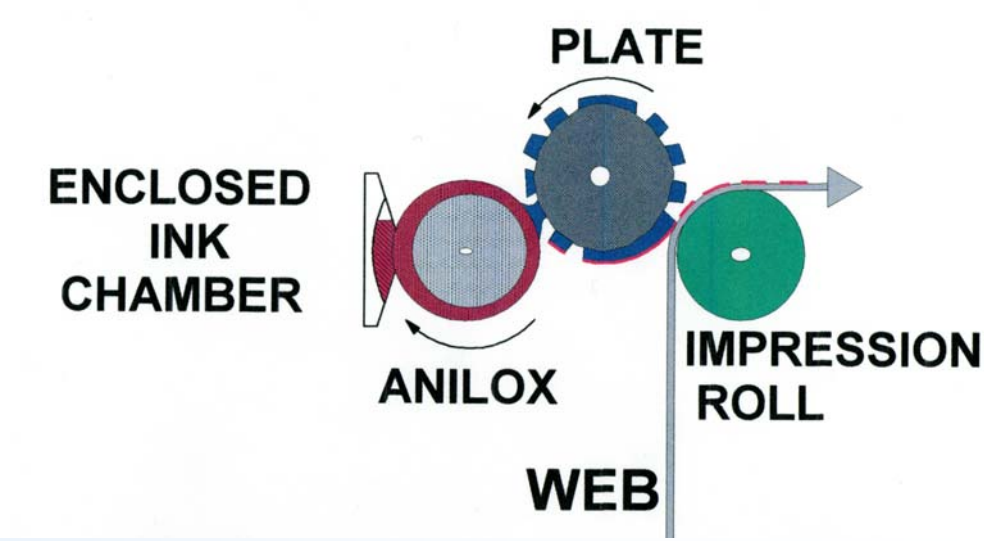




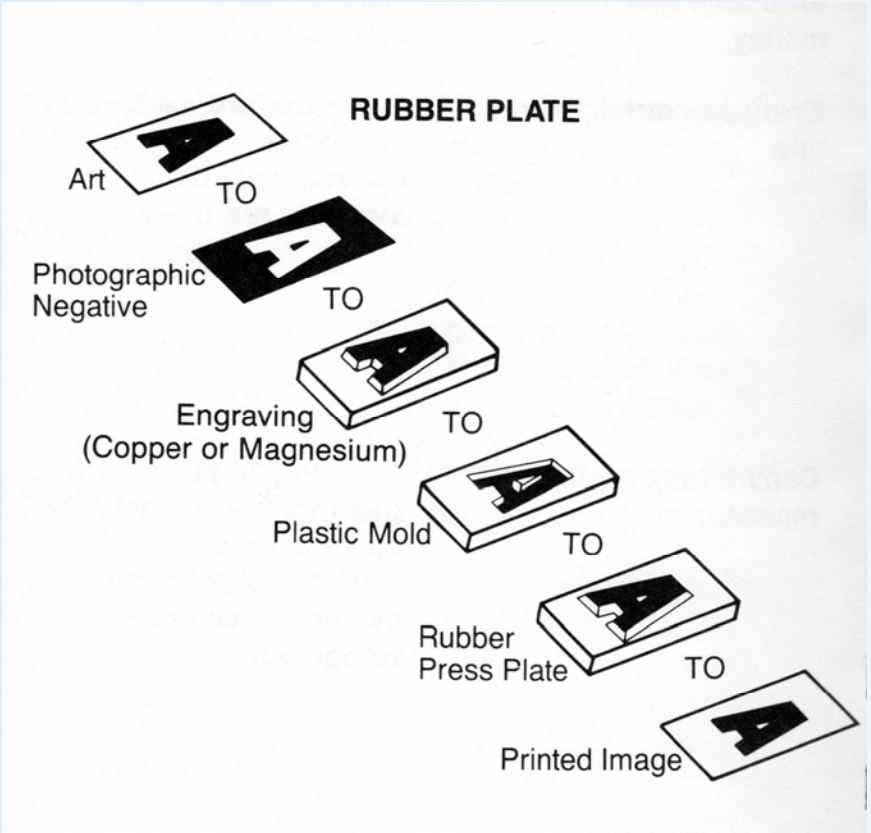
FLEXOGRAPHY Printing - process

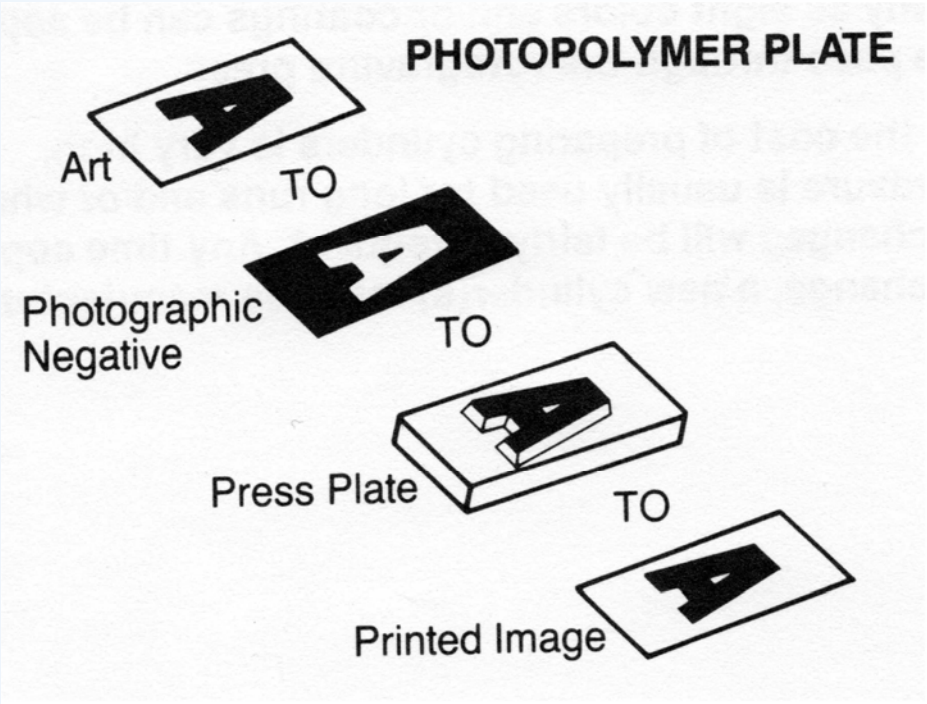






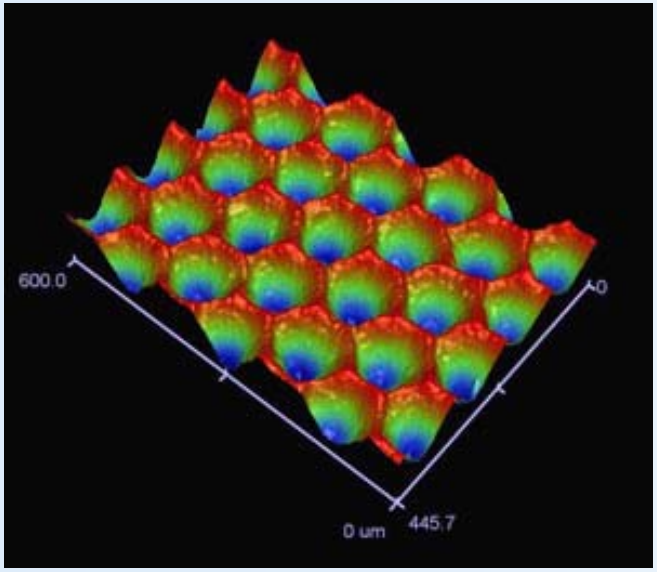
FLEXOGRAPHY Printing - plate structure

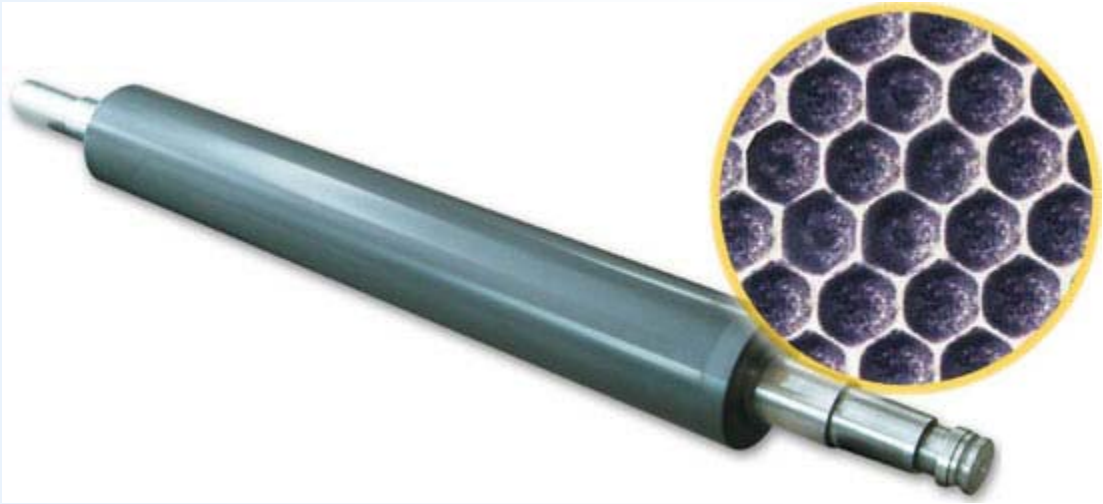




FLEXOGRAPHY Printing - anilox rolls

The anilox roll is a steel or aluminum core cylinder with a ceramic surface that contains millions of very fine cells.
