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Erasmus+ Programme
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ICT-TEX

Training module: FINISHING, PRINTNIG and FUNCTIONALIZATION

Course: Basic Principles of Textile Printing

The course is developed under Erasmus+ Program Key Action 2:
Cooperation for innovation and the exchange of good practices Knowledge Alliance

ICT IN TEXTILE AND CLOTHING HIGHER EDUCATION AND BUSINESS

Project Nr. 612248-EPP-1-2019-1-BG-EPPKA2-KA

❑ DESIGN ASPECTS

- When planning to produce, the design and fabric quality must first be selected. The design should suit the end-use of a product. Analog printing technology, whether flatbed screen or rotary printing, places certain restrictions on the design, number of colors and size of the design unit. Therefore, the original design must always be adapted to the technology to be applied. So at the beginning, printing technology must be defined, as the lengthwise repeat is subject to the limitations of the screens or rollers.
- In addition to the lengthwise repeat, the maximum number of colors that can be printed will depend on the chosen technology and the capabilities of the machine. Depending on this, the design is revised and adjusted to the possibilities of realization.
- When the design is definitely adapted to the capabilities of the available technology and machinery, a design unit, ie a repetition unit, is defined. The repetition unit is then arranged in a size corresponding to the screen to be applied to the given machine. The individual design units (repeats) must fit together perfectly in order to avoid the appearance of discontinuities that become visible when long lengths of fabric are inspected.
- Only then, finally, the color separation is approached, ie the pattern is disassembled into individual effects.

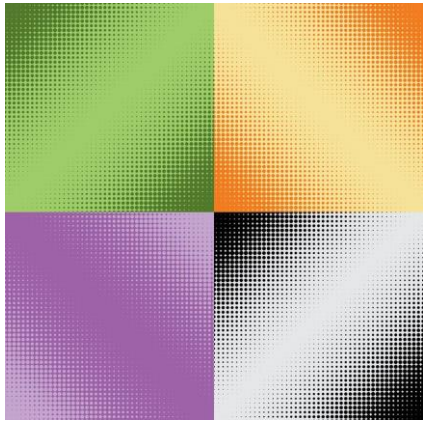
❑ COLOUR (EFFECTS) SEPARATION

❑ Depending on the complexity of the design, we distinguish 4 basic settings of color separation:

- ✓ Preparation of patterns with clearly defined boundaries between individual effects – discontinuous pattern
- ✓ Preparation of patterns with clearly defined boundaries between individual effects – continuous pattern
- ✓ Preparation of patterns with defined color separation but raster effects
- ✓ Preparation of complex patterns with undefined number of colors

❖ Discontinuous pattern (meaning that the one closed composition is repeating unit)

