Diploma in Packaging Technology

part 2

Printing and Decoration of Packaging

Presented & adapted by David Little

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Agenda

Part 1.
Printing and the functions of print
Understanding colour
Preparation for printing

Part 2.
Common printing processes
Judging print type
Digital Printing
Other ways of decorating the pack
Assuring quality
Substrate and processes

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Printing necessary components

- Image
- Plate – method of transfer and reproduction
- Substrate – film, foil, board, paper etc.
- Transfer method – direct / indirect (offset to a blanket)
- Impression cylinder - Solid surface to press against
- Ink – suitable for purpose and method.

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General requirements for all methods - *see page 68-69*

- Accurate material feed system for accurate register of colours
- Ink reservoir and system for feeding
- Metering method to ensure consistent application of ink to the substrate
- Means of getting ink onto the substrate in the required design i.e. printing plates
- Means of effecting good transfer of ink from plate to substrate
- Means of solidifying the inks i.e. drying - *see pages 79-80*

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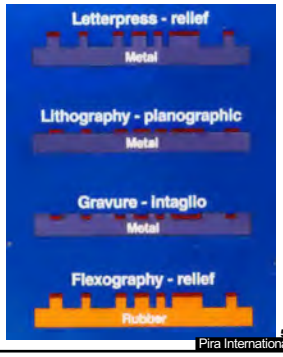
The main printing processes

- Cross-sections of printing plates, showing where ink (red areas) is placed



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Print Samples Process recognition

Key questions

Look for clues, decide whether:

- Volume – Short run or FMCG?
- Quality-low, med or high?
- What substrate material?
- How many colours?

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Print Type / Choice based on run length

(example based on paper substrate)

Short run
- Photograph
- Photocopy
- DTP
- Screen ?
- Digital
- Litho ?

1 - 2,000 units or sheets

Medium run
- Litho
- Digital
- Screen ?
- Flexo ?

2,000 - 5,000 sheets +

Long run
- Litho
- Gravure

6,000 sheets +

Figures are ballpark and dependent on the format, number up, variants, production and print process, market, sector and company.
Technology is driving shorter runs and more variety.

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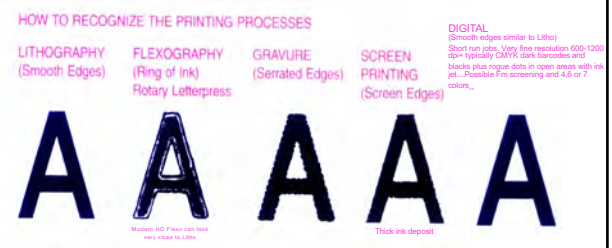
Recognising print processes



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Goals

- Identify printing processes.
- Match substrate to print process.
- Why is this process suitable?
- What other process can be used?

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Process Overview

The Irish Packaging Society

	Plate Type	Transfer Direct/Indirect	Plate reading Right /Wrong	Ink Type	Ink - **Primary** drying method
Litho	Planographic	Indirect	Right	Paste/ high visc.	Oxidation / curing
Flexo	Relief	Direct	Wrong	Liquid / low visc	Evaporation / Curing for film & Absorbtion /Oxidation for Corrugate
Gravure	Intaglio	Direct	Wrong	Liquid / low visc	Evaporation - Curing
Letterpress	Relief	Direct	Wrong	Paste/ high visc.	Oxidation / absorbtion
Screen	Screen Mesh	Direct	Wrong	Paste/ Med visc.	Oxidation / curing
Dry Offset	Relief	Indirect	Right	Paste / high Visc	Curing
Tampo	Intaglio	Indirect	Right	Paste / high Visc	Curing
Digital	N/A	Direct / Indirect	N/A	Liquid ink	Various

	Product Type	Shape 2D / 3D
Litho	Paper / mag / newspaper / sheetfed labels	2D
Flexo	Sheetfed Corrugate / Web fed - flexible film and foil, laminated tubes	2D
Gravure	Web fed - flexible film and foil, some magazine	2D
Letterpress	Mostly labels (dying out) old sheetfed machines- foil blocking and die cutting	2D
Screen	DVD's / Poster / T shirts / some 3D products and speciality products	2D/3D
Dry Offset	Tubs / Pots / Tubes	3D
Tampo	Speciality / Promotional branded items like pens, mugs, golf balls etc.	3D
Digital	Various	Various

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Machine Layouts

- Litho – in line mostly
- Flexo – Film ~stack or Central Impression
  - Corrugated, Label ~ in-line,
  - Carton ~ In-line or CI
- Gravure ~ In-line only
- Screen ~ Separate units / sections-posters.
  or revolving 4/5 col unit T-shirts, CD's

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Lithography

Coldset webfed for Newspaper

Sheetfed B3, B2, B1 in Ireland

Heatset webfed for Magazines

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Offset litho printing

- Sheet fed in Packaging or
  Web fed (Magazines – Heat Set Newspapers - Cold Set)
- High viscosity paste inks, oil based
- Train of rollers to meter even amount of ink to plate
- Planographic aluminium plate, image areas only treated to accept oil-based inks
- Inked plate transfers (offsets) image to blanket
- Image transferred from blanket to substrate
- Inter-station drying with UV only
- Used for printing sheets of board for cartons, paper for labels, metal for containers and closures
- Not tolerant of uneven surfaces

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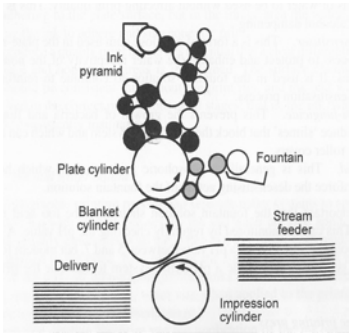
Offset litho

- Plate is dampened first, then inked
- Inked plate transfers image to blanket
- Image is transferred from blanket to substrate by an impression cylinder



