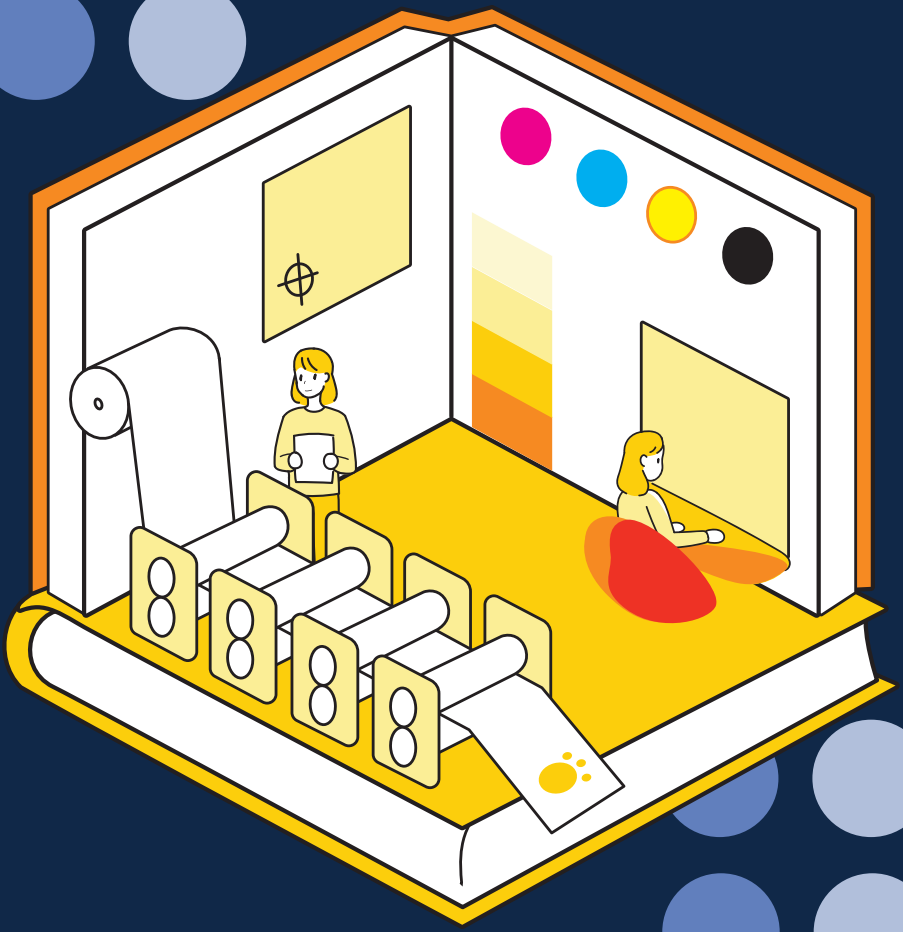
PRINT FOUNDATION

Student Guide to
Graphic Communication



Yeyoung Kim

Graphic Communication & Print Foundation

There is a difference between designing and designing with the understanding of the digital file preparation and the reproduction capabilities and limitations. While some people say print is dead from the trend of newspapers and books digitalizing, we interact with printed products every day: computer keyboard, fabric, to your bag of chips! They are all printed.

This book is focused on the print foundation to aid the students in their education journey to Graphic Communication at Cal Poly, San Luis Obispo.

Print Foundation Contents

- Print Technology & Industry Introduction
- Substrates, Inks & Color Fundamentals
- Digital File Preparation & Workflow
- Binding & Finishing Process
- Career & Concentration

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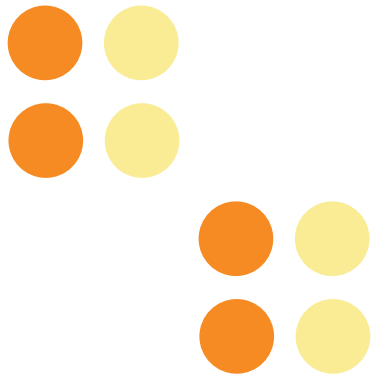

Yeyoung Kim

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Prologue

Into the World of Print

Welcome to Graphic Communication! As the name suggests, it is the study of all communication related to graphics from print to digital communication. While some people say print is dead from the trend of newspapers and books digitalizing, we interact with printed products every day: computer keyboard, fabric, to your bag of chips! They are all printed. People generally imagine a Xerox machine when thinking about printing, but the print industry's press machines are often big enough to fit in an auditorium!

What is Graphic Communication and How is it Different from Graphic Design?

So, what is the difference between Graphic Communication (GrC) and Graphic Design? Fun fact: I confused Graphic Communication with animation. Imagine my surprise when I visited Cal Poly SLO and saw a letterpress at the Shakespeare Museum! Looking back, coming to Cal Poly and majoring in GrC is probably the best decision I made as a freshman. I can confidently say this because the GrC curriculum provides you a solid understanding of topics that are applicable and the qualities that employers are looking for in the Graphic Communication industry.

Graphic Design major at Cal Poly focuses on art history and how to express ideas creatively using various media like painting, ceramics, photography, and digital art.

Graphic Communication — while we design as well — focuses more on the technical and managerial aspects of reproducing design like the current print technology, consumer packaging and book design, marketing, and management.

There is a difference between designing and designing with the understanding of the digital file preparation and the reproduction capabilities and limitations. My hope for this book is to benefit the GrC students in solidifying their GrC foundations and allow professors more freedom to cover wider topics in class.

Again, welcome to GrC and as the fellow member of the Pod (our department mascot is a dolphin), I wish you the best in your education journey at Cal Poly!

Yeyoung Kim

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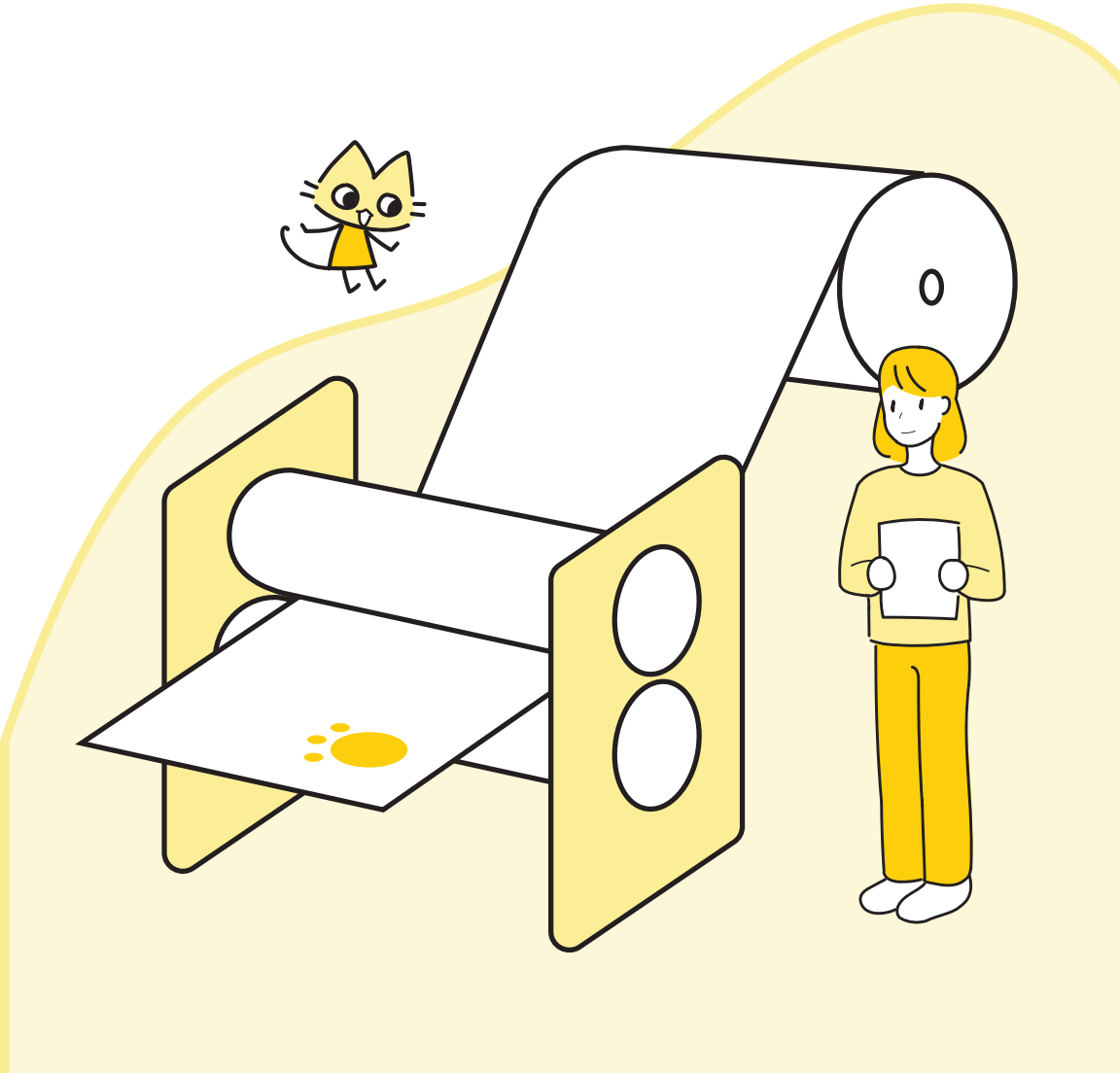
Chapter 1

Print Technology & Industry Introduction



Print Technology Domains

The print technology goes under five domains:

- Relief
- Planographic
- Intaglio
- Porous
- Digital

Sheetfed vs Web Printing

Sheetfed printing has a stack of papers in the paper feeding area and individual sheets are carried through the press. Web printing, also known as rotary printing, has a roll of paper that unwinds and is passed through the press, rewinding or cut into sheets in the end. Web printing is generally faster than sheet printing.

Substrate is the material that is being printed on. It can be a paper, film, or even plastic!