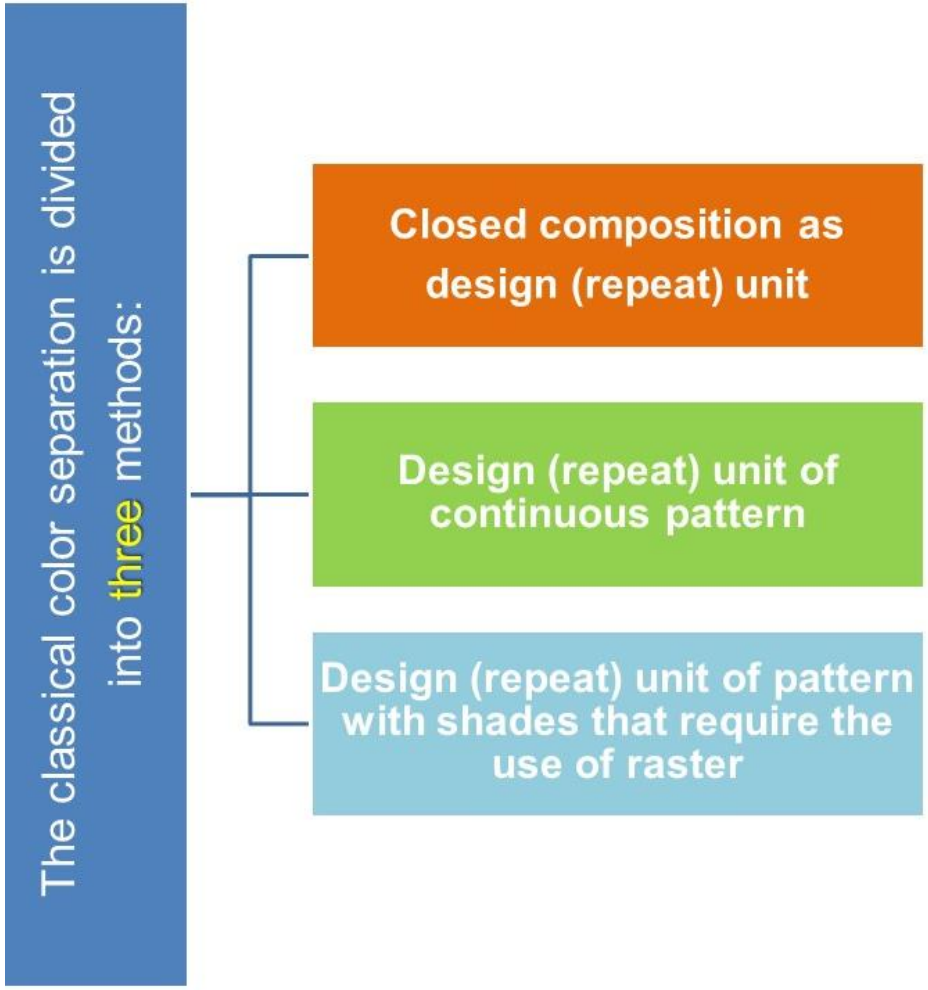
❖ Continuous pattern



❖ Patterns with defined color separation but raster effects

❖ Complex patterns with undefined number of colors

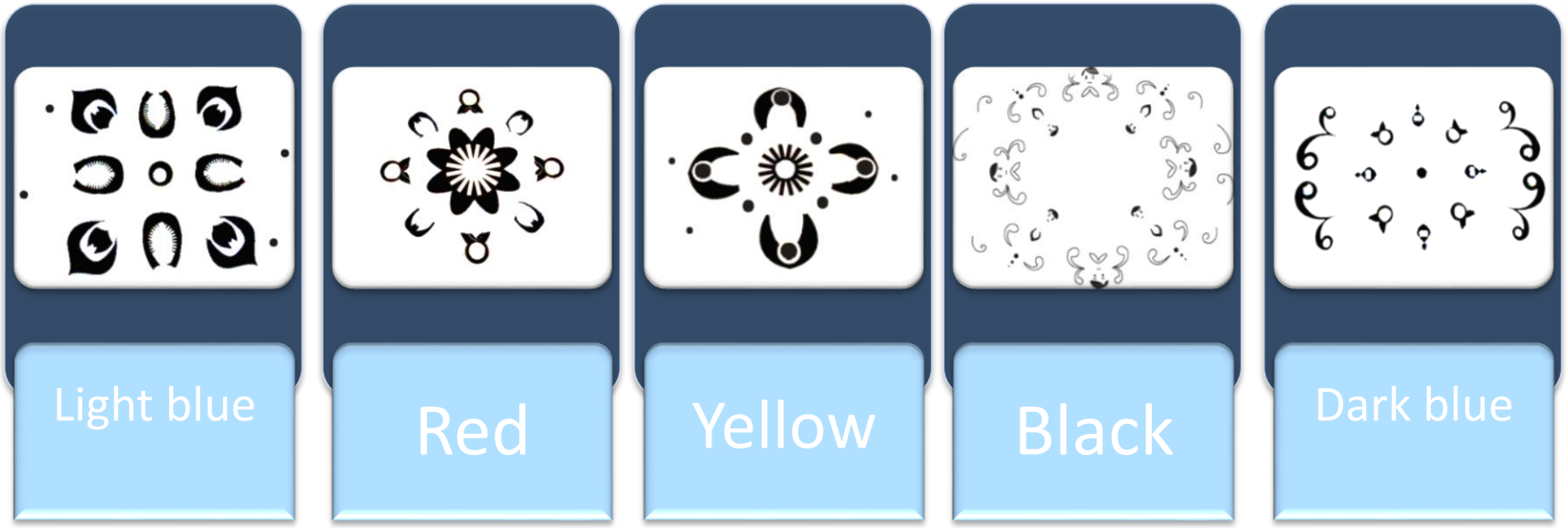
- When preparing a sample for printing, **it is important to follow one rule:**
  - ✓ **As long as we can count and separate the number of colors being present in the pattern, no matter how much these colors overlap or make shady transitions, we always approach the process of classic color separation.** Classic color separation involves the separate separation of each individual color represented in the sample. It can be from 2 colors to 8, 16, 24 or more. The number of colors that can be realized will depend on the capabilities of a given printing machine, but care must be taken to ensure economic viability. Too many colors lead to economic unsustainability because making screens and stencils is time consuming and expensive. Therefore, communication between designers and technologists always revises the look of the design and optimizes the number of colors to achieve a balance between the aesthetic component and the possibilities of the technological process.