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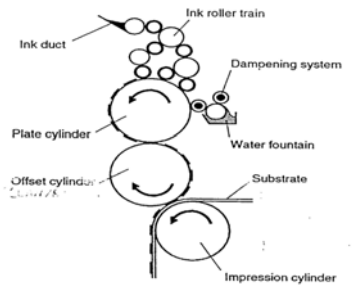
Lithographic

Offset Lithography



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Offset lithography

- Planographic (flat) aluminium printing plate
  - Image areas are treated to attract oil and repel water Oleophilic (hydrophobic)
  - Non-image areas attract water and repel oil Oleophobic (hydrophilic)

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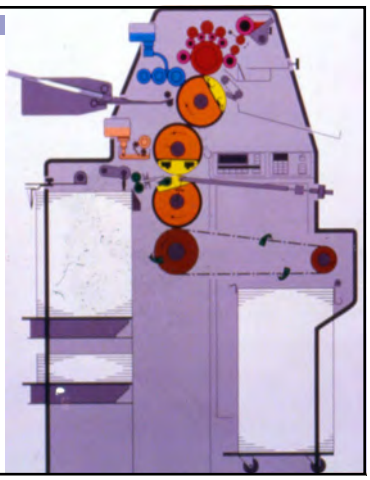
Single station offset litho



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Offset litho - 2 colours + coating

4 colour and coat with extended delivery IR drying

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Ink transfer from plate to blanket to substrate

Multi-station Offset litho

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Offset Lithography

- Sometimes drying between ink stations mostly UV.
- Not tolerant of uneven surfaces
- Produces very sharp images
- Used for printing sheets of:
  - Board for cartons
  - Most paper print magazines, commercial print, jobbing
  - Paper for labels and wrappers
  - Metal for containers and closures
  - Plastic for cartons

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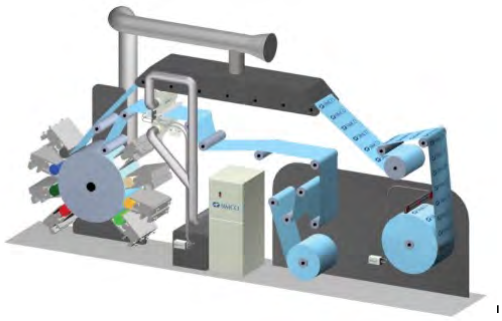
CI Flexographic Press – Central Impression



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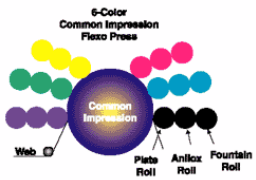
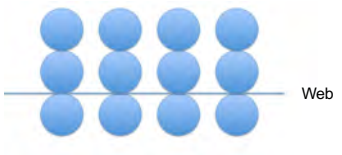
Layout

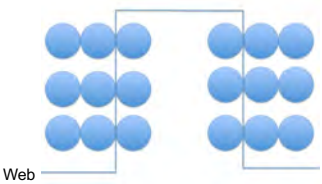
Central Impression



In -Line



Stack



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Flat photopolymer printing plates

Continuous photopolymer sleeves

Continuous cylindrical photopolymer forme is imaged digitally by a laser. This system does not require adhesive tape. The cylindrical forme is pushed onto an air shaft, where it is held securely during the printing process. This system is ideal for long run lengths.

Direct-engraved continuous rubber sleeves

Continuous rubber sleeves are imaged by a laser. This system does not require adhesive tape either. The cylindrical forme is pushed onto an air shaft, where it is held securely during the printing process. This system is ideal for long run lengths and exhibits excellent ink transfer characteristics.

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Flexo

- Web (reel) fed, stations in line
- Used for board and label stock

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In line flexo

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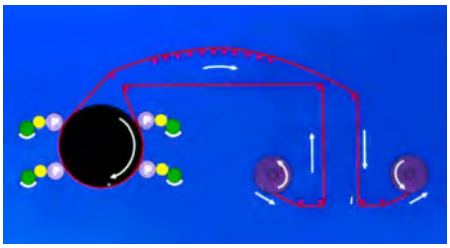
Flexo using a central impression press - good for flexible films



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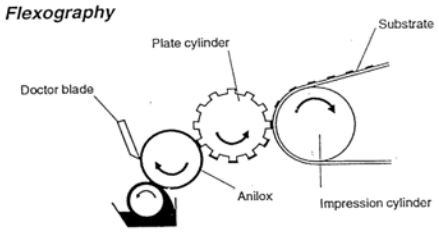
Flexography – (flexo)



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Flexo

- Normally Web (reel) fed
- Sheet fed for corrugate cases
- Low viscosity liquid inks, organic solvent, UV or water-based
- Engraved anilox roller to meter even amount of ink to plate
- To improve quality flexo uses doctor blade on anilox roller

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Flexo

- Relief printing plate made of soft and flexible photopolymer
  - Image areas stand out in relief
  - Non-image areas are recessed
- Ink transfer by anilox roller to relief areas of plate
- Inked plate pressed against substrate using impression cylinder

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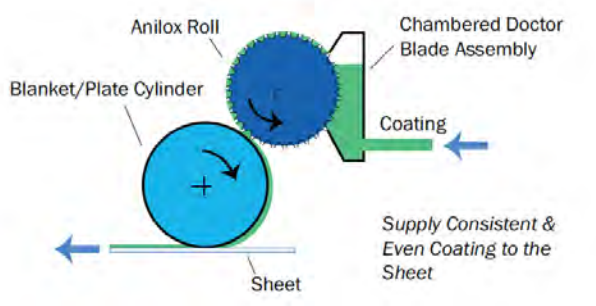
Chambered Doctor blade



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Flexo

- Possible to have Inter-station and/or final drying by IR or UV
- Tolerant of rough (corr) and delicate surfaces(film)
- Subject to image squash – uneven edges/halo affect.
- Used for printing reels of:
  - Board for cartons
  - Film and laminates for flexible packaging
  - Paper for labels
  - Sheets of corrugated board for cases
  - Liners for Corrugated case production