They are specified by their "line screen", or the number of cells per linear inch ranging from below 250 to above 1500.
Lower line screens are used to print a heavy layer of ink such as block lettering. The highest line screens produce fine detail for four-color process work such as reproducing photographs.





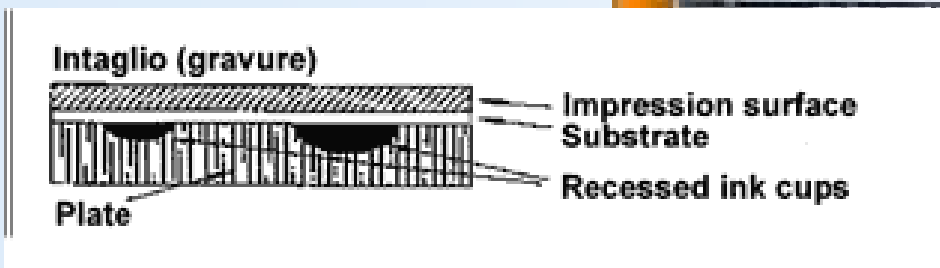
FLEXOGRAPHY Printing - presses

ROTOGRAVURE Printing

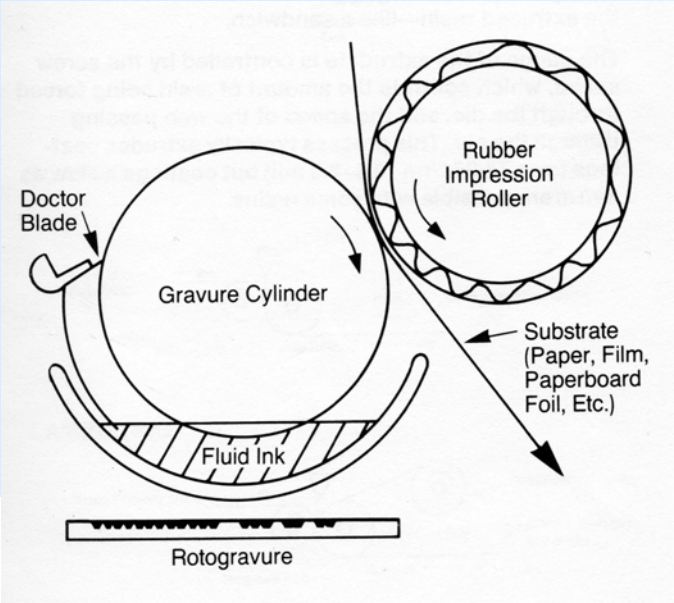
Rotogravure: (typically referred to as Gravure)