1. CLOSED COMPOSITION AS DESIGN (REPEAT) UNIT – CLASSIC Color (effects) separation

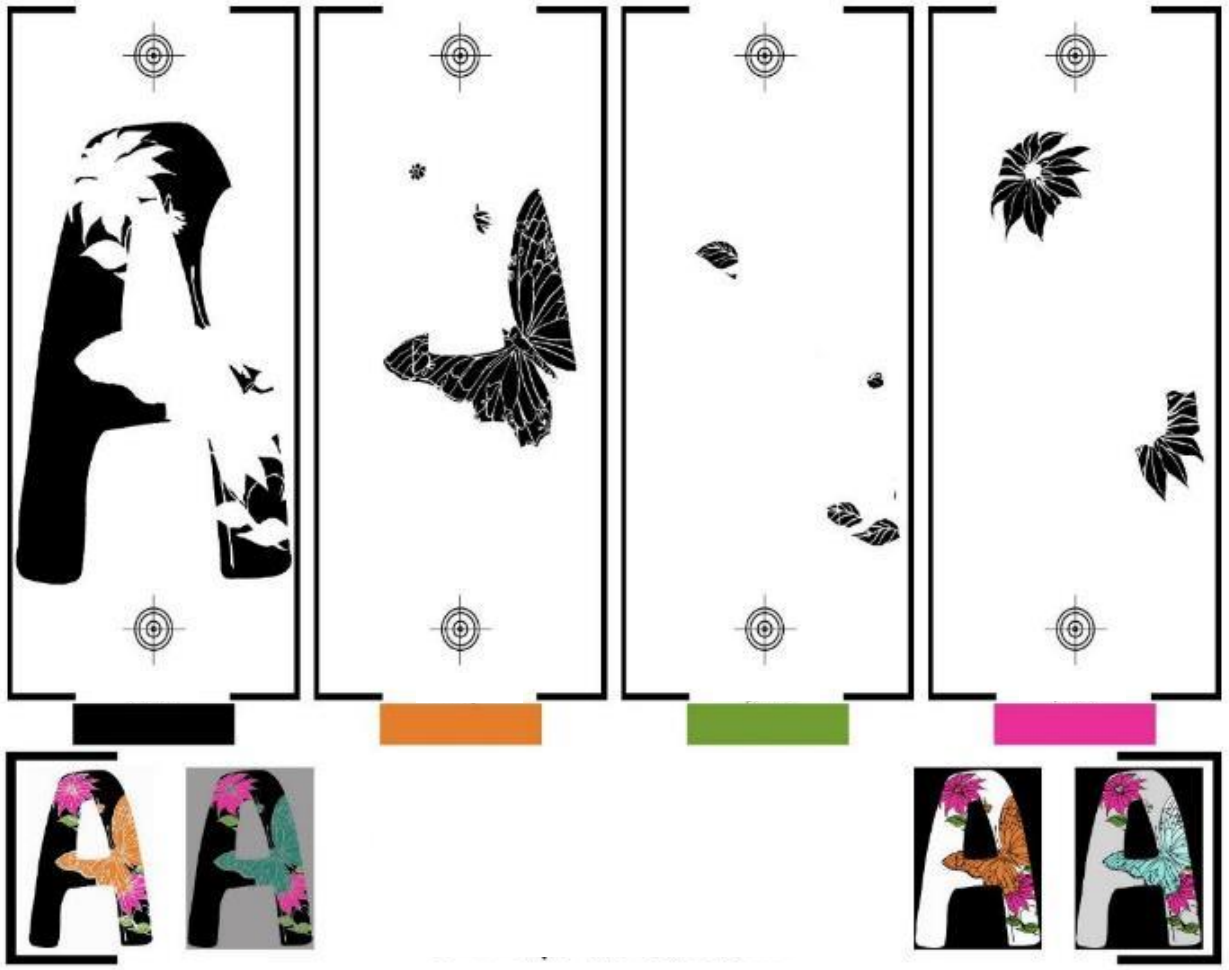
- This is an example of a multicolored, closed composition, which in itself makes the smallest unit of design (repetition).
- ***Repeat unit definition –*** is the smallest unit of a design or pattern that can be continuously repeated in all directions with no appearance of discontinuities or boundaries visible, creating continuous, logic, enclose line of a pattern, adequate to original design.
- Once you have defined what the smallest repetition unit is and which type it is, you single it out as a separate image and define the number of colors represented in the design.