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Plate Thickness Film / Paper / Corrugated

.045"	.067"	.112"	.125"	.155"
1.14mm	1.70mm	2.85mm	3.18mm	3.94mm

Overall	6.7mm	3.68	5.18mm
Plate	3.18mm	3.18mm	3.18mm
Tape	0.25mm	0.25mm	0.25mm
Melinex	0.25mm	0.25mm	0.25mm
Backing Rubber	3mm	-	1.5mm

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Flexo Corrugate plate

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3M
Cushion-mount™ Plus
Flexographic Mounting Tapes

	11 SERIES	19 SERIES	13 SERIES	10 SERIES	17 SERIES	18 SERIES	Thickness
• Easier plate removal • Use with larger diameter print cylinder • Use with thinner plates	E1120	E1920	E1320	E1020	E1720	E1820	0.50mm
	E1115	E1915	E1315	E1015	E1715	E1815	0.38mm
				E1040			1.00mm
				E1060			1.50mm
• Higher plate side adhesion • Use with smaller diameter print cylinder • Better results with thicker plates	E1120H	E1920H	E1320H	E1020H	E1720H	E1820H	0.50mm
	E1115H	E1915H	E1315H	E1015H	E1715H	E1815H	0.38mm
	High quality process and screen work	Process and halftone predominate	Solid and halftone are equally important. Faster press speeds	Solid and halftone are equally important	Slightly more solids in combination of solid and halftone	Mostly solids in combination of solid and halftone	

UK & Ireland Core Range Selector

For more information, or to place an order, call your 3M Sales Contact or 3M Customer Service
0870 60 800 50 www.3m.com/uk/flexo

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Corrugated FFG

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Plates for flexibles

- Flat plates for flexibles are mounted usually as one piece on mounting sleeves.
- ITR sleeves (in the round) are for continous images or long runs and are mounted onto adapters or air mandrels.
- The image repeat is crucial as is any dispro

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Plate adapters

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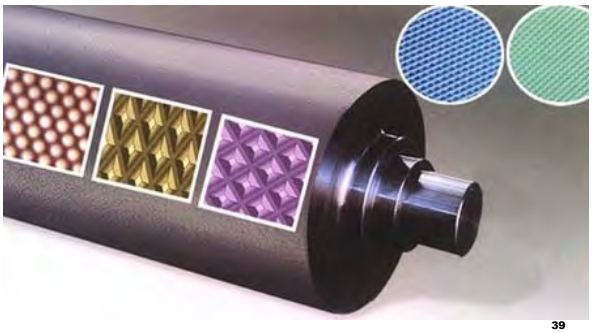
Different cell shapes are available now to help the evacuation of ink



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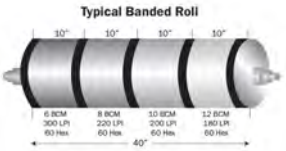
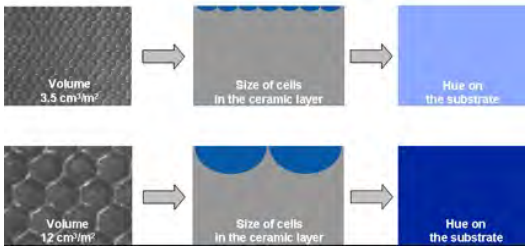
Anilox Screen & Volume



BCM = Billion Cubic Microns



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Anilox volume

- A printer's goal should always be to print with the lowest volume and thinnest ink films possible while maintaining solid ink densities for process or Pantone color matches. Thinner ink films permit higher quality print, improve process efficiency, and increase profitability.

- **How can anilox volume specifications alone have such an impact?**
- Higher quality print—increased process printing resolution capability, less dot gain, increased print contrast, expanded tonal range, smoother vignettes, cleaner screens, less reverse fill-in, ability to print finer type, and improved solid coverage.
- Improved process efficiency—faster drying with less dryer energy required, faster run speeds, improved traps. Standardized rolls stay in press, reducing changeover times and anilox roll inventory.
- Increased profitability—sell higher quality work, produce jobs faster, less ink consumed, increased printing capacity and more business.

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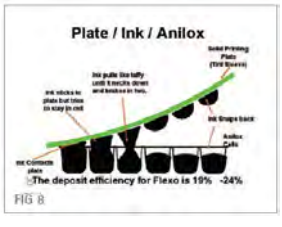
Impact of dirty or worn Anilox

Volume new of 3.8 may only print with a volume of 3.0 for instance.



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Ink viscosity – test e.g. 25 seconds

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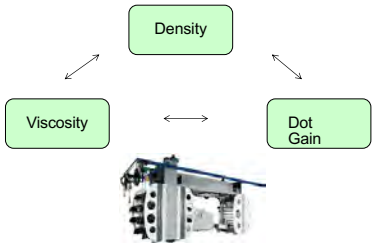
The holy trinity for flexo



Press

Stable Press Inputs (Plates & Tape + Mechanical Conditions / Settings)

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Letterpress

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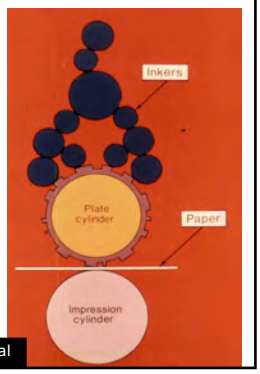
Letterpress printing

- Sheet or web-fed + suitable for 3-dimensional items
- Medium to high viscosity paste inks
- Train of rollers to meter even amount of ink onto plate



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Letterpress printing

- Sheet or web-fed + suitable for 3-dimensional items

Tubs / tubes –dry ofset

- Medium to high viscosity paste inks
- Train of rollers to meter even amount of ink to plate
- Relief printing plate, metal or hard polymer
- Inked plate pressed against substrate using impression roll
- Inter-station and final drying
- Used for label printing
- Dry offset letterpress for printing of containers - image transferred to central blanket and total design transferred to container