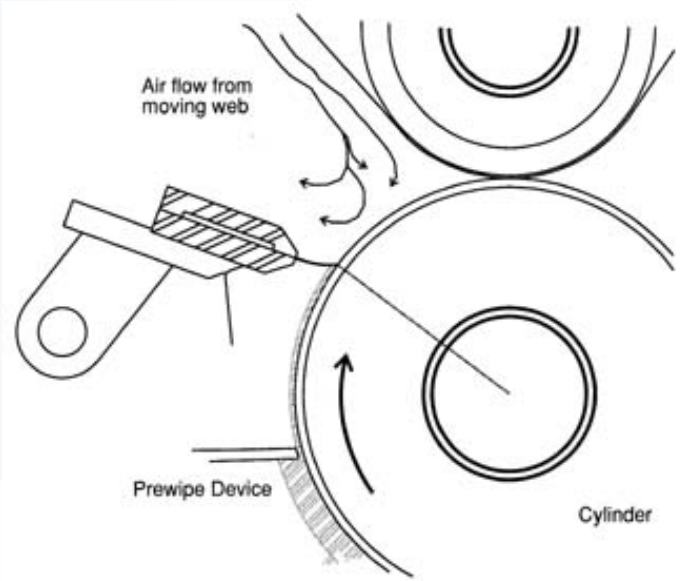
An intaglio process (in-tal-yo means engraved or cut in) in which a negative image is etched into the surface of a copper printing cylinder as tiny cells or dots of various sizes and depths.

The copper is chrome plated for durability. Ink is applied to the surface and a flexible metal blade called a doctor blade removes excess ink, leaving the surface clean, with ink only in the depressions.