- ***Color separation*** **–** each coloured effect is separated as single image which must be prepared as and opaque, black image on translucent foil.



- We see that 5 different colors are defined in the design. When defining the number of colors, we always pay attention to the effects obtained by overlapping certain colors, we do not consider such parts as a separate effect, but we reproduce them in the printing itself by intentionally overlapping effects. This is possible because printing pastes, regardless of the type of dyestuff or pigments, are always transparent, and their overlap leads to mixing of colors and achieving an additional effect.

- **Overlap of two effects**



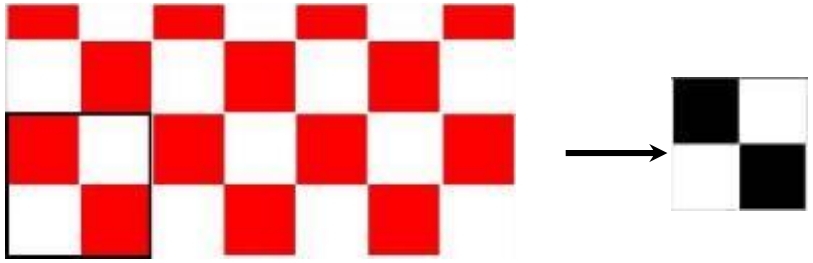
- This is another example of a design that is a stand-alone, closed composition which can be printed on its own, for example on the front of a T-shirt, or can be turned into a continuous pattern by repeating in a certain rhythm.

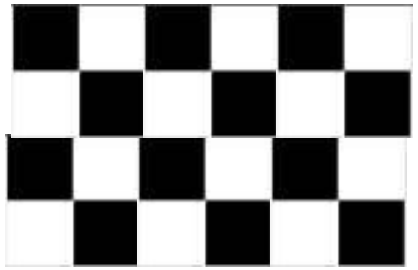
2. CONTINUOUS DESIGN – CLASSIC Color (effects) separation

- In the case of continuous samples, the definition of the smallest unit of design (repeat union) is more complex and requires greater precision, compared to the case described under point 1 (closed composition as a unit of repetition).
- It is necessary to determine the unit of design that can be continuously repeated in all four directions, without visible limits of repetition.
- When the smallest unit is determined in these types of designs, it can be multiplied as many times as the size of the screen we will use allows, but it is important that the boundaries of the repeating unit set are not visible, but that a continuous pattern is formed by repetition.
- Once again, it is important to emphasize that each design must be separated, and the fabric background color cannot be used in exchange for printing an individual element. Printing is always carried out on chemically bleached textile materials, never on colored ones because dyes and pigments, as already mentioned, are transparent and do not have the property of coverage.