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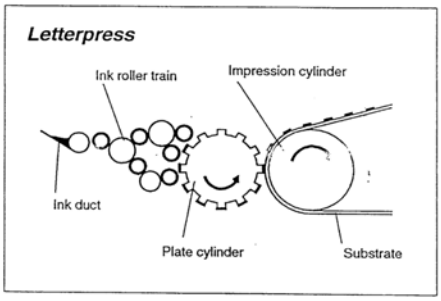
Letterpress



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Letterpress printing

- Relief printing plate, metal or hard polymer
- Inked plate pressed against substrate using impression roll. Direct impression
- Dry offset letterpress for printing of containers - image offset to central blanket and total design transferred to container

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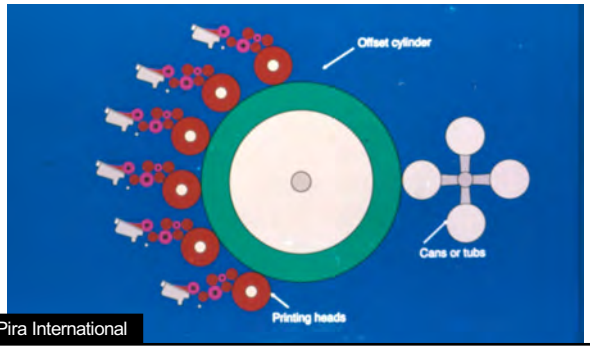
Dry offset letterpress



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Dry offset Letterpress / Dry Offset / Relief Dry Litho

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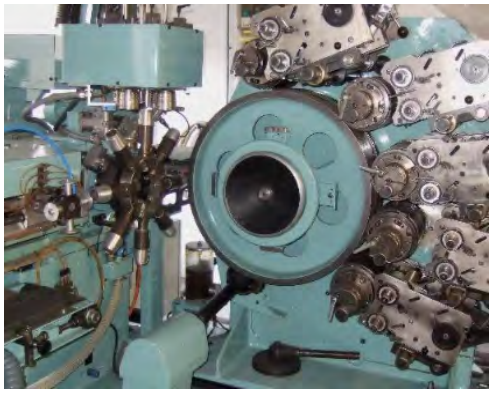

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Gravure press

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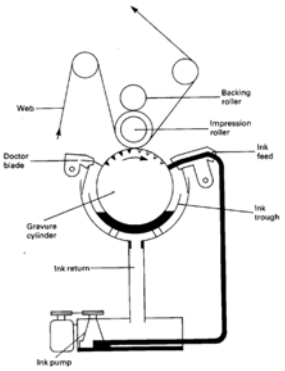
Gravure

- Web (reel) fed
- Low viscosity liquid inks, organic solvent based
- Recessed cells in print cylinder + doctor blade to meter ink



Printing Ink Manual

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Gravure printing

- Web fed, in-line
- Low viscosity liquid inks, organic solvent based
- Recessed cells in print cylinder + doctor blade to meter ink
- Metal print cylinder, chrome plated
- Inked cylinder pressed against substrate using impression roll
- Electrostatic charge to ensure all ink is transferred from cells to substrate
- Inter-station drying
- Not tolerant of uneven surfaces

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Gravure

- Depth of engraving in cell determine ink weight - and colour
- Very accurate control of amount of ink used

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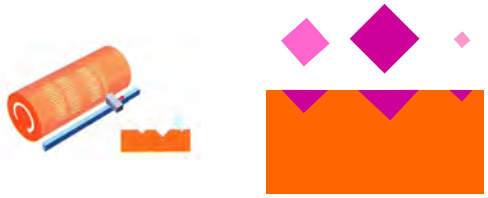
Direct Engraving



DIRECT ENGRAVING

In direct engraving, the printing form is engraved according to digital information.

The engraving is done with a diamond-tipped head whose movement creates halftone wells of differing depth.

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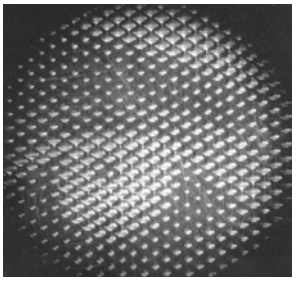
Gravure Cylinder

Microphoto of an engraved gravure cylinder



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Gravure

- Metal print cylinder, chrome plated

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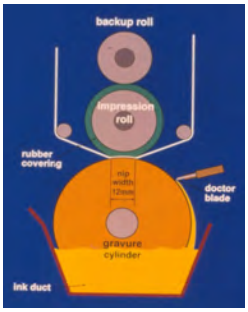
Gravure

- Inked cylinder pressed against substrate using impression cylinder
- Electrostatic charge to ensure all ink is transferred from cells to substrate
- Used for printing reels of:
  - Board for cigarette cartons
  - Foil, film and laminates for flexible packaging
  - Paper for labels



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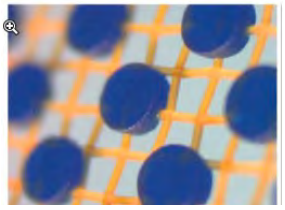
Silk Screen Printing



Ink flows through the areas not blocked by polymer

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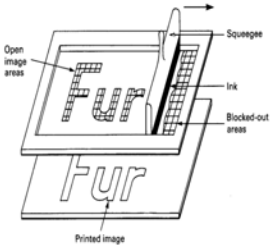
Screen printing

- Medium to high viscosity paste inks
- Image areas of screen are not coated, non-image areas are coated
- Screen flooded with ink
- Squeegee forces ink through uncoated areas



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Screen printing

- Sheet fed + suitable for 3-dimensional items

tubs / tubes

- Medium to high viscosity paste inks
- Screen flooded with ink
- Image embedded into polyester or nylon screen
- Ink forced through open areas of screen using rubber squeegee
- Inter-station drying
- Good for applying heavy coating weights
- Slow process