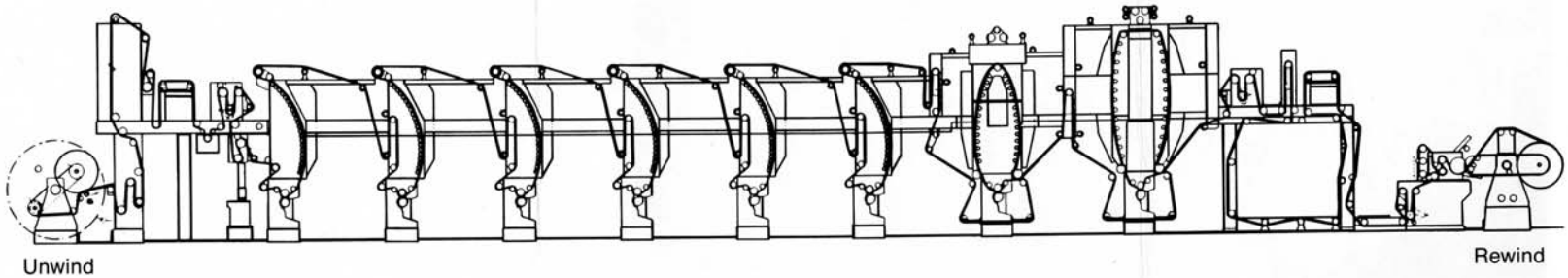


GRAVURE Printing - process

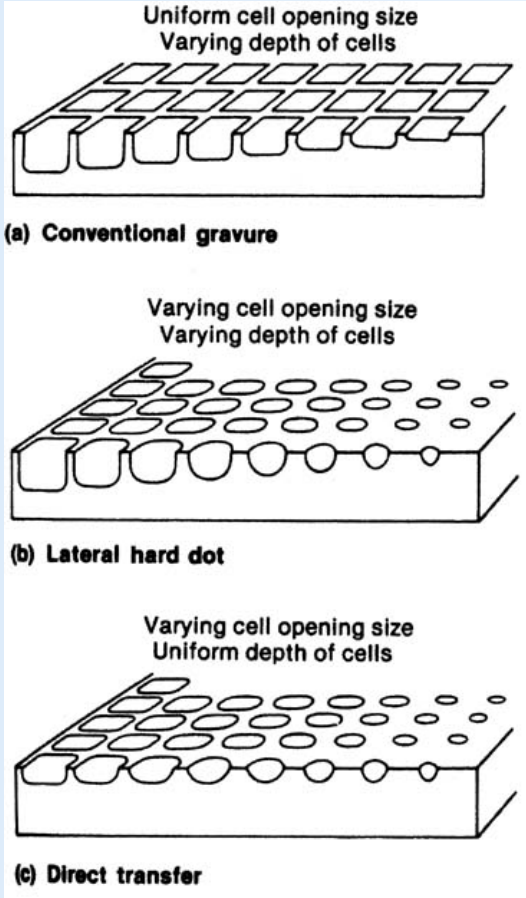


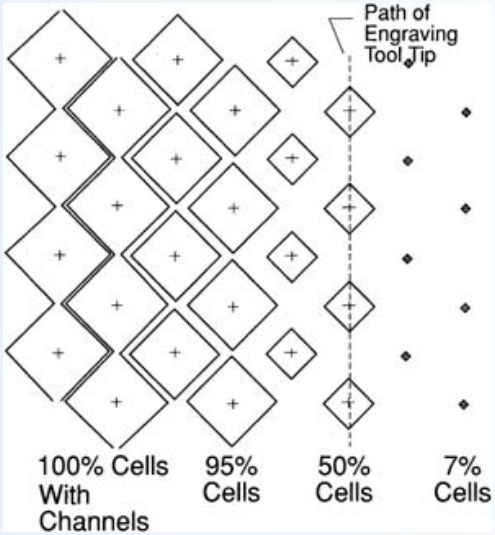


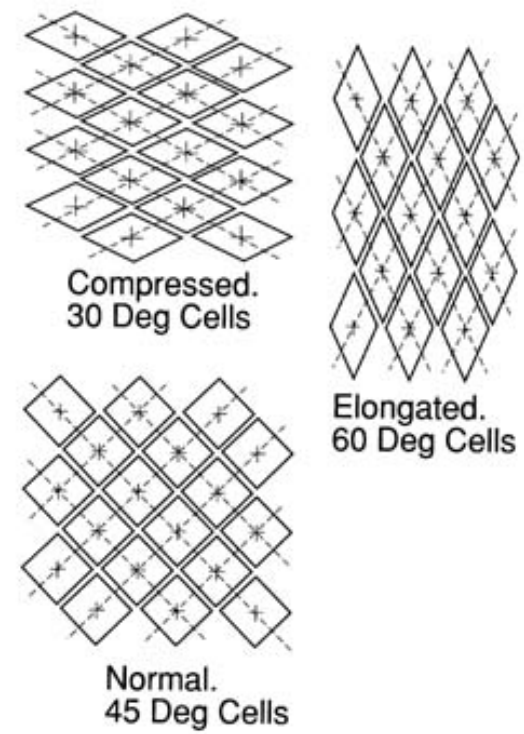
8 COLOR ROTOGRAVURE PRESS

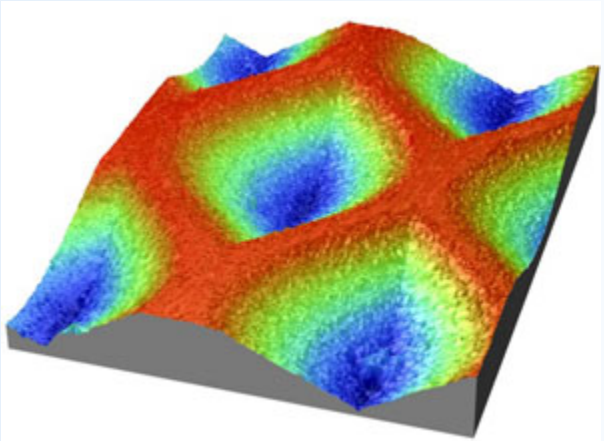


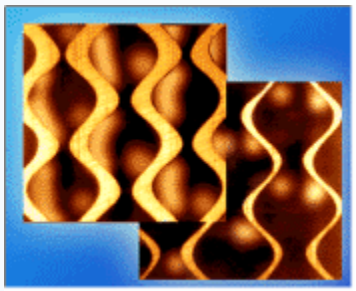
GRAVURE Printing - cell structure









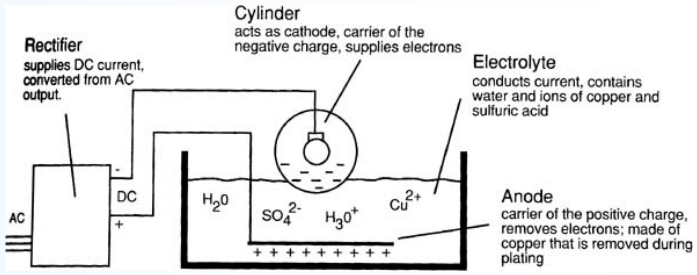


GRAVURE Printing - cylinder engraving

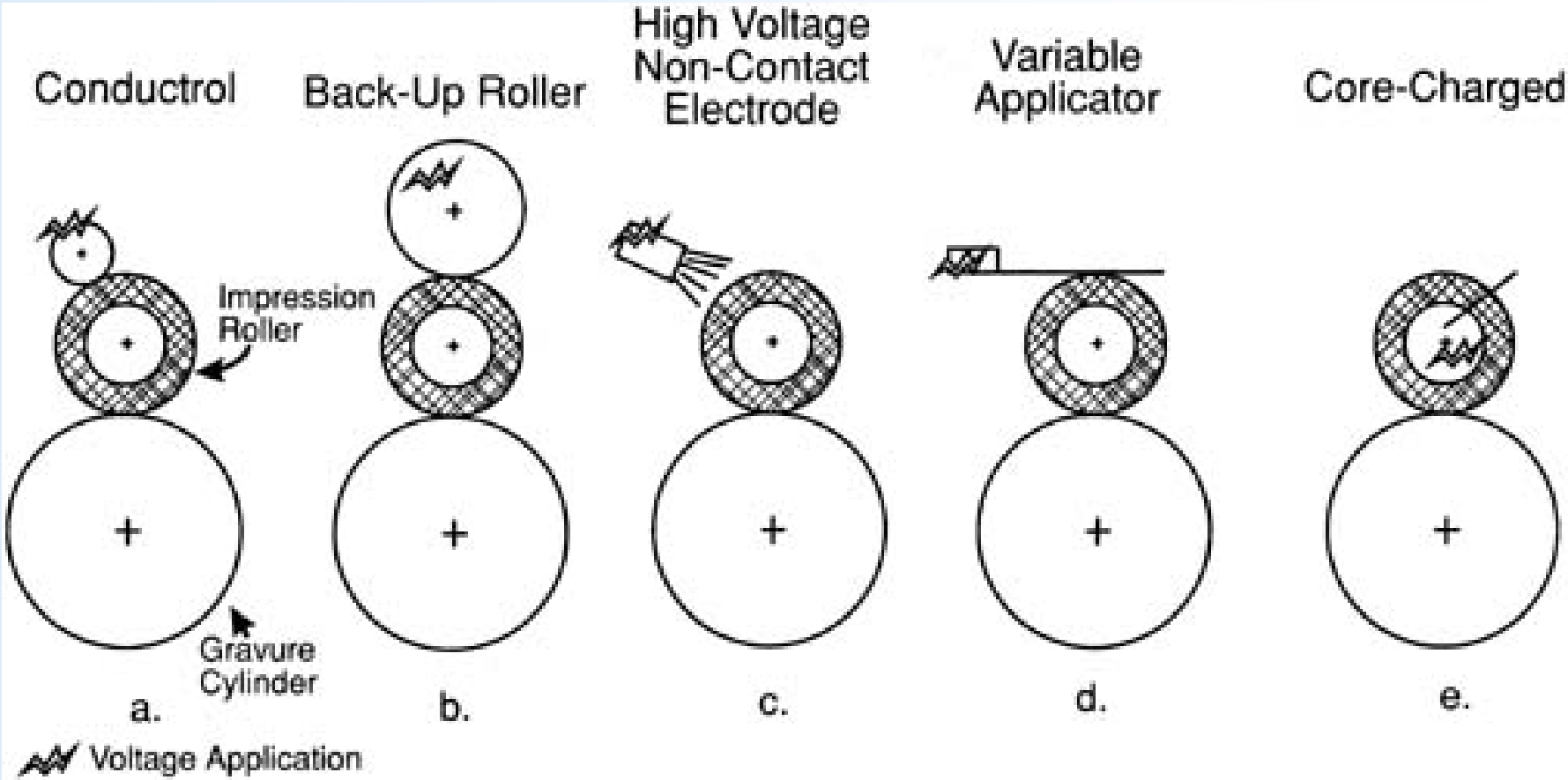
Acid Etching (Diffusion-Etching and Direct-Transfer) **–** Light sensitive gelatins or photopolymers on the coper surface are exposed through a film positive of the image resulting in varying levels of acid resistance. The surface is exposed to acid, resulting in cells of the same size and cell wall thickness but varying depths.