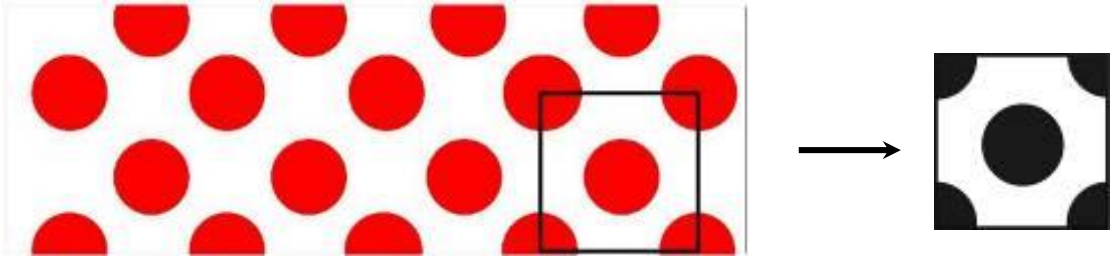
xample for continuous patterns:

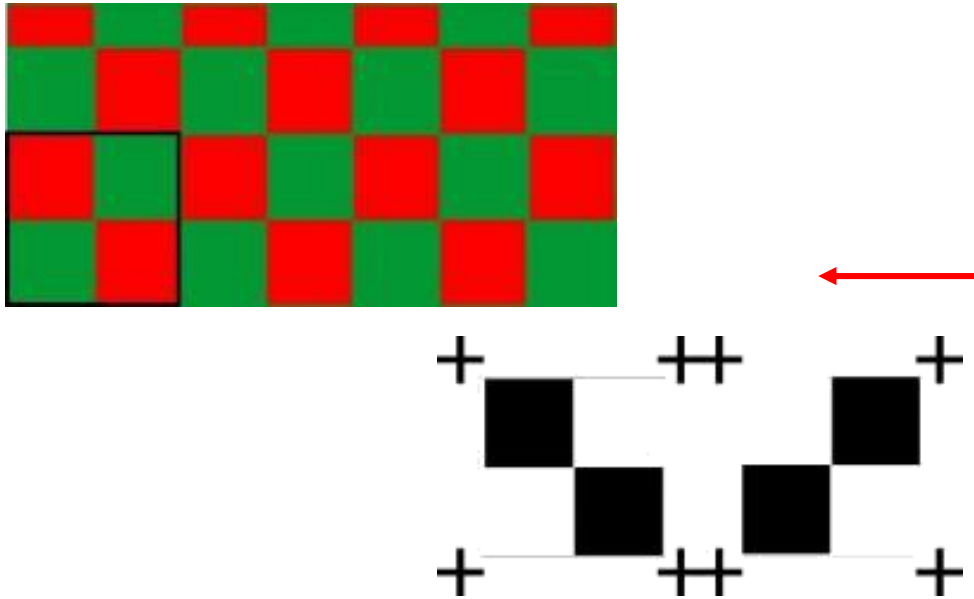
- The principle of separation of the sample into individual effects will be explained on the simplest examples, but it is applicable to all compositions that involve a continuous sample.





- ✓ In the example shown, the red pattern of the squares is printed on a white background. The smallest repetition unit is highlighted in black and white.
- ✓ Now it can be multiplied by forming a repeating block, depending on the size of the screen.