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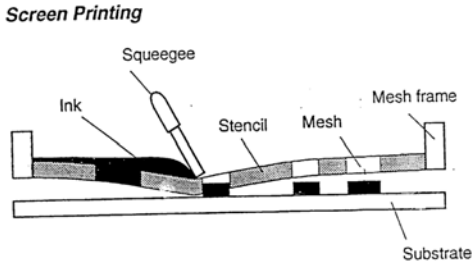
Screen Printing



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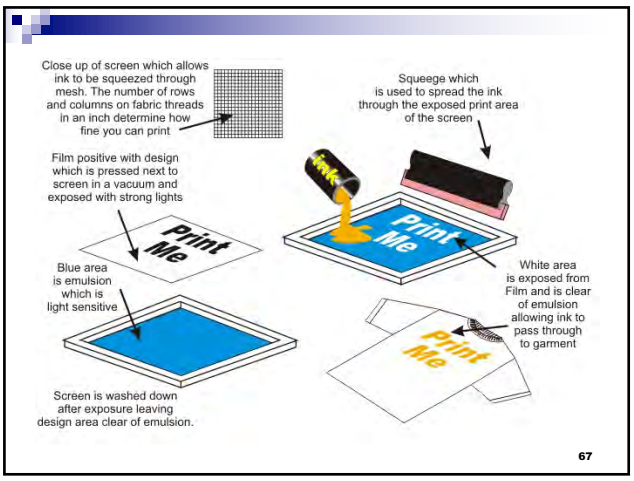

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Screen Printing

- Inter-station drying
- Good for applying heavy coating weights
- Slow process
- Can be flat bed or rotary
- Used for printing:
  - Reels of labels (RFID etc.)
  - Sheets of paper and board
  - Bottles (glass and plastic)
  - Drums
  - T shirts etc

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Single colour screen printer for bottles

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Single colour screen printer for buckets and pails

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Systematic Automation Model SX Screen Printer 6 colour

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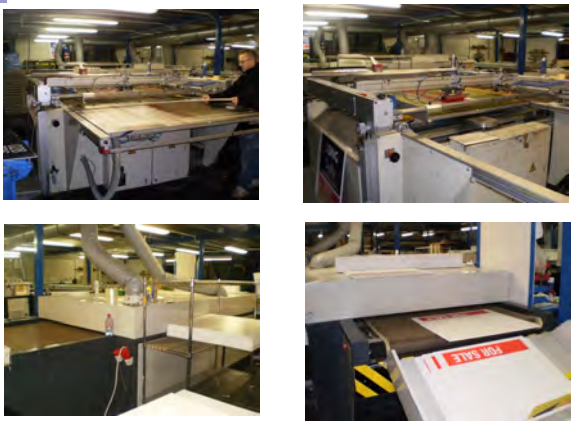

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Tampo or Pad printing

- Suitable for printing in 3 dimensions, e.g. domed caps
- Medium viscosity liquid inks
- Engraved metal printing plate flooded with ink
- Wiper blade removes excess ink
- Flexible pad picks up inked image from engraved cells and transfers to substrate
- Inter-station and final drying - inks may be 2-component and polymerise over 24 hours

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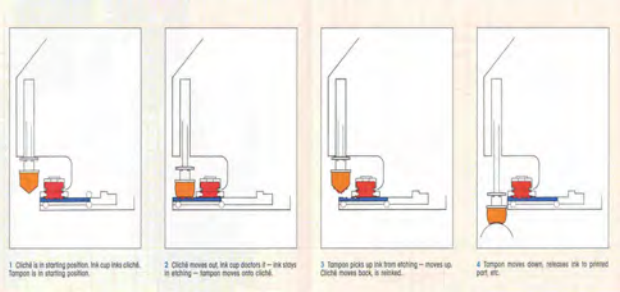
Tampo printing



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Single colour tampo printer

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Coating / Lacquer (Varnish)

- Most printing methods have a coating facility usually inline.
- Coating is widely used to give better rub and product resistance and to enhance the printing with a range of finishes from hi gloss to silk or matt.
- Double coating systems of matt / gloss and pattern varnish are widely used in drinks, cosmetics packaging.
- Some Litho machines have a pre-coater facility. This is located on the front before the Litho units
- Normally a Flexo unit, this can be used for coating or printing metallic silvers, golds etc which are much better at the higher Flexo film weights
- Litho colours can then be registered on the following print units

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Coating / Varnishing

Packaging Coatings

Courtesy of Sun Chemical

Functional				Aesthetic
Resistance **SunRes**	Specialist **SunSpec**	Barrier **SunBar**	Adhesion **SunBond**	**SunInspire**
Chemical	Low odour	Moisture Vapour	Coldseal	Tactile
Friction	Food contact	Oxygen	Heat seal	Metallic
Grease/Oil	Laser	CO2	Primers	Lusture
Heat/Cold	Anti-mist	UV Light	Adhesives	Impact
Lamination replacement		Aroma/Odour	Metallising primers	Unique
Product		Migration	Extrusion primers	
Release				
Water				

New technology area

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Digital printing

- Digital data is fed directly to the printer from the origination processes
- Electrostatic technology, e.g. Xeikon
- Liquid ink technology, e.g. Indigo
- Consumable expensive
- Use will continue to increase with improvements in quality, speed and format

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Digital printing

- Fast set up
- Few press adjustments
- Reduced waste
  - First sheet is good product.
  - No colour variation during the run
- Ability to process short runs
- Personalisation

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Digital printing

- Issues
  - Reliability
  - Press speed / productivity
  - Quality – available colours and resolution
  - Press format
  - Cost of consumables
  - Finishing
- Benefits
  - Fast set up – no make ready
  - Few (no?) press adjustments
    - All control is in pre-press
  - Reduced waste
    - First sheet is good product
    - No colour variation in run
  - Ability to process short runs
  - Personalisation