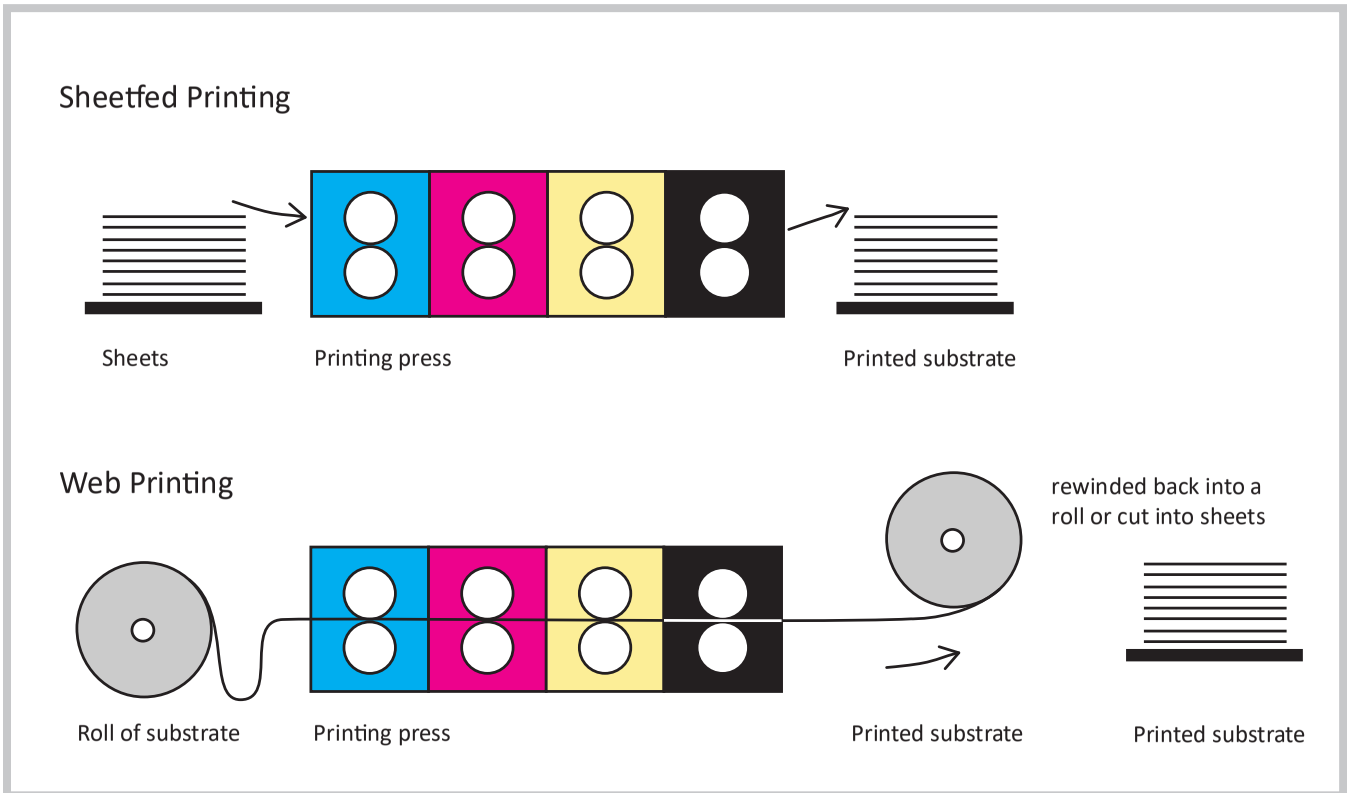


Figure 1: Sheetfed vs Web Printing

Relief Printing

Relief printing is a print method using a raised surface, also called as a relief. The history of relief printing can go as far as cave paintings. The oldest recorded printing was discovered during WW2 in France at the Lascaux cave where sticks and hands were used like stamps to draw the paintings. The technological invention of relief printing began with the letterpress. In the 400-500 AD the oldest letterpress technology was invented in Korea with individual characters made in porcelain and brass. In the 1000 AD Bi Sheng from China created the movable type of Chinese characters. During the peak of Renaissance around 1300-1700s, Johannes Gutenberg made the mold for the movable type of Latin characters to print the bible. The letterpress technology spread from Korea to China to Western Europe through trade. So, the first western letterpress was made by Gutenberg using the idea from Asia.

During medieval times books were expensive to create. Scribes had to write down every word, spending days to create a book. The invention of the western letterpress expediated the process, resulting in 48,000 titles during the Incunabula period of 1451-1501. Printing books exploded in another 50 years resulting in several million titles and spreading rapidly. The letterpress was mostly for the wealthy people, in this case the Catholic church. So the bible began to spread across Western Europe increasing literacy, strengthening religion,

and making it possible for people other than kings to own a book. It is a western biased point of view to claim Gutenberg made mass communication possible because it already existed in other parts of the world. Now letterpress is a very seldom used process as an antique machine.

Flexography

Flexography has the biggest sales volume in relief printing for packaging. In fact, flexo dominates the US packaging because flexo products are food safe, fast, and cheap. Substrates for flexo can range from flexible plastic to corrugated boards. Usually, it is a roll of paper, plastic, or metal foil. Common printed products from flexo are shipping boxes, sticker labels, applesauce container, and your paper Starbucks coffee cup!

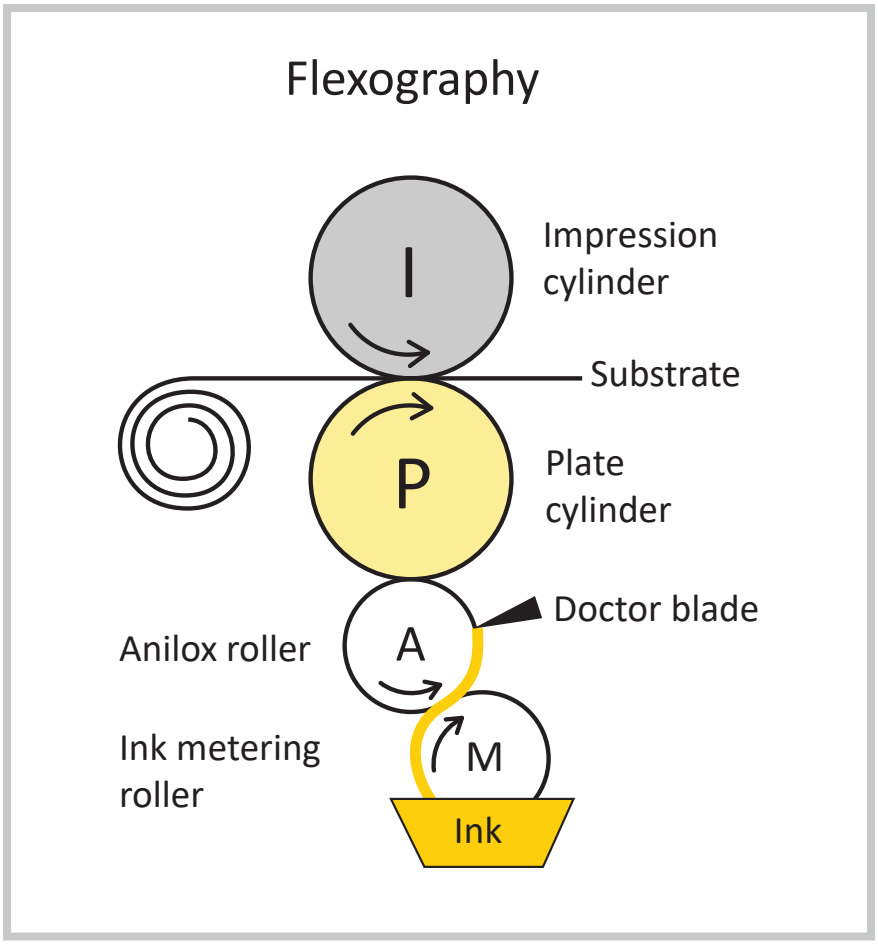


Figure 2: Flexography Mechanism

The flexographic press has a flexible raised polymer or rubber plate wrapped around the plate cylinder. The ink metering roller transfers ink to the anilox roller. Doctor blade on the anilox roller scrapes out the excess ink, leaving only the ink in the pores called "cells". The plate cylinder receives ink from the anilox roller and transfers it to the substrate. The impression cylinder applies pressure to the plate cylinder and substrate, printing the ink to the substrate. The inks mentioned in the book—except the digital printing section—are heavier than water with the consistency between milk and cream.

A plate can print one color at a time, so the substrate goes through multiple plate cylinders to apply different color. *Figure 3* shows the stickers that is printed in three colors: red, yellow, and black. The substrate is passing through the last plate cylinder that applies black ink.

More specific details on flexo platemaking, ink metering, and quality control will be covered in GrC 316 Flexographic Printing Technology.

Figure 3: Flexographic Printing

Planographic Printing

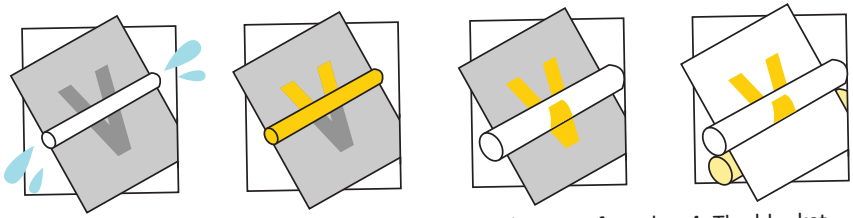
Planographic printing is a print method using a smooth surface, also known as lithography. Lithography was invented by Alois Senefelder in Munich, Germany. The biggest advantage of lithography was the ability to print images and text. For example, the letterpress would not be able to print music notes or illustrations. This invention relies in the law of oil and water repelling each other, having certain area on the plate oleophilic (oil) or the hydrophilic (water). A polished limestone plate is lightly carved, the carved areas becoming oleophilic to receive ink. The plate is first dampened with water then the ink is applied to the image area. The paper is applied to the plate with pressure and you get a printed copy. Now the limestone plate is seldomly used since the development of the aluminum plate and offset lithography.

Offset Lithography

Offset lithography has the biggest sales volume in planographic printing for publication printing and folding cartons. Instead of a flat limestone, offset uses the aluminum plate which is inexpensive to make and use. Aluminum plate also has longer lifespan than limestone plate. The aluminum plate is wrapped around the plate cylinder for printing and is removed when the job is done. Offset has a blanket cylinder inserted between the plate and impression cylinder. The rubber in the blanket cylinder is resistant to water, transferring the ink to the substrate with better quality. This allows the press to print consistently for a long period of time.

More specific details on offset platemaking, ink-water balance, and quality control will be covered in GrC 328 Offset Printing Technology.

Figure 4: Offset Lithography Process



1. The plate is dampened by the dampener rollers. The image area repells water.

2. Ink rollers apply ink to the "oleophilic" (image) areas on the plate.

3. Ink is transferred from the plate cylinder to the blanket cylinder. The water stays behind.

4. The blanket cylinder transfers ink to the press sheet.

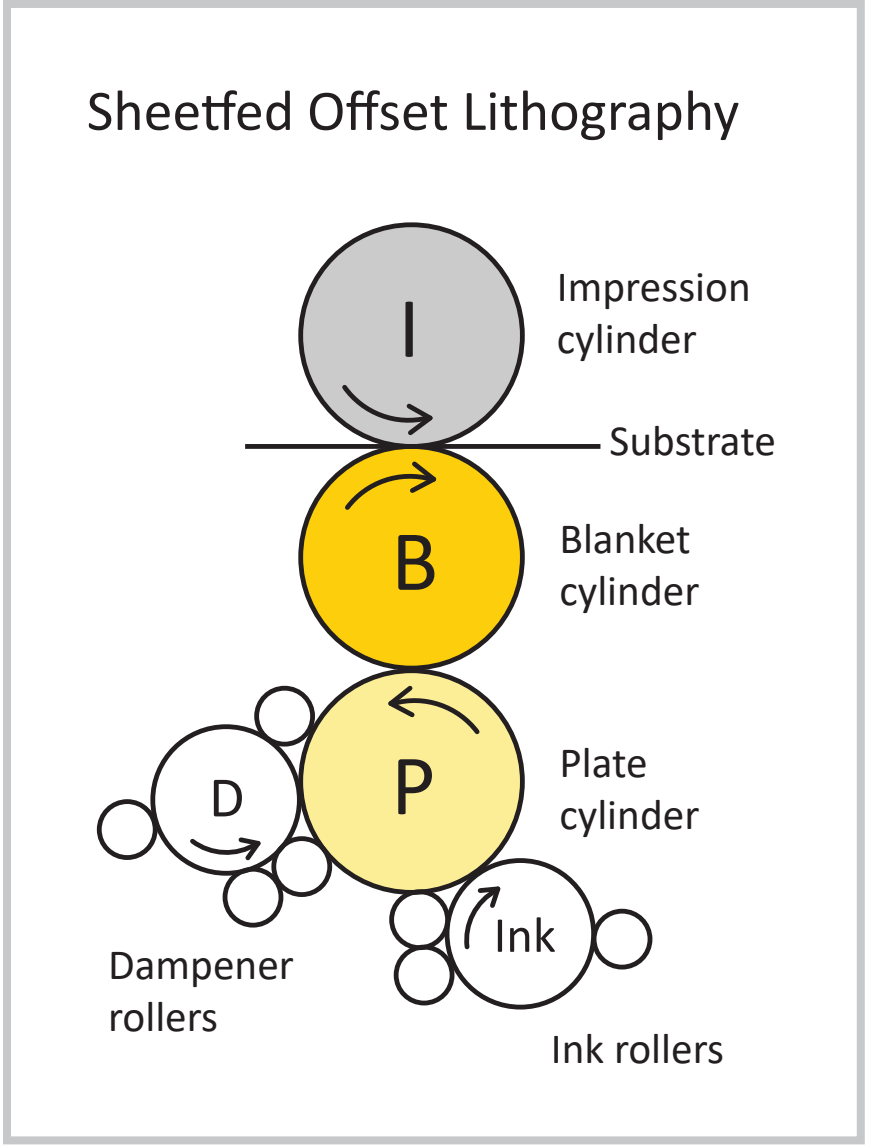


Figure 5: Offset Lithography Mechanism

Intaglio Printing

Intaglio printing is the opposite of relief printing where the image area is engraved into steel or copper. Intaglio press is x100 more expensive than offset. Sheetfed "Engraved" Intaglio printing is expensive and fairly rare. Their products are currency, security printing, and professional stationery. Did you know the "The United States of America" on a US dollar is engraved by hand? You can consider printing money at Washington DC as your career!