Electromechanical Engraving - The original copy is scanned into a computer and digitized. The computer then controls a diamond stylus that cuts the cells into the surface of the gravure cylinder. Cell depth and cell area are varied simultanously by using a tapered engraving head.

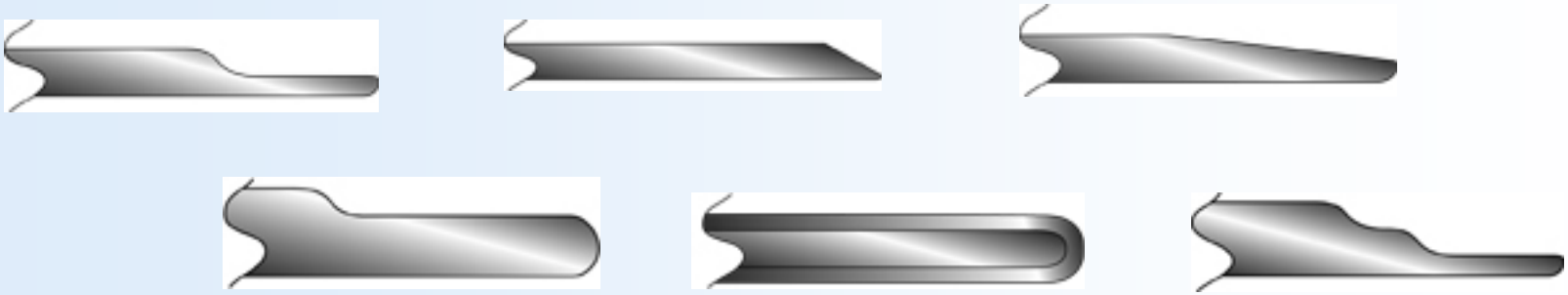
Laser Engraving – The method of choice to produce Flexo anilox rolls with some applications in gravure printing. An original is scanned into a computer, the various image densities are determined, and lasers etch the cylinder. Highly reflective copper is a poor material choice so alternative special alloys, plastics and ceramics are used.

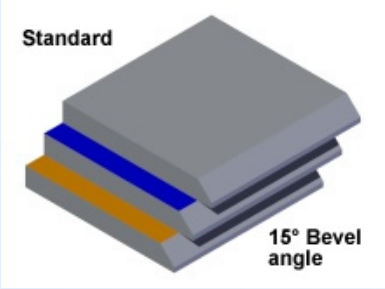


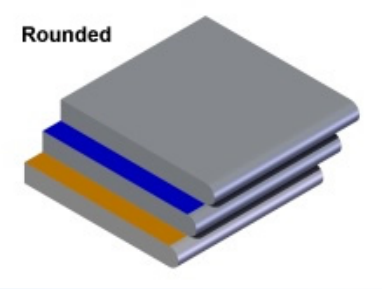
GRAVURE Printing - electrostatic discharge ESA

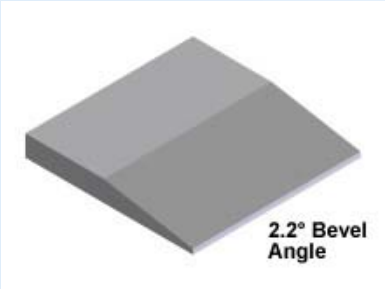


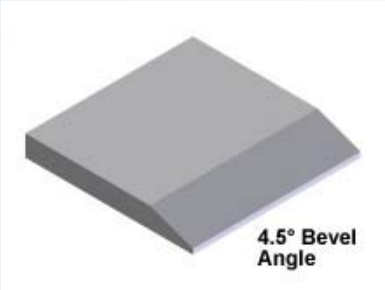
GRAVURE & FLEXO Printing - doctor blade design