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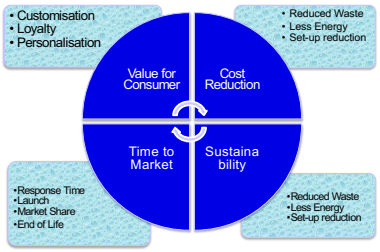
Direct & Indirect benefits of Digital Printing Ref: HP



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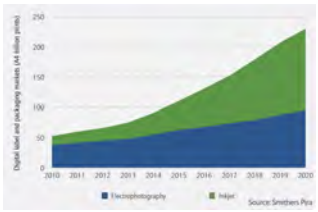
Digital printing

- Digital print for packaging is worth $13.2 billion in 2017, and will climb to $23.2 billion in 2022 (Pira)



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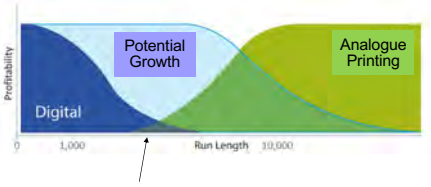
Digital Printing



Currently breakeven is approx. 4,000 (B2) sheets, possibly more, if there is a lot of different designs or files.

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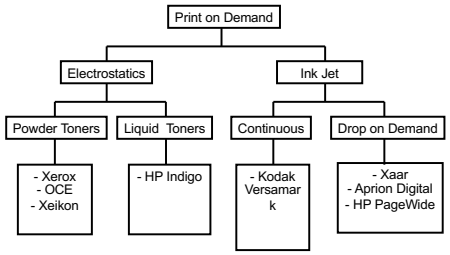
Digital Technologies



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Digital Printing on Board and Flexible Films

HP Indigo 30000 Digital Press

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Digital printing

Make a new printing image every revolution of the press

HP Indigo 30000 Digital Press

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Ink Jet Printing

- Ink-jet printing is a non-contact process
- Two types
  - Drop on Demand
  - Continuous

http://www.koniaminolta.com/inkjethead/technology/technology.html

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Various Digital Labels Types

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Digital Printing on Corrugated

- HP PageWide T1100S Press
  - High-speed, ultra-wide simplex colour inkjet web press for corrugated packaging.
  - Print speeds up to 600 ft/min (183 m/min)
  - Up to 330,000 ft2/hr (30,600 m2/hr)
  - Up to 110-inch (2.8 m) web width

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Digital Printing

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Three Dimensional Imaging (Printing)

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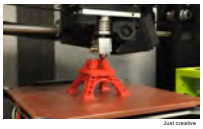
3D Printing

Additive Manufacturing

- Mock-ups / One-offs / prototypes
- Potential to developing further as production method for complex or designed niche products.
- Tooth caps, joints, shoes, models, components etc.



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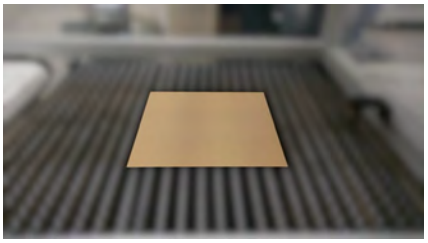
Laser Cutting & 'creasing'



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Finishing Processes (Digital)

Courtesy of HP

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Other decoration techniques

- Varnish – IR (water based)
  UV(high gloss)
- Embossing
- Heat transfer of single or full colour image
- Foil blocking-gold/silver or other colours
- Metallising
- Celloglaze
- Labeling:
  - spot
  - wraparound
  - sleeving

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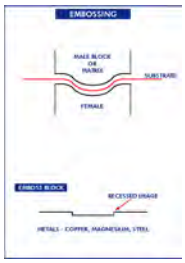
Embossing

- Not very effective on s/a labels.
- Very effective on cartons for drinks and cosmetics, premium pack can be enhanced by embossing logo's and now braille.
- A set of metal dies raises part of the design in relief, high tool costs.
- An inline process on labels and flexo cartons.
- A separate process for litho cartons although simple embossing can be done on press and usually during the cut / creasing operation.



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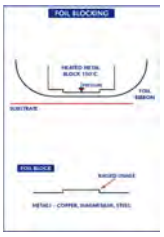
Foil Blocking

- A value adding process.
- Transfer of a highly finished foil ribbon to the substrate using heat and pressure on a metal block with a relief image.
- Wide range of foil materials available in golds, silvers and other metallic and non-metallic colours.
- A bright and fully opaque finish not achievable by printing.
- A 'cold' process is now available.



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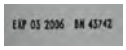
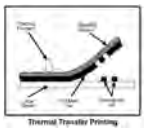
Applying variable information

- Blind embossing / debossing



- Thermal transfer



- Inkjet printing

- Laser printing

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Printing inks

Printing ink components
Printing inks consist of three main components:
Pigments, colorants.
Varnishes (binding agents)
Additives (oils, pastes, drying agents).

The dissolving process of a resin in a solvent (or water) for producing varnish

How one recognizes the quality of a particular printing ink
One can tell that a printing ink is of good quality when it runs well on the press, and the printed results conform to the standard of quality expected by the printer and the customer. The quality of the ink is always rated by the quality of the printed result.
Ink is one of the main areas to optimise to achieve consistent quality.

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Required printing ink properties (paperboard substrate)

For packaging
High scuff resistance, no set-off in the delivery pile, good brilliance.

For commercial printing
Optimal image reproduction, high gloss, good scuff resistance.

Catalogues, magazines
Brilliance, fast drying, not affected by heat (Heatset).

Newspapers, books
Fast absorption, smudge-proof print.

Other properties may also be required such as light fastness, resistance to coating solvents (spirit, nitrocellulose), and with packaging also resistance to the contents (soap, washing powder, etc.).