Rotogravure

Rotogravure has the biggest sales volume in intaglio printing for publications printing and packaging labels. The advantage of rotogravure is being inexpensive for BIG numbers like millions of copies for newspaper or billions of information labels for drugs. Rotogravure is banned in California because it uses mostly toxic ink that causes air pollution. The etching or engraving for this large-scale production is done mechanically using the diamond stylus. This creates a very severe serrated edges to every straight line, allowing to differentiate from the other printing process.

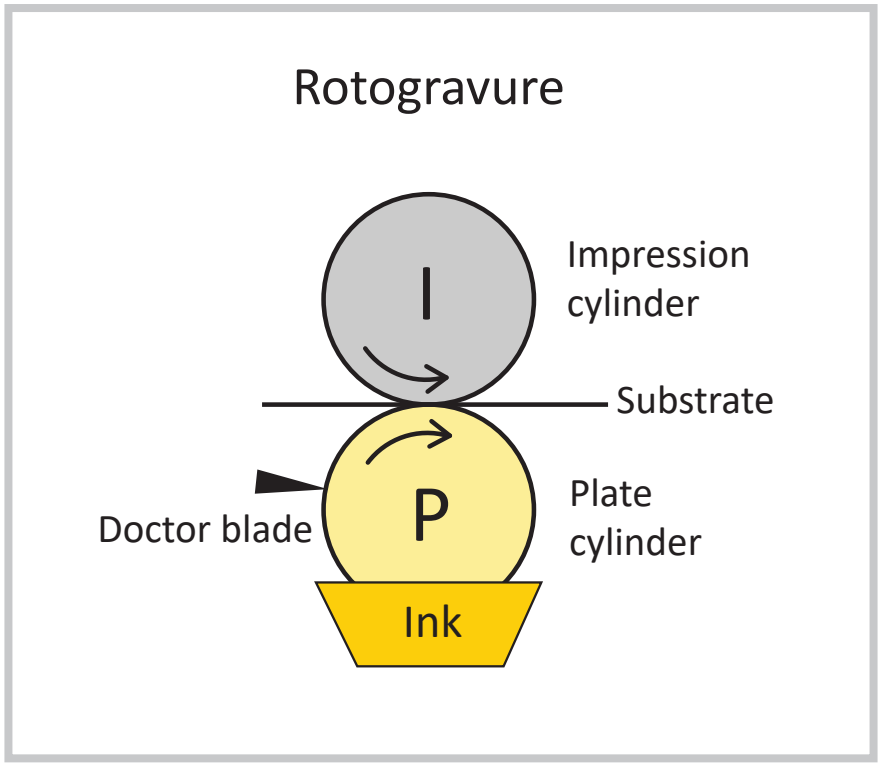


Figure 6: Rotogravure Mechanism

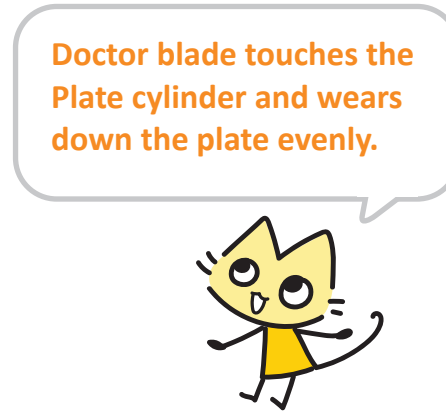


Figure 7: Rotogravure Plate Cylinder

Diamond Stylus that engraves the images on the copper plated plate cylinder

Pad Printing

Pad printing is a unique print technology under intaglio printing. Pad printing has the ability to print on objects that are irregularly shaped, like golf balls, keyboards, or wristwatch faces. It can also use epoxy inks which do not wear down easily.

Digital Printing

Digital printing does not involve the platemaking process because the images are directly transferred from computer to paper. You may be familiar with the digital printers in libraries and offices that can print on letter sized papers. With many innovations, digital printing has grown to take a seat in the commercial printing market.

Digital print is optimal for quick print or short-run production. Flexo, offset, and rotogravure create many paper wastes during the setup process. For example, offset use approximately 100 paper to set balance of water and ink. For one copy of offset it would cost about $500. However, the average cost per copy will go down significantly when the print quantity increases. *Figure 8* shows the average cost per copy does not change for digital printing, resulting the cost to be comparably more expensive than offset when printing in large quantities.

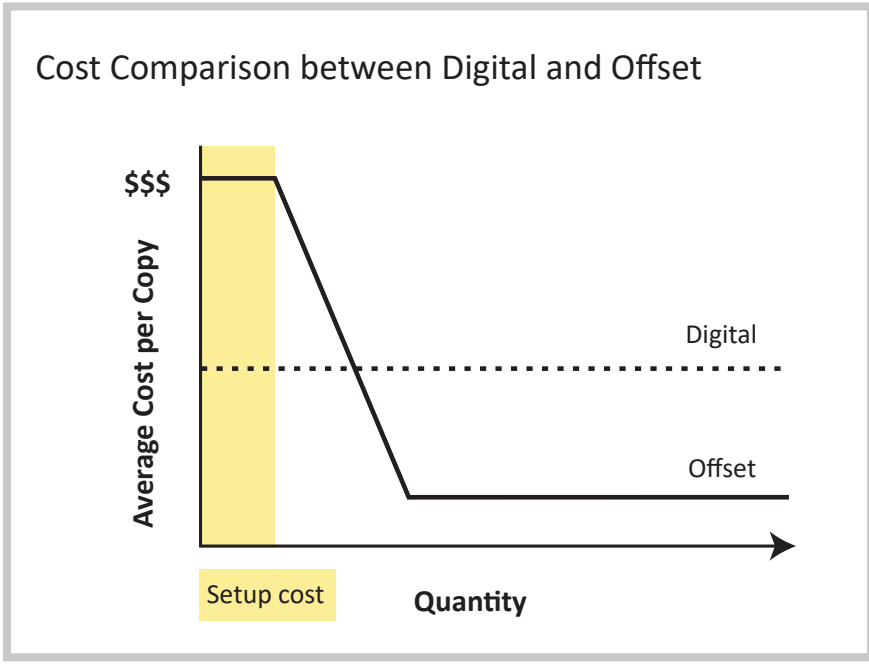


Figure 8: Digital vs Offset Cost

Another advantage of digital printing is the ability to print variable images. While the other print methods must create a plate and only the same image on the plate cylinder can be printed, digital printing can print different images every time. Therefore, digital printing has gained popularity in short-run publishing and customized printing. Toner and ink-jet printing make up the largest sales volume under the domain of digital printing.

Toner Printing

The toner printing, also known as electrophotographic printing, was invented by Chester Carlson, the creator of Xerox machine. Using the law of opposite charges attract and same charges retract, he situated the black powder, the tiny Baby's Breath lycopods, on paper and cooked it in the oven. The pods were burnt to the page and a copy was done! While the International Business Machines (IBM) turned the invention down claiming it was impractical, the Battelle National Laboratory, a pure research group for government military, funded to produce the product because the government wanted to print copies of documents chemical, toxic, and radiation free. The toner printing product, named the Xerox machine, became a successful commercial product under Haloid company we know today.

The "dry printing" process is what makes toner printing unique. A laser passes through the liquid crystal display (LCD) shutter, gets reflected by a spinning polygon mirror to land on the photosensitive drum. The laser charges image area of the drum to negative, which will attract the positive charged toner dust to the drum. As the drum rolls it contacts with the paper substrate, transporting the toner to the substrate. The substrate will pass through the fuser, melting the toner to the paper. Excess toner left on the drum will be removed by the cleaning unit and the drum's surface will be positively charged again via electrostatic charging wires.

Make sure to never open the toner container for fun. Toner dust is so small, it needs a special vacuum cleaner to clean them. Because laser is involved in the printing process, the name "laser printer" or "toner printer" is used interchangeably.

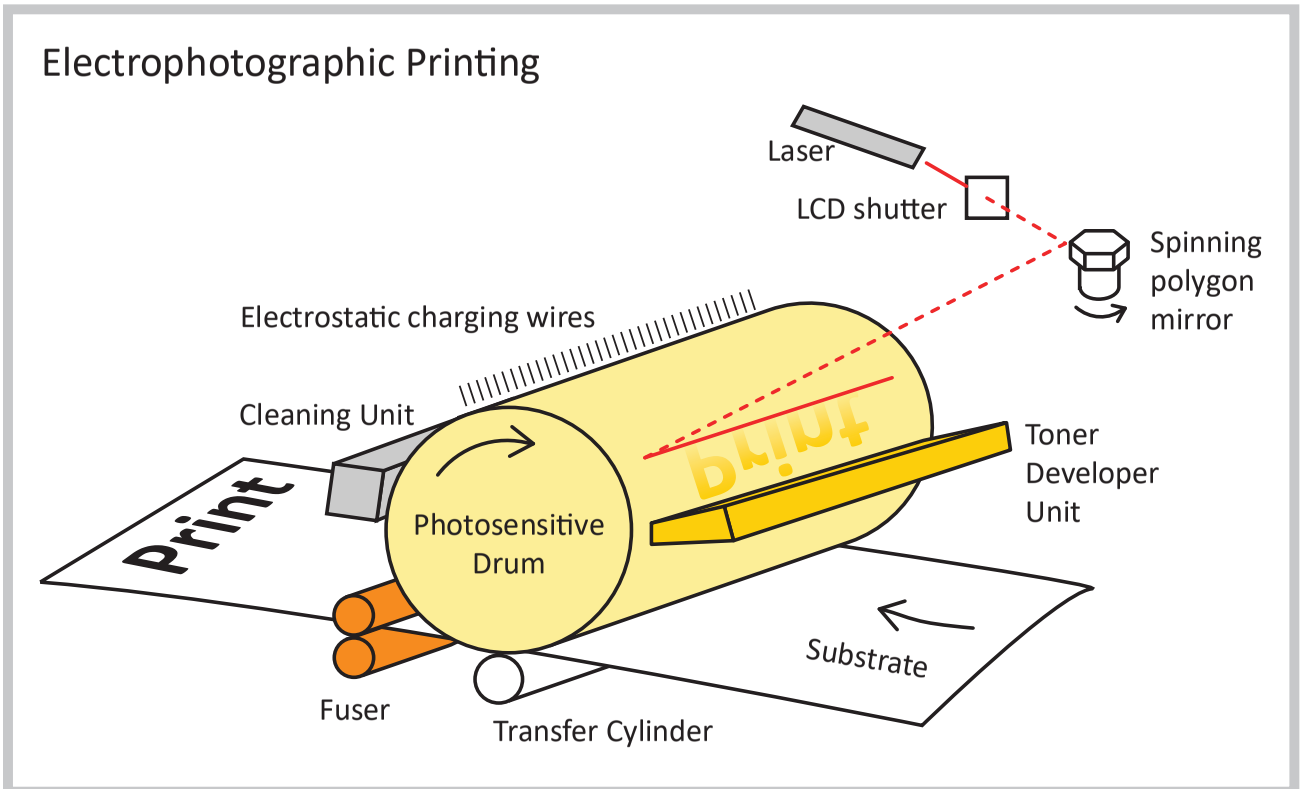


Figure 9: Electrophotography Mechanism

Ink-jet Printing

Ink-jet printing was invented by William Thomson, also known as Lord Kelvin. He was a telegraph operator, working with Morse code to send and receive messages. One day he missed 5 minutes of message using the restroom. In order to avoid this predicament again, he grabbed a roll of paper, and a clock motor to feed at constant speed. A container of ink was attached to an opening that was blocked by the telegraph pin: this is so that whenever the telegraph pin moved, the ink would flow down according to the ticks. The result of this experiment was patterns of the Morse code on paper.

There are two types of ink-jet technology today: thermal ink-jet nozzles and piezoelectric ink-jet nozzles.

Thermal ink-jet nozzles were originally invented at Canon in Japan, and patented by Canon and Hewlett Packard. The expiration of the original patterns opened the market to new innovators. Thermal ink-jet heads are extraordinarily reliable, accurate and fast. Their main drawback is that they can only use aqueous (water-based) inks. This limits their usefulness for outdoor applications, where solvent inks are better. Thermal nozzles will eventually fall from thermal/mechanical exhaustion, requiring the heads to be replaced.