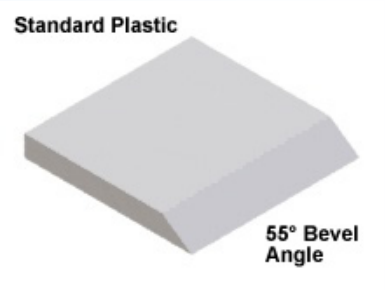












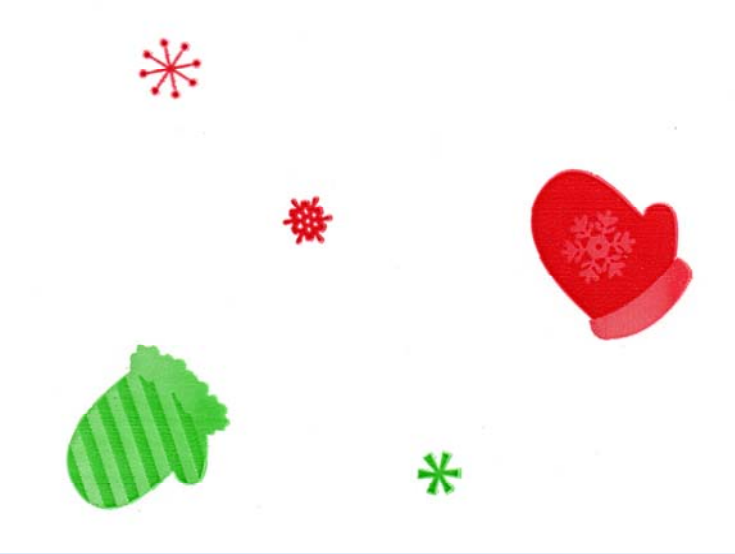
GRAVURE Printing - presses

LINE Printing

Single colors are printed at varying densities

Individual colors <u>do not</u> overlap or combine to form <u>new</u> colors

The number of colors in a design is limited by press capability



Flexo LINE Printing - reverse print film

Flexo LINE Printing “Screened” - surface print film

Gravure LINE Printing - surface print

4 Color PROCESS Printing / CMYK

Red, green and blue are the primary colors of light as perceived by the eye

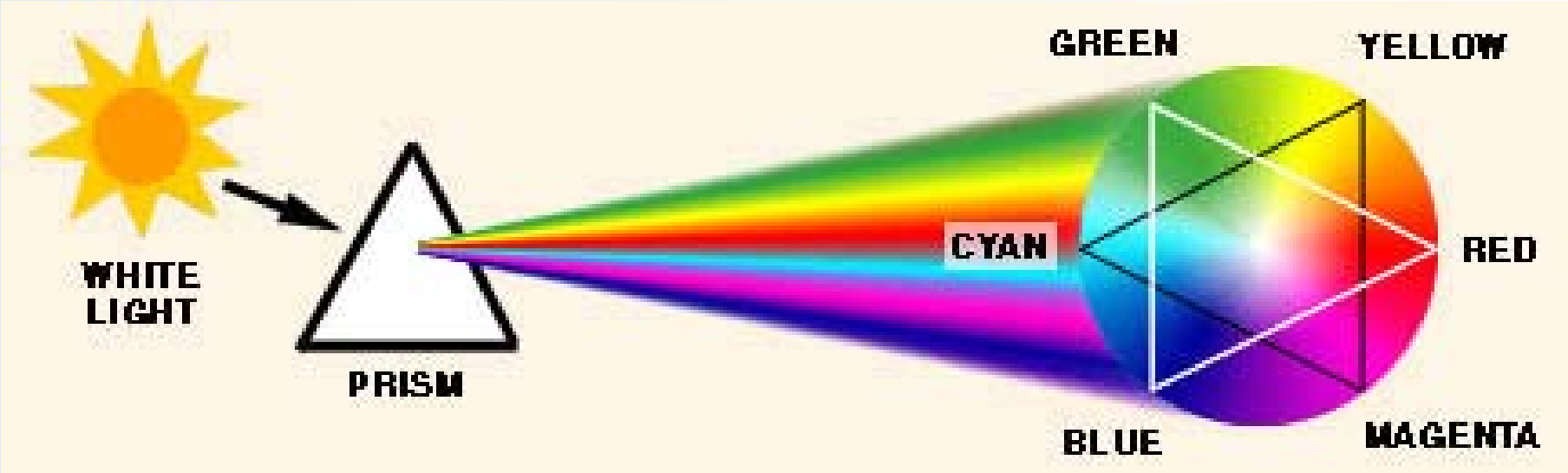
When the three colors are together in a spectrum they create white
The absence of color altogether is black

This works great for digital images on computer and TV screens
It does not work well when printing colors on a substrate

The base colors for process printing are CMYK and not RGB
CMYK are subtractive colors or secondary colors of red, blue and green

Blue + Green = Cyan (B+G = C)
Red + Blue = Magenta (R+B = M)
Red + Green = Yellow (R+G = Y)
And Black = K

4 Color PROCESS Printing / CMYK



4 Color PROCESS Printing / CMYK

The image is separated into 4 different color values
Cyan / Magenta / Yellow / Black

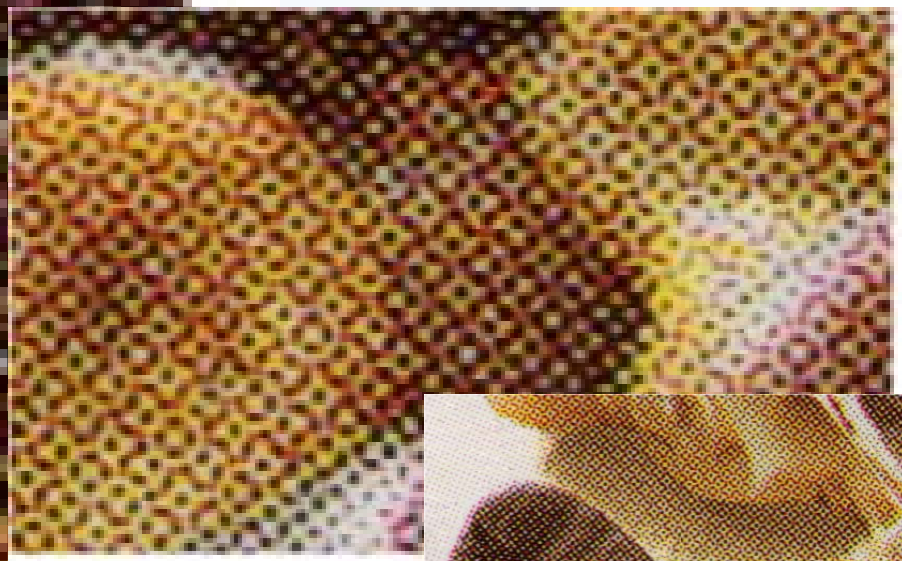
Individual colors are printed as dots at varying densities

Individual dots combine to form <u>additional</u> unique colors

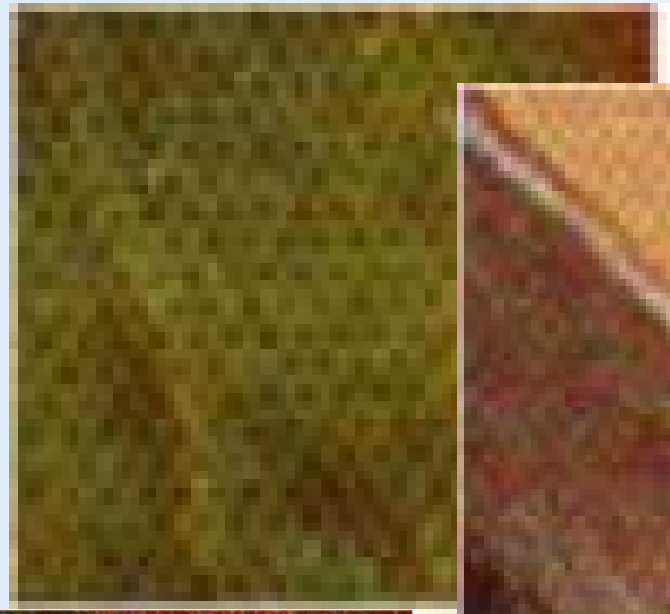
In Packaging printing , 4 color process is typically combined with line colors to accurately represent trademarks and logos and to maintain color consistency over large areas of solid colors