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Inks

- Typically 3 types - Water based, Solvent based or UV.
- Pigments - provide the colour
- Vehicle - a resinous component that binds the pigment particles and adheres them to the substrate
- Additives – Wetting agents, dryers, antioxidants, viscosity control agents, tackifiers etc.

Some processes require
- Solvents – Dissolve the resins and fluidise the formula so it will flow and wet the substrate

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Methods of drying / solidifying Inks

- Evaporation – of solvent or water
- Absorption – of water or solvent (penetration)
- Oxidation – where oily substance absorbs oxygen and polymerise to a hard film
- Chemical Curing – where a chemical reaction occurs resulting in the formation of a dry film. Initiated by either
  - addition of a second component 2 part
  - High temperature drying (stoving metal sheet)
  - UV radiation
  - Infra-red radiation
  - Electron beam, radio frequency, or microwave.

see table page 80

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Ink management

- Use of ink company personnel on printing site
  - Provide total service – colour matching, management of ink stocks and disposal
- Colour matching
  - Often uses computer system and spectrophotometer to predict colour formulation
- Other ink performance requirements must be built-in to formulation, e.g. rub resistance, light fastness
- Importance of keeping inks clean and free from contamination by dust and dirt
- For solvent and water-based inks, importance of minimising thickening
- Importance of cleaning plates, cylinders, rollers and troughs after use

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Assuring quality

- Print adhesion:
  - consider surface of substrate
- Rub resistance
- Product resistance
- Colour fastness
- Surface slip
- Colour to standard
- Text to standard
- Odour

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Odor neutrality (Food grade inks and machine oils etc)
Odor neutrality is a major issue for packaging printers in particular and often presents all suppliers in the production chain with problems that are very difficult to solve.
All oils and alkyds that dry by oxidation develop an intrinsic odor in the printing ink which is intensified by the addition of drying agents.

This together with the paper pulp and the usual combinations of starch, casein and synthetic dispersions in the coating mixture can lead to an uncontrollable and intensive development of odor that spreads into taste sensitive goods such as candies and chocolate.

Since this impairment is only noticeable after the goods have been packed and stored for some time, this can lead to spoilage. Therefore it's important that packaging printers always use the same proven materials and have standardized working methods. And when printing ink suppliers are to formulate new color shades, they should be instructed to pay special attention to odor neutrality.

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Comparisons

	Lithography	*Flexography*	*Gravure*
Short runs	best	good	not suitable
Long runs	good	good	best
Plate lead time	shortest	medium	longest
Fine lines	best	good	poor
Large solids	good	better	best
Register	best	lowest	intermediate
Gain	lowest	most	intermediate
Uncoated paper	good	best	not suitable
Plastic film	good, with special inks	good	good
Screen range	200+	133 to 150	200+
Ink formulation	oil-based paste	widest latitude	low viscosity

Soroka: Fundamentals of Packaging

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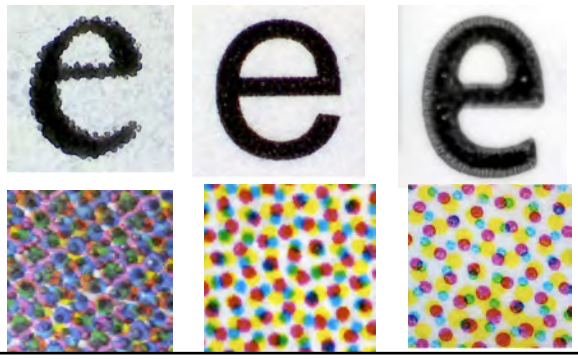
Gravure - Litho - Flexo



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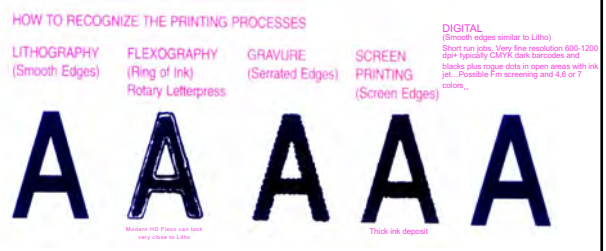
Recognising print processes



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Print Samples - Process recognition

Key questions

Look for clues, decide whether:

- Quality-low med high
- Substrate material
- Number of colours
- Volume

- Now use a lens to confirm.

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Match Plate / Ink / Print method with substrate

- List as many primary packs types as possible
- List as many substrate types as possible and match to the main most used, print process.

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	Litho	Flexo	Gravure	Letter	Screen	Other / Digital
Paper						
Corrugate						
Carton						
Tubs						
T shirt						
Posters						
Books						
Mags						
F/film						
Labels						
Bags						
Foil						
Tubes						

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	Litho	Flexo	Gravure	Letter	Screen	Other / Digital
Paper	XX	X	X	X	X	X
Corrugate		XX				X
Carton	XX	X			X pvc	
Tubs						XX
T shirt					XX	X
Poster	X				XX	XX
Books	XX					
Mags	XX		X			
F/film		XX	X			
Labels		XX	X	X		
Bags		XX	X			
Foil		XX	X			
Tubes		X			X	XX

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Process Overview

The Irish Packaging Society

	Plate Type	Transfer Direct/Indirect	Plate reading Right /Wrong	Ink Type	Ink - **Primary** drying method
Litho	Planographic	Indirect	Right	Paste/ high visc.	Oxidation / curing
Flexo	Relief	Direct	Wrong	Liquid / low visc	Evaporation / Curing for film & Absorbtion /Oxidation for Corrugate
Gravure	Intaglio	Direct	Wrong	Liquid / low visc	Evaporation - Curing
Letterpress	Relief	Direct	Wrong	Paste/ high visc.	Oxidation / absorbtion
Screen	Screen Mesh	Direct	Wrong	Paste/ Med visc.	Oxidation / curing
Dry Offset	Relief	Indirect	Right	Paste / high Visc	Curing
Tampo	Intaglio	Indirect	Right	Paste / high Visc	Curing
Digital	N/A	Direct / Indirect	N/A	Liquid ink	Various