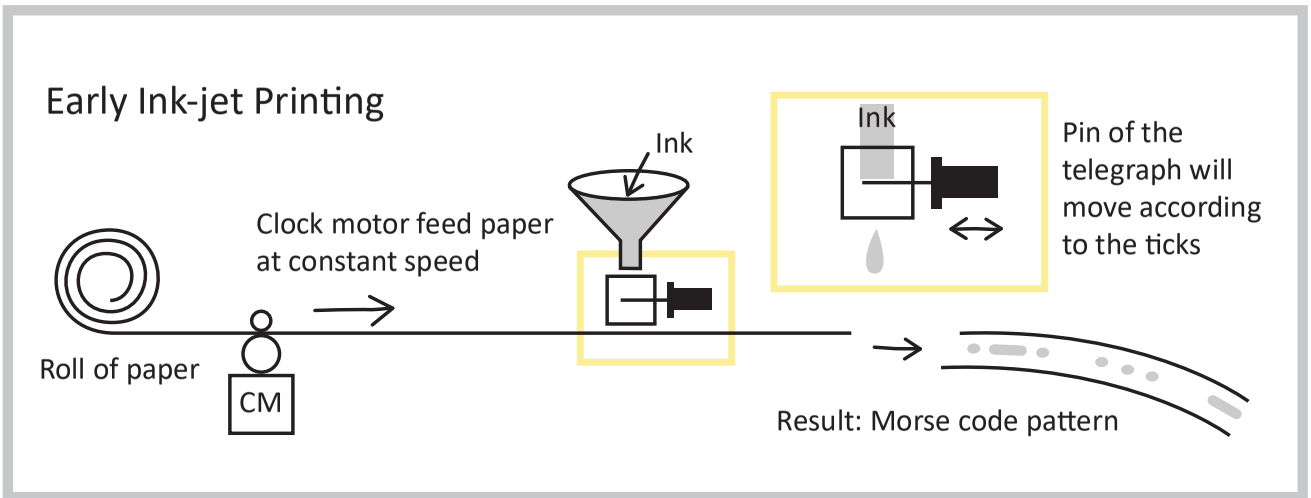


Figure 10: Early Inki-jet Mechanism

Piezoelectric ink-jet nozzles are used in Epson and other printers. Piezoelectric heads have the benefit of being able to print with almost any kind of ink including pigment and solvent-based inks. They do not use heat to work. The piezoelectric crystal twists when electric current goes through, allowing the ink to pass. Another benefit is that piezoelectric nozzles have no significant failure rate— they will print indefinitely without replacement. Though they are mechanical in nature, they are also "solid-state"—indicating that they have no moving parts, just parts that change shape.

While the toner is rather limited in the print market, ink-jet can now print on anything and have no 100 pound waste like offset. Do not ignore inkjet, it is the most significant machine currently for the graphic art industry.

Porous Printing

Porous printing works with ink passing through the porous area. Screen printing has the biggest sales in porous printing for garment printing and industrial printing.

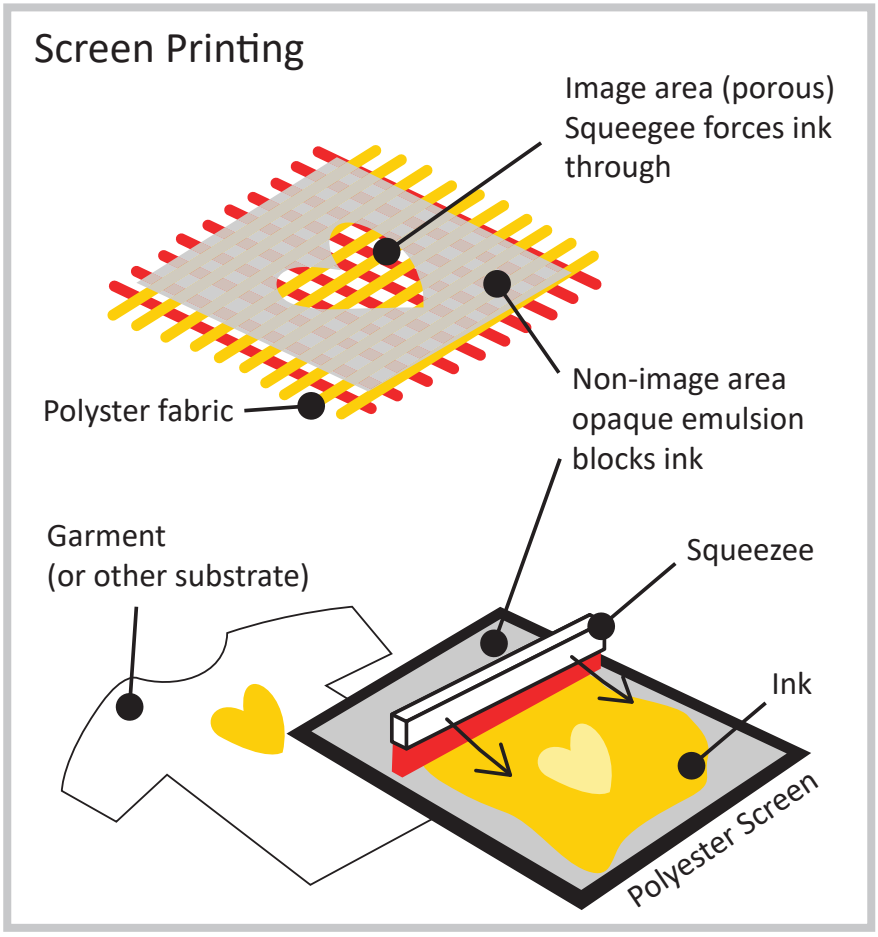


Figure 11: Screen Printing Mechanism

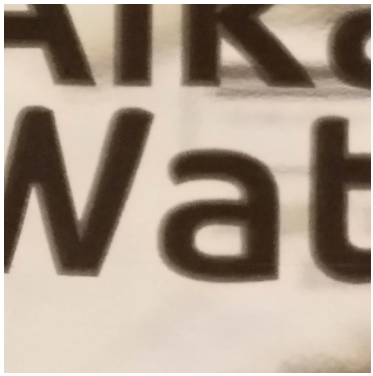
Common **garment printing products** are the t-shirt or sweater prints. The trend of influencers (YouTubers) selling custom printed t-shirts for self-promotion is nice for the screen printing companies. While ink-jet can print on garments as well, it cannot replace screen printing because it is not fast enough.

Common **industrial printing products** would be automobile. Every single windshield in automobile has screen printing because the glue used for cars does not stick to glass but sticks to ink on the glass.

Hybrid Printing

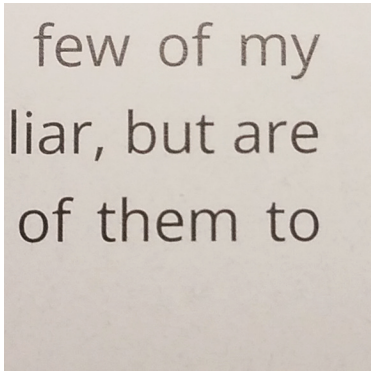
The new trend in the print industry is hybrid printing, which is combining the printing technology mentioned above for more efficient printing. For example, screen printing with ink-jet in the process can customize shirts!

How to Identify Print Process

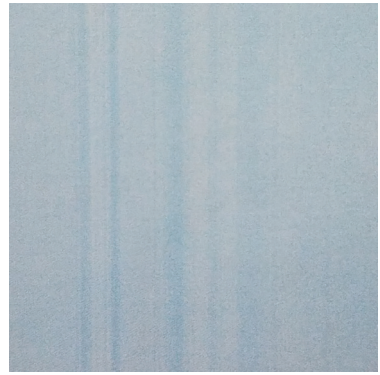


Flexography has a halo around the linework because the polymer plate squeeze against the substrate.

Rotogravure has a very severe serrated edge on every straight line because of the diamond stylus.



Offset has sharper, cleaner, and gorgeous text. When no flaws can be seen with thick and thin elements are perfectly reproduced, it is printed in offset.



Ink-jet printed papers can have their ink nozzles plugged during the printing process, resulting in a banding on print areas with large ink coverage.

Toner has a special texture and shine on the print that cannot be found in other printing process. Stray toner dust can get onto images areas where they are not supposed to. If you see a random colored dot on the paper, it is most likely toner printed.

Print Standards

Standard is an agreed upon set of procedures offering a common expectation. Standards exist so the customer can expect consistent quality of print from a press in Illinois or Texas when the company says they use the same standard.

Type of Standards

- Proprietary (company specific)
- De Facto (happened overtime)
- Industry Specification
- Formal Standards (recognized through ISO or ANSI)

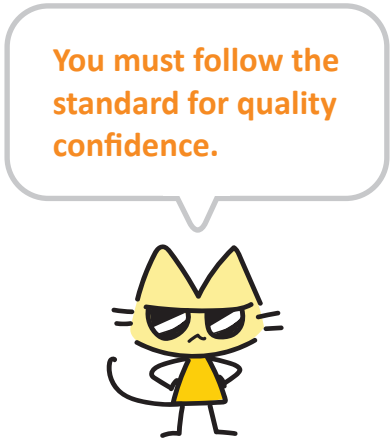
The Industry Specifications You Should Know

- FIRST (Flexographic Image Reproduction Specification & Tolerances)
- SWOP (Specification for Web Offset Publications)
- GRACoL (General Requirements for Applications in Commercial for Web Offset Lithography)

Standards Organization You Should Know

- ISO (International Organization for Standards)
- ANSI (American National Standards Institute)
- CGATS (Committee for Graphic Arts Technical Standards)
- Trade Associations (FIRST, SWOP, GRACoL)

There are also standards for gray balance and spot colors, but more specific details on standards and workflow will be covered in GrC 316 Flexographic Printing Technology and GrC 328 Offset Printing Technology.



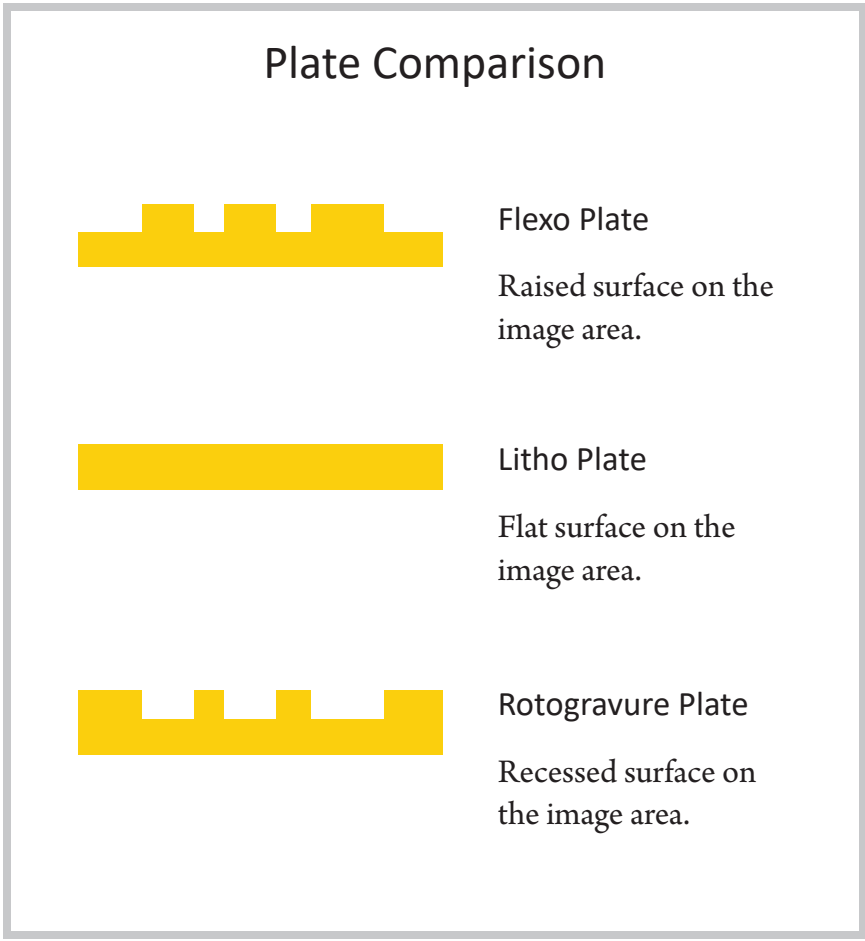
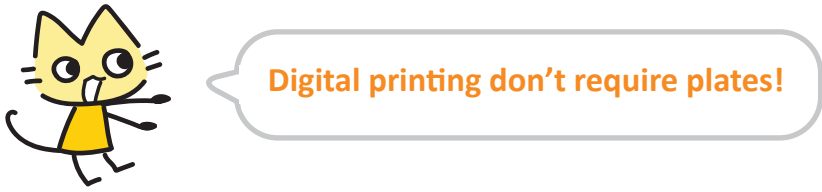


Figure 12: Plate Comparison



Chapter 2

Substrates, Inks & Color Fundamentals

Advanced print technologies today enable the press to print on various substrates, from textiles, corrugated boards, plastic, to mugs. This book, however, will briefly go over the paper substrate and ink properties' important concepts.