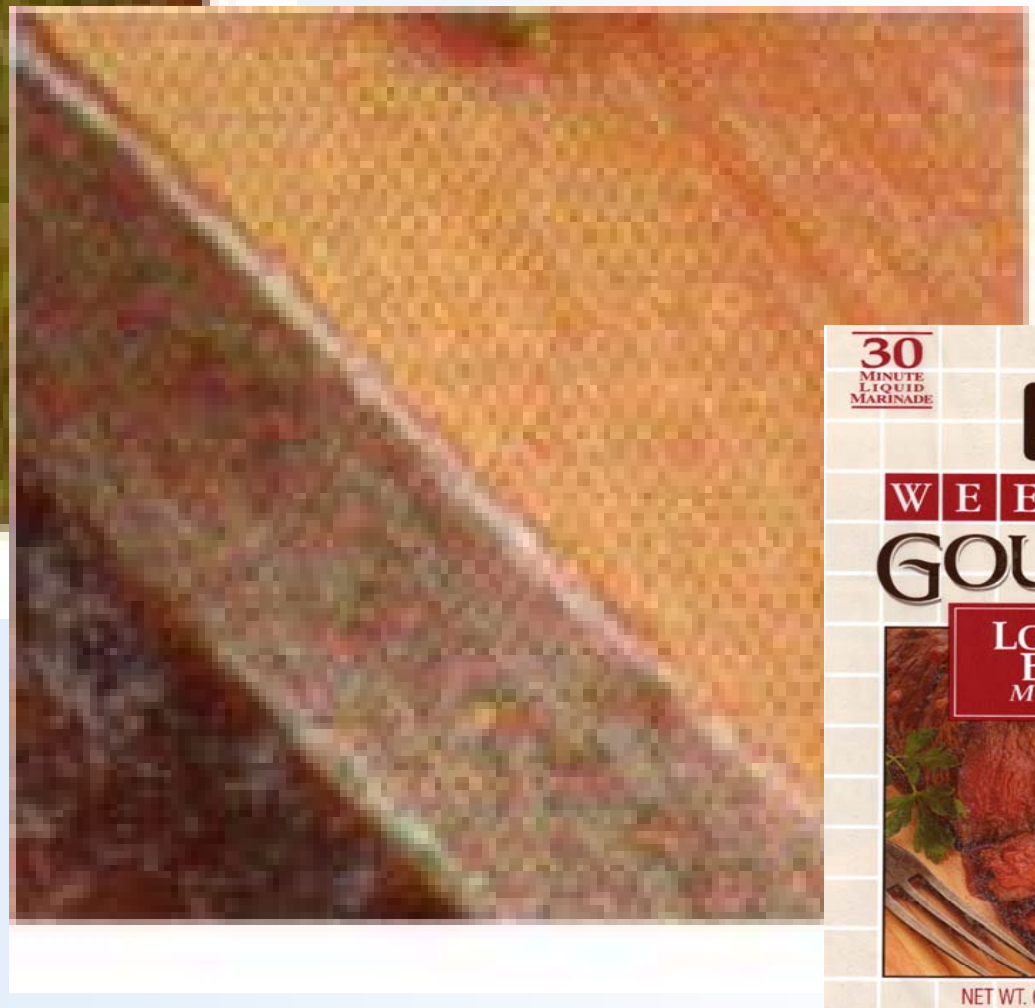
The number of final colors in a design is nearly limitless