	Product Type	Shape 2D / 3D
Litho	Paper / mag / newspaper / sheetfed labels	2D
Flexo	Sheetfed Corrugate / Web fed - flexible film and foil, laminated tubes	2D
Gravure	Web fed - flexible film and foil, some magazine	2D
Letterpress	Mostly labels (dying out) old sheetfed machines- foil blocking and die cutting	2D
Screen	DVD's / Poster / T shirts / some 3D products and speciality products	2D/3D
Dry Offset	Tubs / Pots / Tubes	3D
Tampo	Speciality / Promotional branded items like pens, mugs, golf balls etc.	3D
Digital	Various	Various

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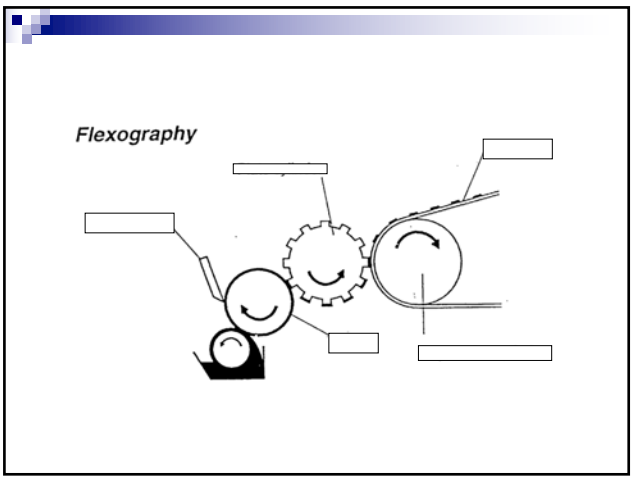

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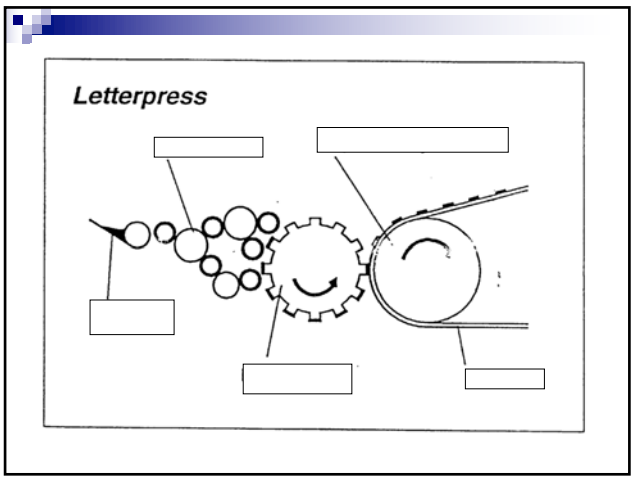

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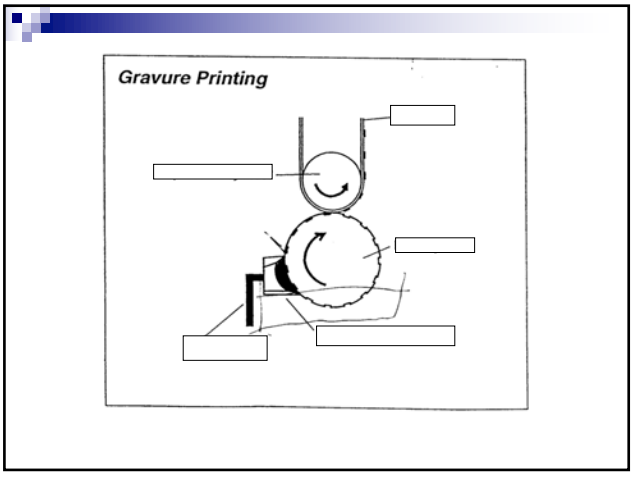

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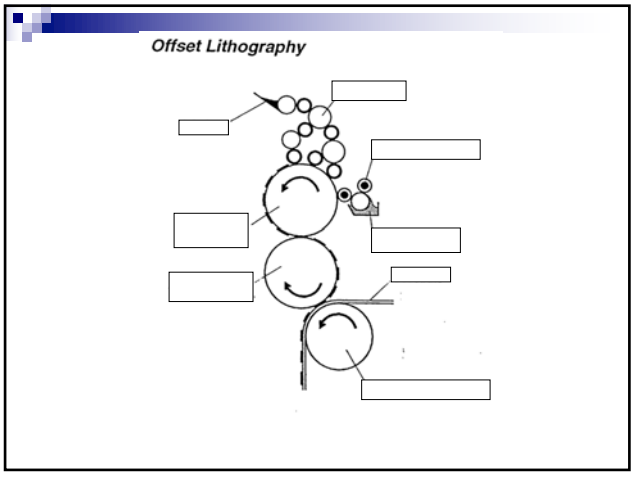

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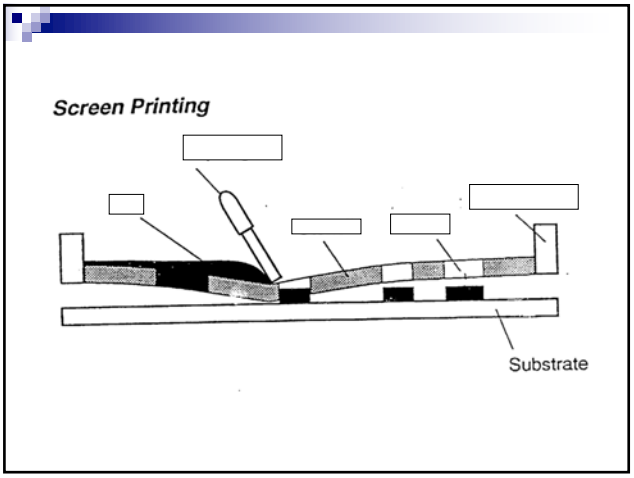

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Any Questions?

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