More specific details on papermaking, properties of paper and ink, and packaging substrates will be covered in GrC 211 Substrates, Inks and Toners and GrC 337 Consumer Packaging.

Paper Substrate

History of Papermaking

Before paper was invented, history was recorded on leaves and animal skin.

2200 BC	Egypt used papyrus to record their knowledge.
105 AD	Cai Lun from China developed the process of papermaking.
12th century	papermaking technology arrived in Europe.
1680	Hollander Beater was invented, replacing stamp mills and produced paper pulp from cellulose plant fibers.
1812	Fourdrinier Paper machine was invented. This is our current way of making paper.

Paper is created in big rolls of batches that are cut into smaller size for sale. The paper product is not limited to the letter sized paper we put into Xerox machines, but they can be napkins, paper towels, to toilet papers! The fiber source, pulping process, and additives determine the final properties of the paper. For the packaging and print industry the properties of the paper will determine the quality of their product.

Important Paper Properties

Coated Paper: Cast, Gloss, Matte, Dull

Uncoated: Various surface textures (embossed, antique, eggshell, vellum, smooth finish, super calendared, felt finish, laid finish)

Dimensional Stability

Paper expends with more moisture. If the paper's dimensional stability is low, the image will expend with the paper during the print process, making them less accurate.

Grain Direction

The fiber orientation that occurs during the paper making process. Determines the strength, hydroexpensivity, stiffness, and the folding of the paper.

The paper type (coated/uncoated) decides how the paper feels and how the ink looks on paper. For example, the same ink will look dull on a plain copy paper while it will look shiny and brighter on gloss coated paper.

Paper Specification

The print industry uses paper specification to calculate the pricing of the paper. They sell the paper in sheets and rolls. The whole world uses the metric system for papers (Ex. A4 sized paper) that do not create waste when cut to smaller sizes (Ex. From A2 to A4 paper size). US is one of the two countries that still uses inch units. This US system produce 30 percent paper waste when cutting the paper into sizes.

Terminology for Paper Specification

- Metric Paper Size — A series and B series
- Metric Paper Weight — GSM (grams per square meter)
- Basis Weight — lb for 500 sheets of basic size
- M-Weight — per 1000 sheets
- CWT — per 100 lb

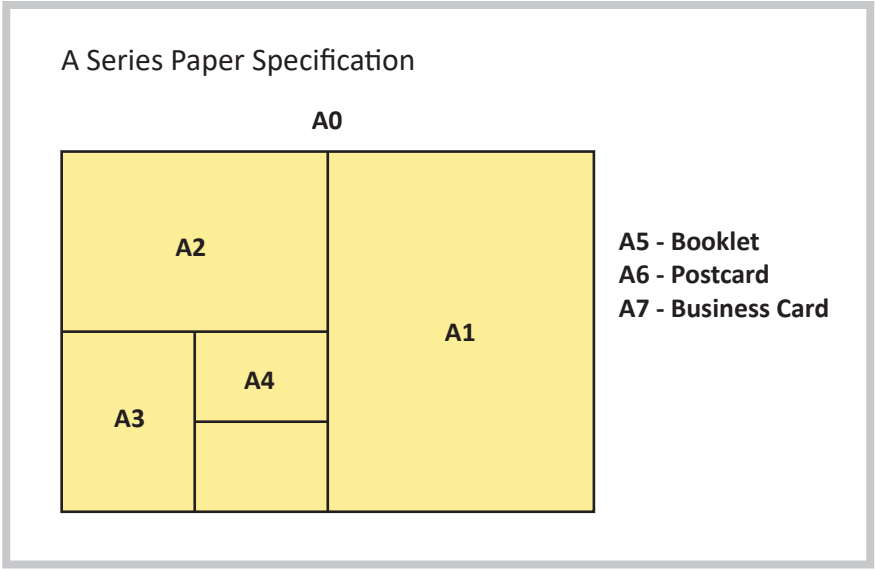


Figure 13: A Series Paper Specification

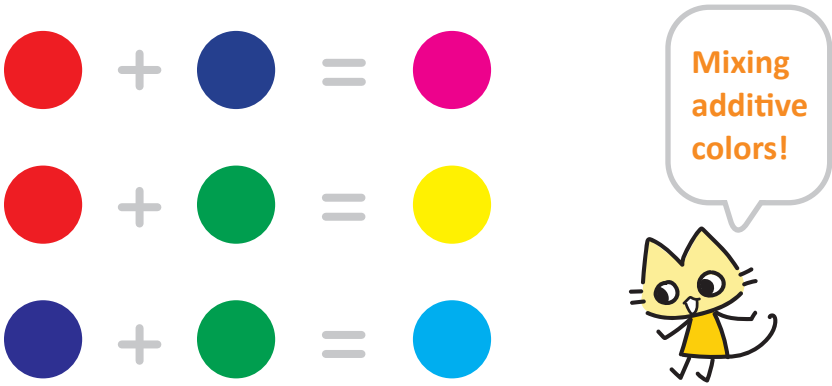
A7 is a typical business card size, but you can design in different sizes!

More specific information on paper specification, cost estimating, and calculations will be covered in GrC 211 Substrates, Inks and Toners and GrC 404 Data Management, Estimating and Visualization in Graphic Communication.

Color Fundamentals

Before we talk about inks, it is important to understand how our eye perceive color.

Our eye has sensors, the cones and rods, that register the light signals and sends them to our brain where it interprets them as colors. Isaac Newton discovered that the white light is a combination of red, green, and blue— we call this primary colors.



When you mix red light with blue light, magenta color is made.
When you mix red light with green light, yellow color is made.
When you mix blue light with green light, cyan color is made.

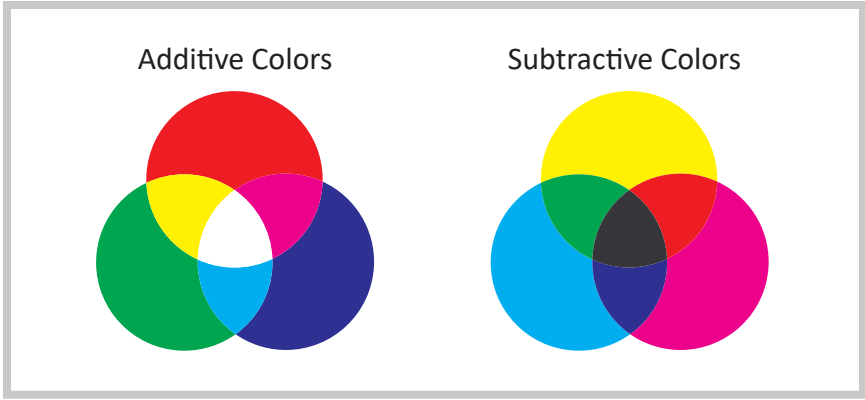
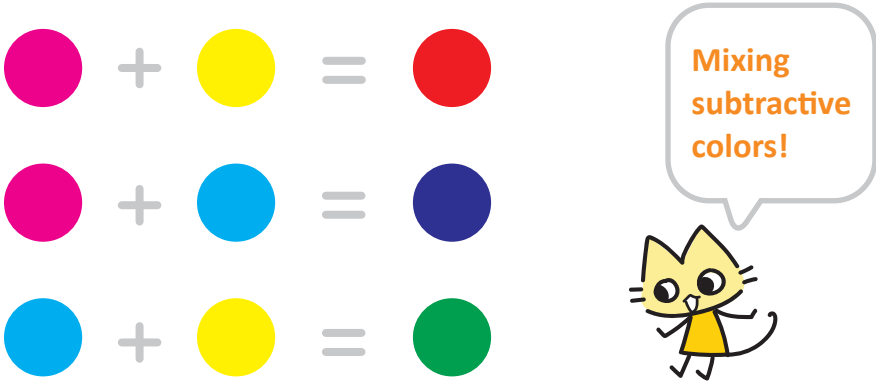


Figure 14: Additive Colors vs Subtractive Colors



When you mix magenta ink with yellow ink, red color is made.
When you mix magenta ink with cyan ink, blue color is made.
When you mix cyan ink with yellow ink, green color is made.

Now bear with me, I understand this is confusing. When working with color light, we call this **additive color system** because "light" is being added. If this sounds crazy to you, try mixing the colors of the light using flashlights with red, green, and blue filters.

What is a color black then? We get black when RGB lights gets absorbed or there is absence of light.

What happens when you mix red, blue, and green "paint"? You get a weird brown color. This is because paint and inks are **subtractive color system**. When we look at the trees, their leaves look green because when white light hits the leaves, green light gets reflected while the red and blue light gets absorbed. The absorbed lights get "subtracted" and our eyes only see the color light that gets reflected. The secondary colors (cyan, magenta, and yellow) that complement (opposite of) the primary colors (red, green, and blue) are very useful in the printing industry because mixing secondary color inks create primary colors.

How does this apply to print? Well, we have primary colors (RGB) and want to print them. Unfortunately, ink does not work the same way as lights, so we have to convert the color by inverting them to secondary colors (CMY) to print. Only mixing CMY will make a muddy brown color, so black ink (K) is always included when printing color photos.

Here is how the CMYK plates will look like when the photo is color separated for the printing.

Photo by Boris Smokrovic from Unsplash

Figure 15: Color Separation

Inks

Inks have two main categories: paste ink and fluid ink. Offset and screen printing use paste ink, while flexo and gravure use fluid ink. Do not imagine watercolor for fluid inks. They are thick in consistency that stretch like melted cheese! Ink also do not have the same stickiness: so like peanut butter and jelly, the stickiest ink get printed first. The order of inks in offset printing is usually K > C > M > Y.

Process colors— also known as "print colors"— are CMYK that will be mixed in printing.

Spot colors are specific colors like Coca-cola red. Spot color inks ensure the exact color will be printed consistently.

Color consistency is important because they can determine brand identity. Magazine and newspaper prints are not as strict in color consistency. However, there are limitations to the colors that can be reproduced with CMYK inks so sometimes spot colors like orange and violet are included as extended color gamut.