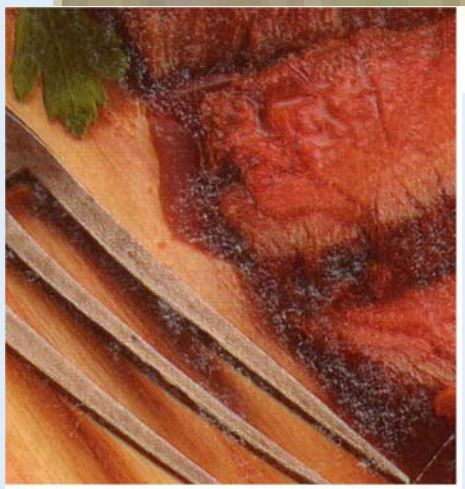
Flexo PROCESS / reverse print film

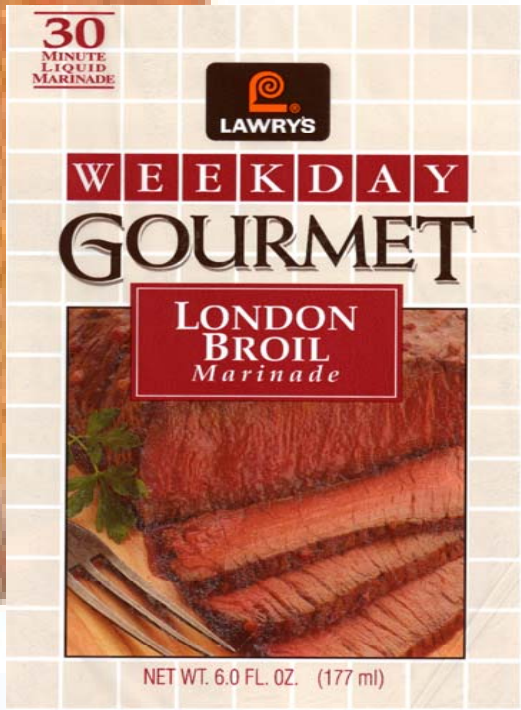


Gravure PROCESS / reverse print film





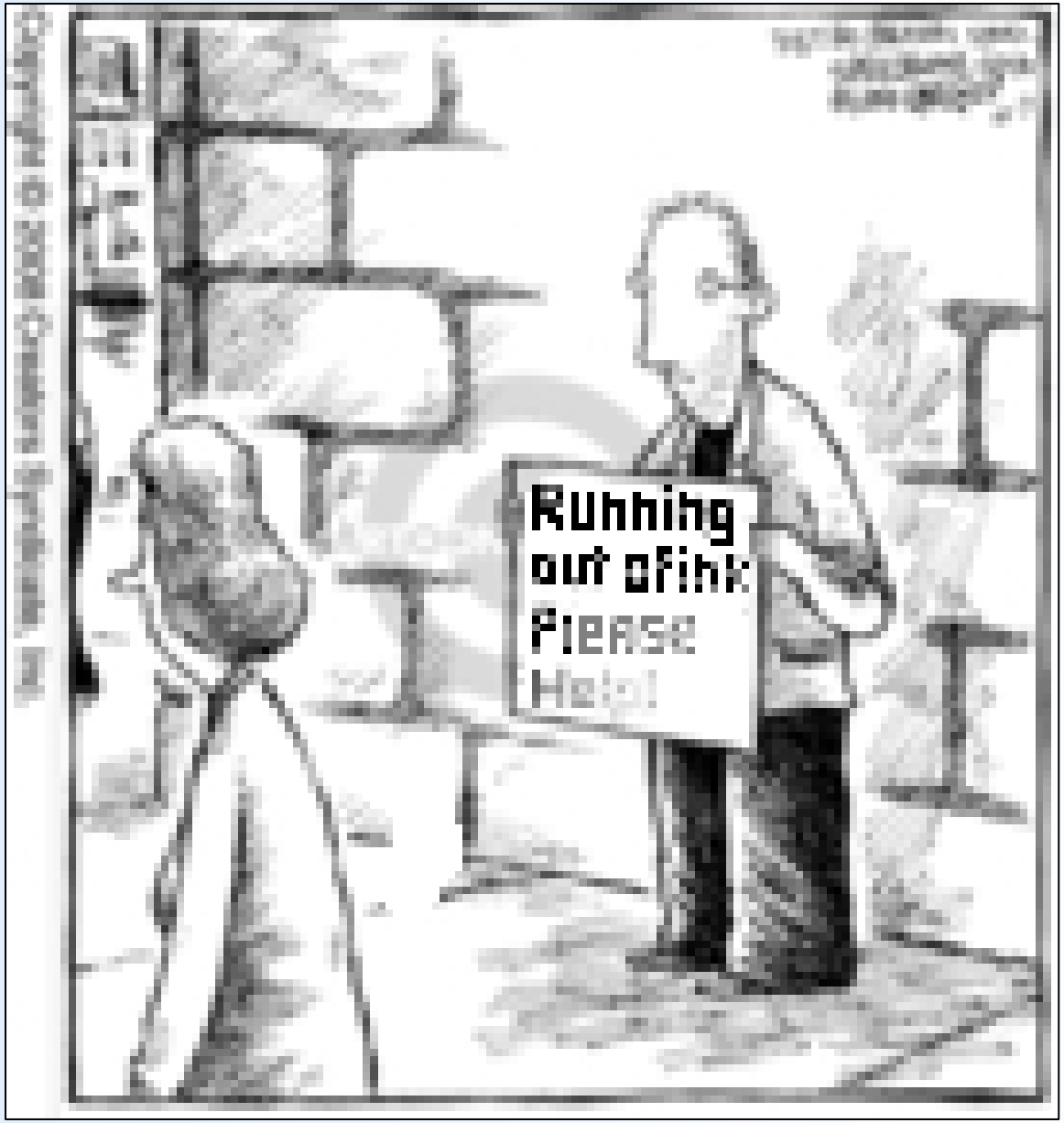




Gravure PROCESS / surface print paper

ROTOGRAVURE vs. CI FLEXOGRAPHY

	GRAVURE	FLEXO
Printing Press Footprint	larger	smaller
Printing Press Cost	much higher	lower
Operating Costs (utilities and overhead)	slightly higher	lower
Maintenance	slightly higher	lower
Cylinder / Plate cost	much higher	lower
Impressions per Cylinder / Plate	very high w/ rechrome	lower
Make-Ready Time	generally longer	shorter
Water Base / Solvent Base	solvent – water?	both
Substrate Flexibility	less	more
Process Flexibility (coating & laminating)	more	less
Print Quality (detailed process printing)	exceptional	improving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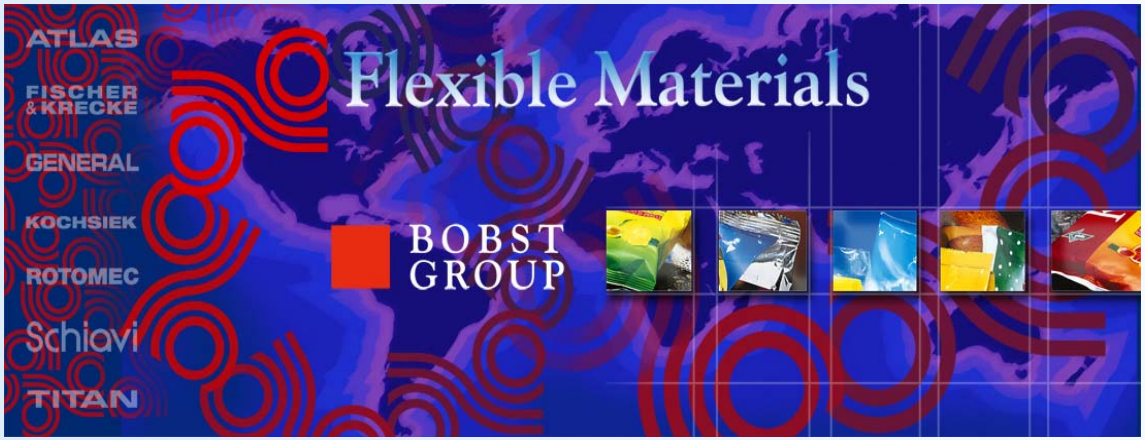

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Thank You

PRESENTED BY

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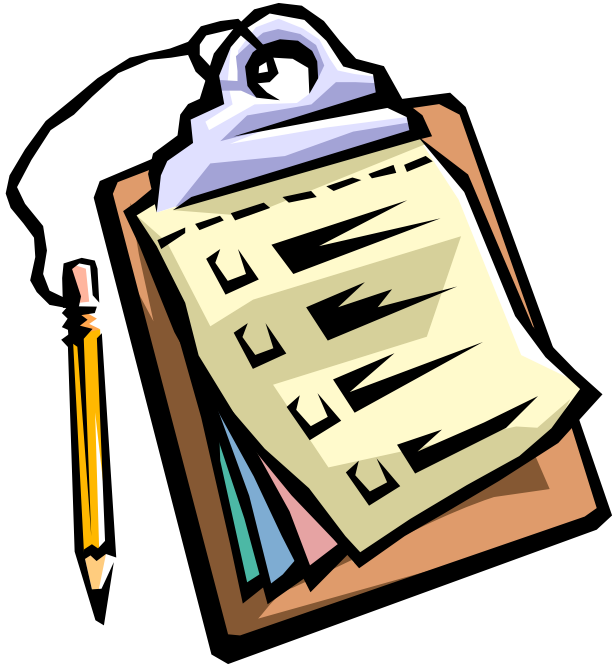

Please remember to turn in your evaluation sheet...