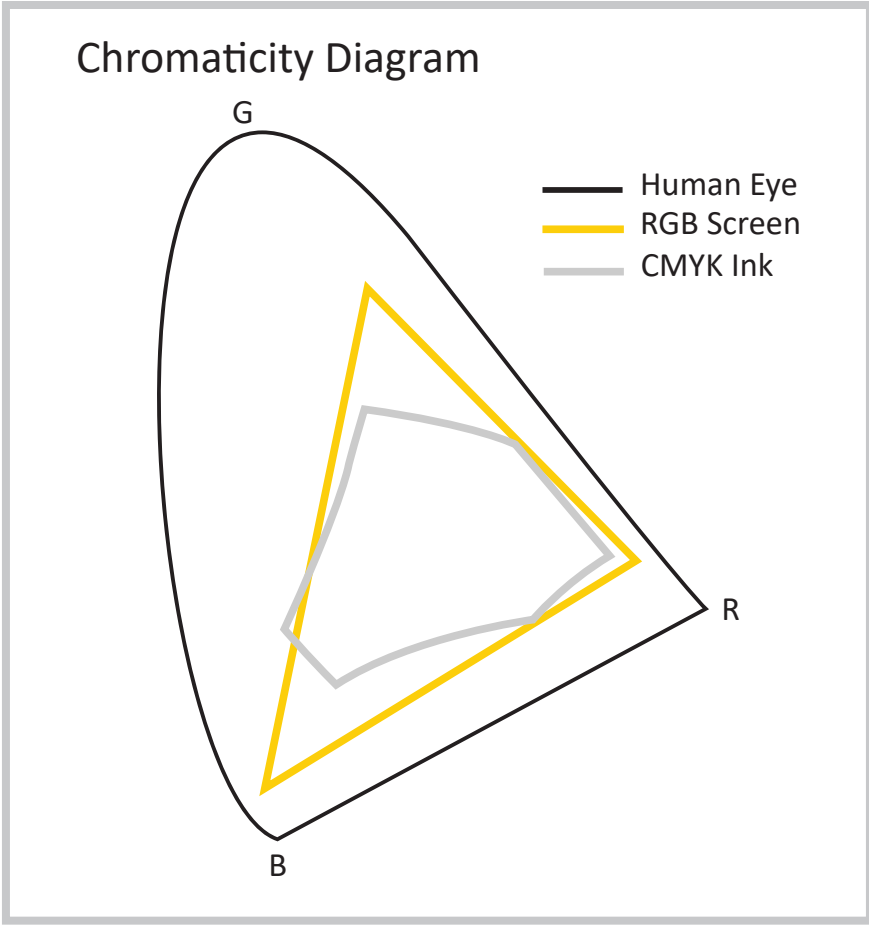


Figure 16: Chromaticity Diagram

Our eyes can see much more colors than what the RGB screen and CMYK ink can reproduce!

Chapter 3

Digital File Preparation & Workflow

Digital Publishing History

Digital publishing is the creation of documents for broad distribution using computer small enough to fit a desktop.

1961 — IBM Selectric typewriter (TM) was the first to change the font and size of the text on the same document.

1984 — Macintosh was the first to have the Graphic User Interface (GUI) in computer.

1985 — PageMaker, which later evolved to Adobe InDesign, was the first to develop a virtual desktop publishing application.

In the early computer days, there was no pretty websites or video player. People had to learn code to communicate with the computer displaying only green text on black screen. That is why Macintosh computer by Apple with the GUI was a great hit.

Postscript is the output processor in printing. It contains RIP and translates documents for the printer.

Raster Image Processor (RIP) is a hardware that receives the data in description language to convert it into a raster image.

The first postscript was created by the Adobe company. Steve Jobs from Apple was a visionary about graphic arts and funded Adobe for their project. This was before scanners or common image file (PDF), so the idea of a digital printer that allows universal language and pictures was a challenge with great potential.

Production Workflow

In the early 1980s there were clearly defined, specialized professions for the print production workflow: Typesetter, photographer, designer, and printer. Now with the current desktop publishing applications open to the public, the assignment of each tasks has been redistributed and blurred between professions. It is important to understand who you have to go through to get a print job done.

- Sales and Customer Service Representative
- Planning, Estimating, and Scheduling
- Vendors and Suppliers
- Preflight
- Prepress
- Production
- Warehouse and Shipping

This book will briefly go over preflighting and introduce important concepts that is necessary to understand the industry terms.

More specific details on proofs, color separation, preflight, and production workflow will be covered in GrC 201 Digital Publishing Systems and GrC 203 Digital File Preparation and Workflow.

Preflight

Preflight is a checking process of the files for errors before they are run to production. Preflight involves proofs, fonts, and quality checks in the graphic elements.

Font Technology

Not all fonts are created equal across platforms. The platform here means the Mac and Windows computers. Some font files can only be translated in one platform (Mac) and not the other (Windows). This poses a problem of being unable to read the words of the document created by a Mac when that is shared to Windows. The creation of cross-platform font format later on solved the problem.

- Type 1 (PostScript fonts) — NOT cross-platform
- TrueType — (by Apple) NOT cross-platform
- OpenType — YES cross-platform

Common problems that occur during preflight are missing fonts. This occurs when the client does not package their files with the fonts.

Image Resolution

LPI, DPI & PPI

Lines-per-inch (LPI) describes the frequency of halftone dots, measured along a row of dots.

Dots-per-inch (DPI) describes the resolution of an output device such as desktop printer, imagesetter, or a platesetter. Visualize the physical laying down for ink drops to form the image.

Pixels-per-inch (PPI) describes image resolution in the computer screen.

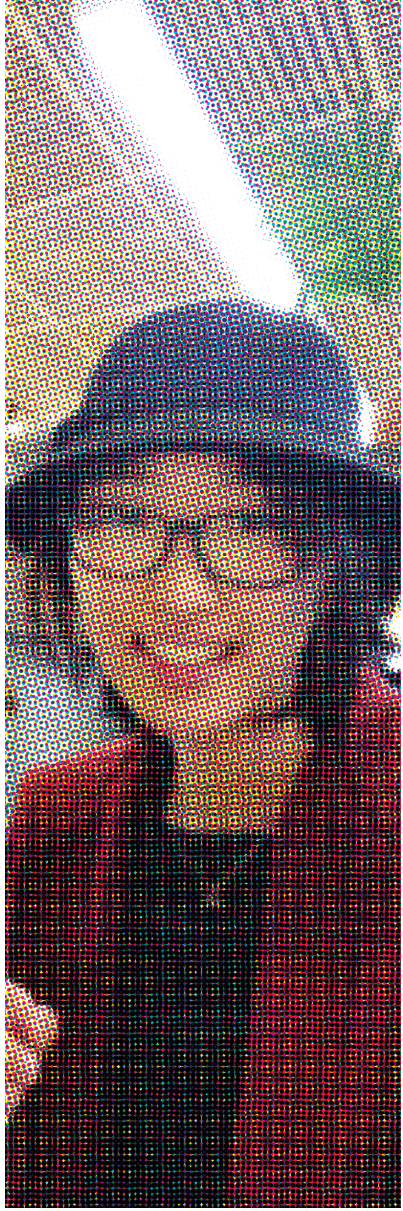
Magazines usually have 150 lpi resolution and newspapers 85 lpi. Printers usually have 600 dpi resolution and for computer to plate (CTP) device 2400 dpi. The ideal PPI for good print resolution is 300 ppi and for website 72 ppi.

Understanding Halftone for Print

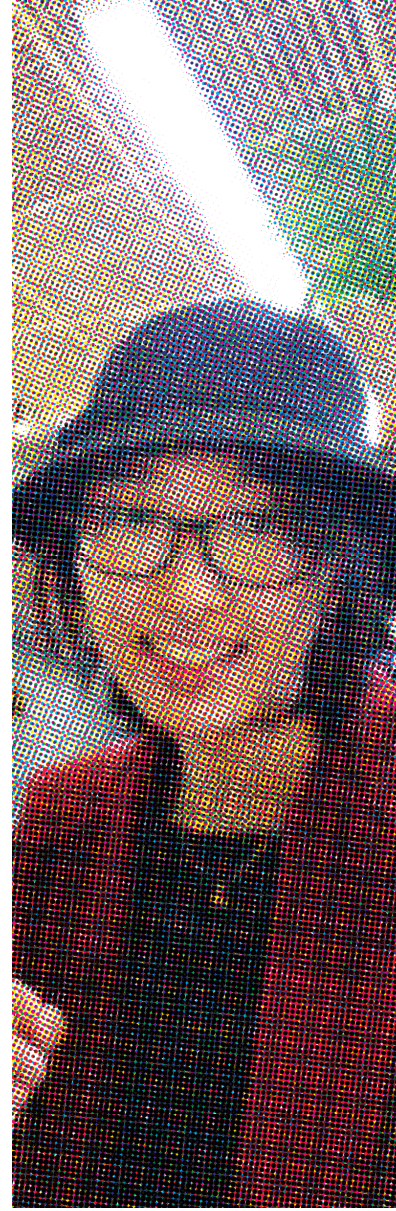
The **halftones** are used for printing images. Instead of mixing the inks individually for the exact color as a painter would, we control the ink droplet's size and concentration on the image to express different colors and tones. Every dot (ink droplet) location exists in the center of the grid of squares. Each square can have dots of varying sizes from tiny black dot in white background, tiny white dot in black background, and no dot at all.

Rosette pattern is the ideal ink placement result for color printing. Halftone dots for different colors pile on top of each other in at least the 30 degree difference to prevent a **moiré pattern**, an optical pattern that is seen in print because of bad halftone placement.

Figure 17: Halftone, Rosette & Moiré Pattern



Rosette Pattern
C = 105 degrees
M = 75 degrees
Y = 45 degrees
K = 0 degrees



Moiré Pattern
C = 105 degrees
M = 120 degrees
Y = 110 degrees
K = 95 degrees

Photo by Yeyoung Kim

Raster vs Vector Image

Have you ever wondered when you are texting why sending a photo takes longer than sending a text? When you take photo with a digital camera, it has light filters for RGB that translate into data for individual pixels for the image. Pixels are tiny squares that make up the digital screens displaying light. Smooth, high quality photos require more pixels.

Figure 18: RGB Color Channel
Photo by Kwang Mathurosemontri from Unsplash

R channel + G channel + B channel
= RGB color channel for full color photos!

All photos are raster images, an image with a set resolution. The quality of the raster image decreases when enlarged. An image that retains its quality when enlarged is a vector image, an image created by mathematical equations.

Raster Image — image with a set resolution. The quality of the image decreases when enlarged.

Vector Image — image created by mathematical equations. The quality of the image does not change when enlarged.

Lossy vs Lossless File Format

When saving image files, it is important to use the appropriate file format to prevent image quality loss.

Lossy — lose some data of the original image. Do not get 100 percent data back. *Ex. JPEG*

Lossless — decompress data back to its original form without loss. *Ex. GIF, PNG, TIFF, SVG*

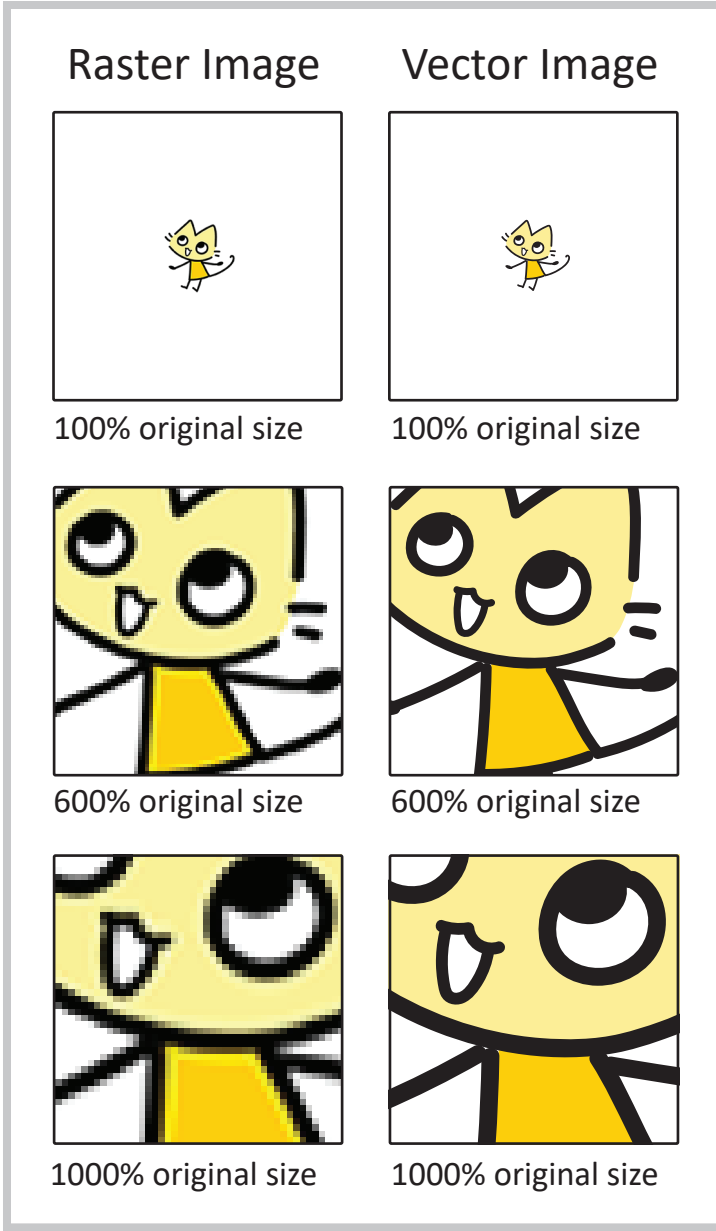


Figure 19: Raster vs Vector Graphic

File Preparation

Trapping — an overprint of colors at the edges of the butting color areas to camouflage any slippage.

Imposition — combined individual pages in the proper pagination of plating.

Proofs — a simulation of the results expected from the printing press. *Ex. Digital Proof, Scatter Proof, Soft Proof, Hard Proof, Imposition Proof*

Color Separation — For the non-digital press, individual plates for each ink color have to be made. The print files are usually color separated for CMYK plates.

PDF — Portable Document Format (PDF) that consistently keeps graphic integrity, is device independent, and secure.

You can see the text colors go across the edges of the text area to ensure the area is fully colored.

Figure 20: Trapping

Process Controls

Registration Marks — indicator for whether the registration of the plates is aligned.

Trim Marks — indicator for where to trim off the print

Fold Marks — indicator for where to fold the print.

Color Bars — check consistency of ink laydown.

A printer cannot print all the way to the edge of the paper. This is why the designer have the design extend over the paper size, known as **bleed**, and have them printed on a bigger paper and trimmed to the desired size.

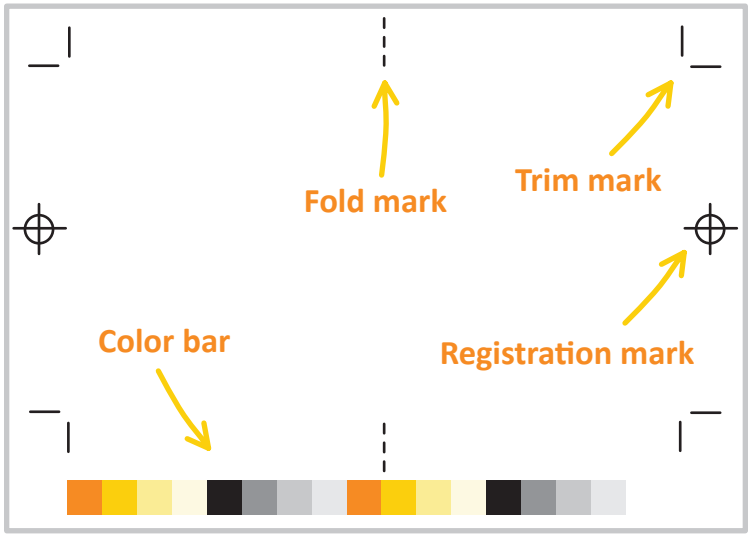


Figure 21: Process Controls

Common Problems in Printing

Doubling — second image appears along the side of first image.

Slur — dots appear elongated/smeared on a single unit.

Scumming — non-image area accept ink.

Tinting/Toning — emulsified ink (ink in water) transfers to printed sheet as background tint.

Set-off — ink transfer to the backside of the substrate because print stacked on top of each other while the ink is not completely dry.

Hickey/Donut — paper dust or coating particles sticking on the plate, creating spots without ink.

Moiré pattern — optical pattern that is seen in print because of bad halftone placement.

Designing for Web and Why it is Tricky

- Dynamic screen sizes (computer, smart phone, tablet)
- How will the fonts and images adjust to screen size?
- How will the user navigate on the screen?

The User Experience (UX) and User Interface (UI) are the recent professions that specialize in designing the user's experience when navigating or interacting with a website, mobile app, or a product. This process involves wireframing, UX design laws, research, coding, and prototyping.

More information on UX/UI, wireframing, accessibility, and web optimization will be covered in GrC 338 Web Development and Content Management, GrC 339 Web Design and Production, and GrC 429 Mobile User Experience.

Chapter 4

Binding & Finishing Process

Binding and finishing process are the final addition one can do to add value to their product. For a book it would be putting the book content together. For a packaging it would be die cutting, gluing, and folding. For a fancy wedding envelop it would be foil stamping and embossing.

More specific details on imposition, cutting, finishing, and related technologies will be covered in GrC 324 Binding, Finishing, and Distribution Processes.

5 Common Type of Folds

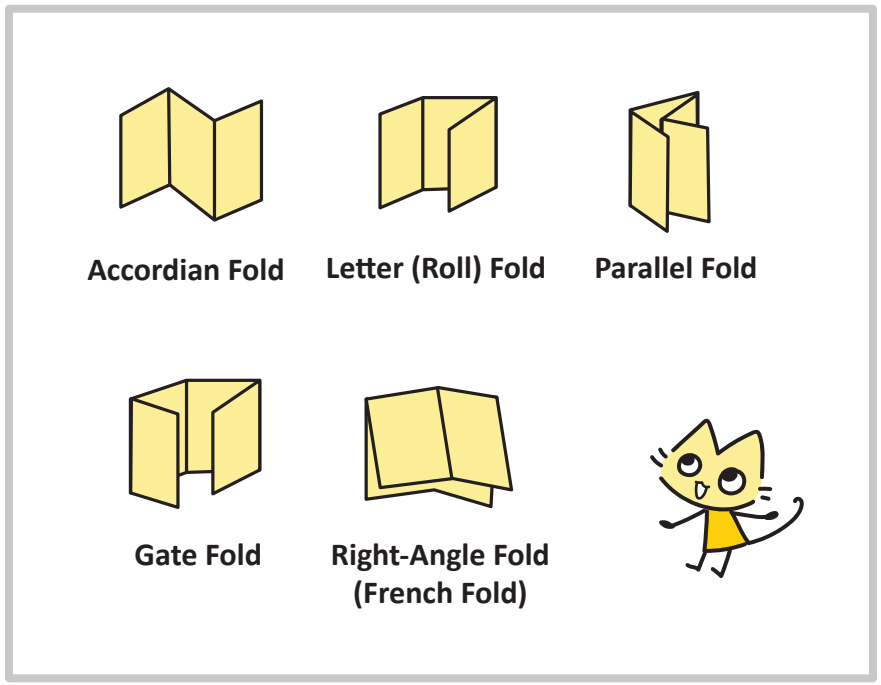


Figure 22: Common Type of Folds

Parallel folds are easier to produce.
Right-angle folds are more common.

Fold Terminology

Panel — front and back section of the folded piece.

Flap — a fold with a panel not extending as far as the other panel.

Spreads — graphics crossing two or more panels.

Pages — a single-sided section of the book.

Leaves — single sheets in a book containing two pages.

Scoring — creasing the sheet before folding.

Books have leaves.
Folded pieces have panels.

Type of Binding

Saddle Stitch — binding with a metal wire. You can saddle stitch a book at home with a stapler! Common saddle stitch products are comic book and magazines.

Perfect Binding — commonly known as paperback. The papers are glued together with a cover substrate.

Case Binding — commonly known as hardcover. Case binding is the most expensive binding operation. They can be elegantly sewn together or glued directly to the backbone of the book. There are options to bind as round back, tight back, and flat back.

Mechanical Binding — mechanically bound books can lay flat and can contain multiple paper types and weights. There are options to bind with spiral wire, spiral plastic coil, and double wire.

Finishing Process

Foil Stamping — foil is stamped onto the substrate, giving a shine a metallic ink cannot reproduce.

Embossing — raising an image on the substrate by pressing substrate against the die with the image shape.

Debossing — lowering an image on the substrate by pressing substrate against the die with the image shape.

Foil Embossing — raising an image on the substrate with the foil on the image area.

Varnish — a clear coat that can be applied on the surface to add a shine to the image area.

Figure 23: Foil Stamp

Figure 24: Emboss

Figure 25: Emboss on Tin

Embossed tin with the silver areas not printed.

Figure 26: Varnish

Butterfly image areas have varnish, making them shine.

Figure 27: Foil Stamp vs Metallic Ink

Foil stamp has more shine than metallic ink.

Box on top has gold foil stamp and the box on bottom has metallic ink.

Die Cutting

It would take forever to cut out 1000 boxes with scissors! **Die cutting** makes the process much faster. Like a cookie cutter, the blade is shaped into the desired mold and is set to a machine that will punch through substrate. Most stickers, packaging, and product labels are die cut!

Laser cutting is great for extremely intricate work, but it is a very slow process. Therefore, laser cutting is used for very short runs and most cutting is done by die cut.

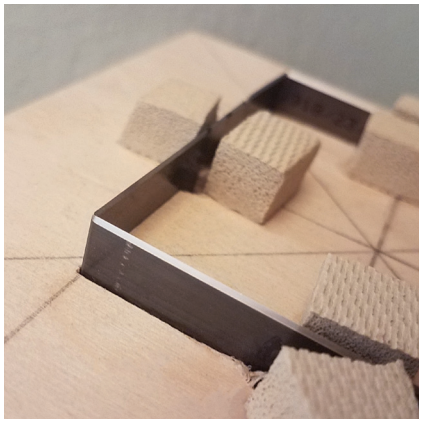
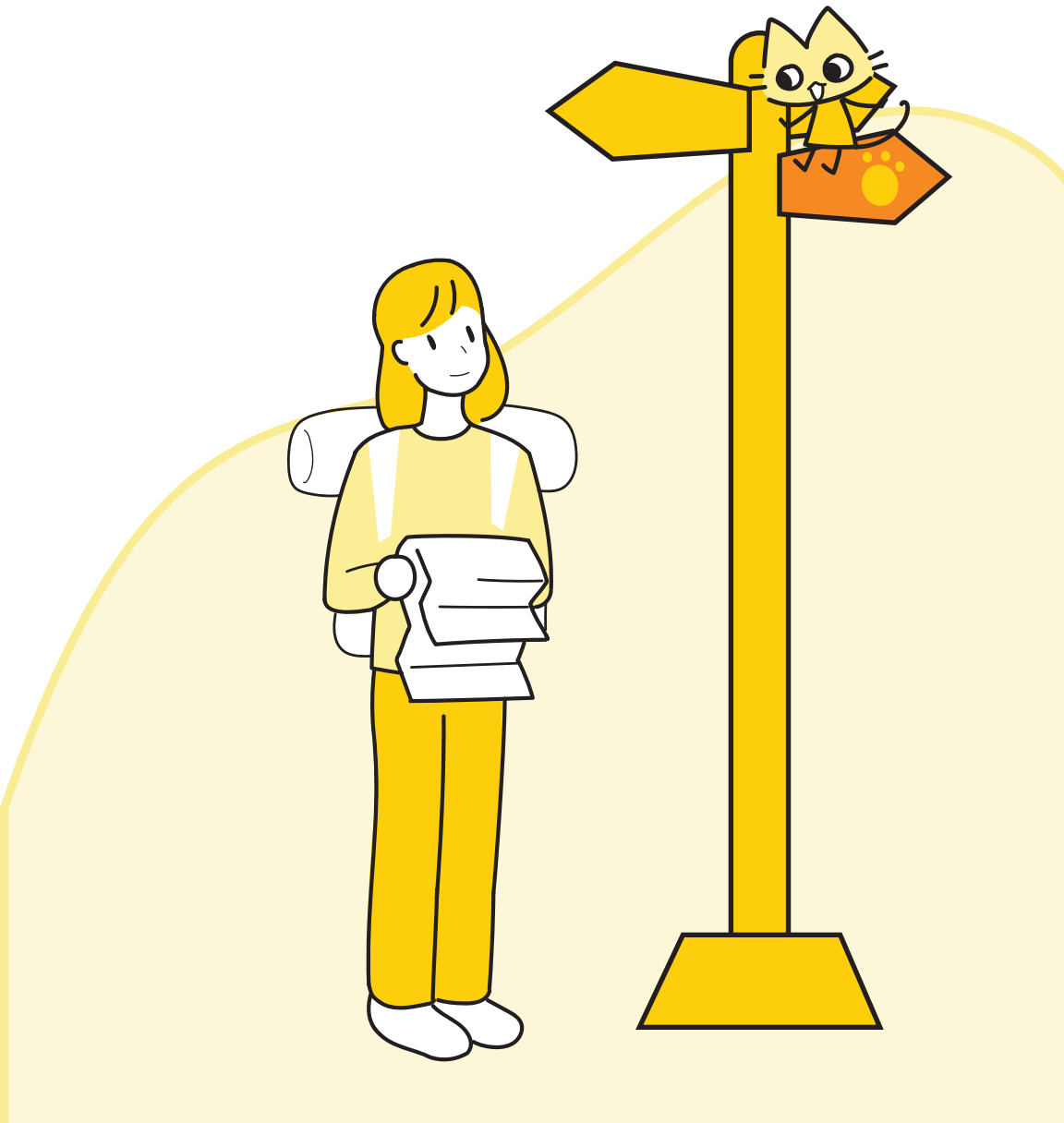


Figure 28: Steel Rule Die Cut Cutting Mold

Figure 29: Die Cut Label

Chapter 5

Career & Concentration



Now you may be thinking, "How does this apply to the career I want to take?" Do you want to work in marketing? Magazine publishing? Web development? Product Management? In the developed society we live today, most careers involve digital and physical media. Understanding the capabilities and limits of the printing and digital technology will allow you to navigate the related career well informed.

About the Cal Poly GrC Department

With Cal Poly's motto of **Learn by Doing**, you will gain a hands-on experience on the printing technology, design, and production management.

The GrC Department's Mission:

"To pursue excellence in education through theoretical and experiential methods to discover, apply, and articulate fundamental technologies, applied aesthetics, and management in graphic communication."

The GrC Department's Vision:

"In pursuing a culture of innovation that leads the graphic communication discipline, we will create a reputation that prompts the profession to think first of Cal Poly Graphic Communication students for their excellence."

Bachelor of Science (BS) in Graphic Communication

The courses for BS Graphic Communication consist of 72 units of General Education, 16 units of support courses, 72 units of major courses, 29 units of concentration courses, and a 3 unit senior project.

The 72 units of major courses provide a solid understanding on design reproduction technology, web development, management, and packaging. They also cover marketing, strategic trends, estimating, and Human Resource management.

In addition to that, the GrC concentration courses allow students to dive further into the topic of their choice: DRT, UX/UI, GCM, GP, and ICS.

GrC Concentrations

Design Reproduction Technology (DRT)

DRT concentration consist of book and magazine design projects and more design classes!

Topics DRT focuses on are

- Design with the reproduction process in mind
- Design for both print and web
- Design technology and principles
- Advertising and publication production and design
- Typography for print and web
- Technical limitations and production requirements
- Software knowledge for design and production

DRT Career Opportunities are

- Print Buyer
- Production Artist
- Advertising and Packaging
- Project Manager
- Book and Magazine Publishing
- Prepress and Production
- Digital Design
- Web Design and Development

User Experience/User Interface (UX/UI)

UX/UI concentration consist of web and mobile design projects with coding classes!

Topics UX/UI focuses on are

- Web technology
- Digital Video
- Animation
- Digital audio
- Interactive content
- Digital photography

UX/UI Career Opportunities are

- Web Development and Design
- Digital Media Production
- Digital Media Management
- Hardware Development
- Software Development
- Quality Assurance
- Customer Service

Graphic Communication Management (GCM)

GCM concentration consist of business and communication classes which are essential in managing in business!

Topics GCM focuses on are

- Plant management
- Planning
- Manufacturing and system analysis
- Quality control
- Production control
- Estimating and financial control
- Marketing and sales
- Personnel relations
- Statistical process control (SPC)
- Total quality management (TQM)

GCM Career Opportunities are

- Plant Management
- Planning
- Production Scheduling
- Estimating
- Printing Marketing and Sales
- Customer Service
- Technical Specialist
- Quality Control

- Print Buying
- Human Resource Management
- Process Control
- E-commerce

Graphics for Packaging (GP)

GP concentration consist of packaging project with specialty printing, food processing, and production management classes!

Topics GP focuses on are

- Package design and creativity
- Packaging substrates
- Converting Technology
- Package engineering
- Consumer tastes
- Brand security and smart packaging

GP Career Opportunities are

- Digital File Creation
- Packaging Graphics
- Package Printing Specialist
- Smart and Active Packaging
- Packaging Quality Control
- Structural Packaging Design

Individualized Course of Study (ICS)

ICS concentration gives you the power to customize your area of study! If you want to pursue ICS, you must consult with the concentration coordinator and department head, and provide a written justification for the courses and the way they constitute a cohesive, integrated program of study.

So you have chosen the unpaved path… good luck hero.

Minor

You can explore other topics you are interested in with a minor! I know a few GrC students who checked out Agriculture minor or Photography minor. Many GrC students concentrating in GP take the Industrial Technology and Packaging (ITP) minor.

As for me, I took Computing for Interactive Arts (CIA) minor because I was interested in animation! Since you are already a Cal Poly student, you should use that opportunity to check out all the available courses and resources Cal Poly has to offer. **:D**

Senior Project

Senior Project is a great opportunity for your portfolio! You can create something new or improve a pre-existing process or product of your choice in a quarter. They can be a mobile cooking recipe

app, rebranding a company, or a book like the one you are reading right now!

I remember being fascinated in learning about the printing history and ink in my freshmen year and wished there were a book that compiled all the basic information for review. The GrC Department did not have a textbook that covered the foundation of Graphic Communication for students to refer to. So, I turned this into my Senior Project!

Final Thoughts

Studying college level courses are not an opportunity that come by easily. I recommend taking full advantage of being a Cal Poly student to explore areas of your interest and get the full experience the tuition is worth! I recommend taking a *ENGL 310 Corporate Communications* and *COMS 384 Media Effects*!

Here's a final tip: Organize all your work, volunteer, and education experience in a document which I call the Master Resume. Having all that information in one place will aid you in creating a customized resume to the position you are applying for.

Thank you for reading this book. I hope it was fun and easy to follow the information. Good luck in your endeavors and I hope you find the career path you want to take. **:D**

Key Words

ANSI — American National Standards Institute.

Basis Weight — lb for 500 sheets of basic size.

CGATS — Committee for Graphic Arts Technical Standards.

Color Bars — check consistency of ink laydown.

Color Separation — For the non-digital press, individual plates for each ink color have to be made. The print files are usually color separated for CMYK plates.

CWT — per 100 lb.

Debossing — lowering an image on the substrate by pressing substrate against the die with the image shape.

Dots-per-inch (DPI) — describes the resolution of an output device such as desktop printer, imagesetter, or a platesetter. Visualize the physical laying down for ink drops to form the image.

Doubling — second image appears along the side of first image.

Embossing — raising an image on the substrate by pressing substrate against the die with the image shape.

FIRST — Flexographic Image Reproduction Specification & Tolerances.

Flexography — has the biggest sales volume in relief printing for packaging.

Foil Embossing — raising an image on the substrate with the foil on the image area.

Foil Stamping — foil is stamped onto the substrate, giving a shine a metallic ink cannot reproduce.

Fold Marks — indicator for where to fold the print.

GRACoL — General Requirements for Applications in Commercial for Web Offset Lithography.

Grain Direction — the fiber orientation that occurs during the paper making process.

Hickey/Donut — paper dust or coating particles sticking on the plate, creating spots without ink.

Hybrid printing — is the combination of the printing technologies for more efficient printing.

Imposition — combined individual pages in the proper pagination of plating.

Ink-jet printing —has two types of ink nozzles: thermal ink-jet nozzles and piezoelectric ink-jet nozzles. Toner and ink-jet printing make up the largest sales volume under the domain of digital printing.

ISO — International Organization for Standards.

Lines-per-inch (LPI) — describes the frequency of halftone dots, measured along a row of dots.

Lossless — decompress data back to its original form without loss. *Ex. GIF, PNG, TIFF, SVG*

Lossy — lose some data of the original image. Do not get 100 percent data back. *Ex. JPEG*

Metric Paper Size — A series and B series.

Metric Paper Weight — GSM (grams per square meter).

Moiré pattern — optical pattern that is seen in print because of bad halftone placement.

M-Weight — per 1000 sheets.

Offset lithography — has the biggest sales volume in planographic printing for publication printing and folding cartons.

OpenType — YES cross-platform.

Pad printing — has the ability to print on objects that are irregularly shaped, like golf balls, keyboards, or wristwatch faces.

PDF — Portable Document Format (PDF) that consistently keeps graphic integrity, is device independent, and secure.

Pixels-per-inch (PPI) — describes image resolution in the computer screen.

Postscript — the output processor in printing. It contains RIP and translates documents for the printer.

Process colors — the CMYK that will be mixed in printing. Also known as "print colors".

Proofs — a simulation of the results expected from the printing press. *Ex. Digital Proof, Scatter Proof, Soft Proof, Hard Proof, Imposition Proof*

Raster Image — image with a set resolution. The quality of the image decreases when enlarged.

Raster Image Processor (RIP) — a hardware that receives the data in description language to convert it into a raster image.

Registration Marks — indicator for whether the registration of the plates is aligned.

Rosette pattern — ideal ink placement result for color printing.

Rotogravure — has the biggest sales volume in intaglio printing for publications printing and packaging labels.

Screen printing — has the biggest sales in porous printing for garment printing and industrial printing.

Scumming — non-image area accept ink.

Set-off — ink transfer to the backside of the substrate because print stacked on top of each other while the ink is not completely dry.

Sheetfed printing — has a stack of papers in the paper feeding area and individual sheets are carried through the press.

Slur — dots appear elongated/smeared on a single unit.

Spot colors — specific colors to ensure the exact color will be printed consistently.

SWOP — Specification for Web Offset Publications.

Tinting/Toning — emulsified ink (ink in water) transfers to printed sheet as background tint.

Toner printing — also known as electrophotographic printing, is the "dry printing" process. Toner and ink-jet printing make up the largest sales volume under the domain of digital printing.

Trapping — an overprint of colors at the edges of the butting color areas to camouflage any slippage.

Trim Marks — indicator for where to trim off the print.

TrueType — (by Apple) NOT cross-platform.

Type 1 (PostScript fonts) — NOT cross-platform.

Varnish — a clear coat that can be applied on the surface to add a shine to the image area.

Vector Image — image created by mathematical equations. The quality of the image does not change when enlarged.

Web printing — also known as rotary printing, has a roll of paper that unwinds and is passed through the press, rewinding or cut into sheets in the end.

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Illustration & Photo References

Figure 1, 2, 4~11, 13, 14, 16, 17, 19

Illustruations created referencing GrC 101 lectures and handouts.

Figure 3

Photo from GrC 316 Lab.

Figure 12

Illustration created referencing GrC 201 lecture.

Figure 15

Photo by Boris Smokrovic from Unsplash.

Figure 18

Photo by Kwang Mathurosemontri from Unsplash.

Figure 20

Photo of Kleenex brand tissue.

Figure 21, 22

Illustrations created referencing GrC 324 lectures and handouts.

Figure 23, 24, 28

Photo from GrC 324 Lab.

Figure 25

Photo of Whittard Chelsea Earl Grey Black Tea container.

Figure 26

Photo of Commerce Printing & Marketing Solutions page from 2020 Visual Media Guide by Visual Media Alliance.

Figure 27

Photo of Lotte Ghana Chocolate and Meiji Black Chocolate.

Figure 29

Photo of hand sanitizer from Bath & Body Works.

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2020 Fall Quarter GrC 316 Lab Members

Sticker Design Featured in Flexography Section

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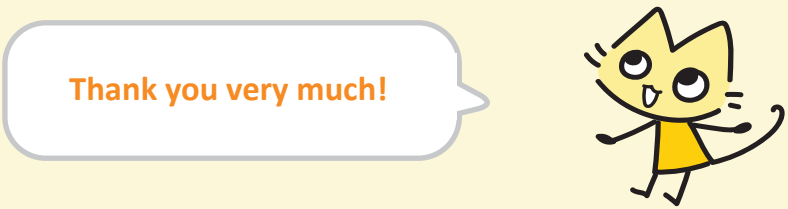
My Family and Friends

The Graphic Communication Department

Robert E. Kennedy Library



About the Author

Yeyoung Kim is a fourth-year Graphic Communication student at California Polytechnic State University, San Luis Obispo concentrating in UX/UI and minoring in Computing for Interactive Arts.

She values creativity and education that inspire, motivate, and empower people to create a better world. In the constant flow of information and communication, Yeyoung pursues to create a compelling design that capture people's attention and is natural and easy to process.