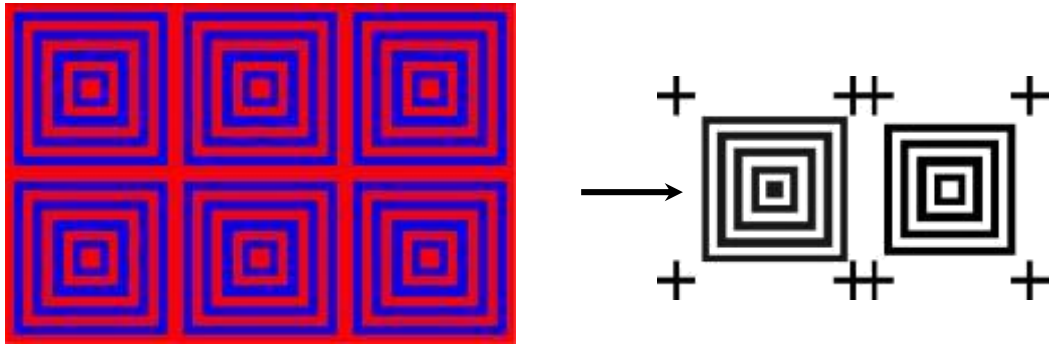




- This pattern consists of two effects - red and green. This example refers to the previously mentioned, the impossibility of printing on colored substrates.
- In the case that this sample would be printed on the principle of green printing on a red background, or vice versa, red printing on a green background, a satisfactory color ratio would not be obtained.

- Due to the transparency of the usual printing paste, there would be a strong interaction between the color of the paste and the color of the substrate and completely lose the intensity and purity of colors (there is a type of cover printing pastes, but they will be discussed in the following chapters. effects, and do not count as conventional printing pastes).

- The same applies to the following example:



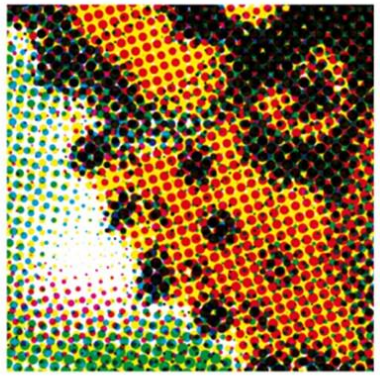
- The crosses marked on the separated effects are the so-called **position crosses**. They indicate the exact position of the screen, in order to accurately position the individual effect during printing.

- **These crosses are only used for hand screen printing**. In any form of machine printing, since the movement of the screen and the textile material are synchronized and automated, it is not necessary to mark the position crosses.

3. COMPLEX DESIGN – FOUR COLOUR separation

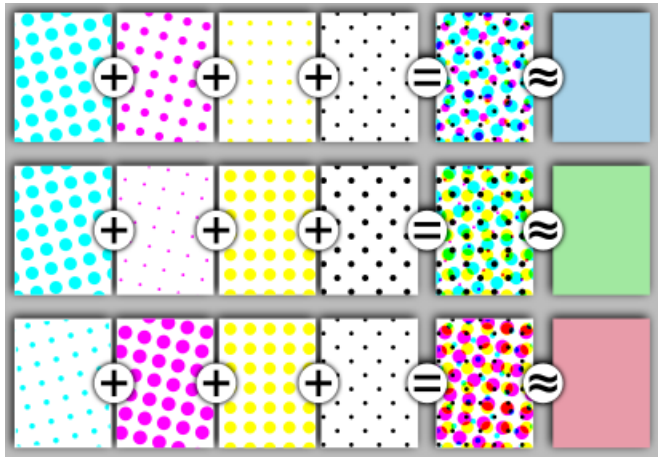
- Four-color separation refers to raster colour separation and printing with four primary process colours - Cyan, Magenta, Yellow and Black, the so-called CMYK printing or ***HALFTONE SCREEN PRINTING***
- Halftone printing technique requires constant number of screens, and is always 4, regardless the number of colours in given image or design. Each colour of the image is produced by mixing of 4 process colours – CMYK.


FINAL CMYK

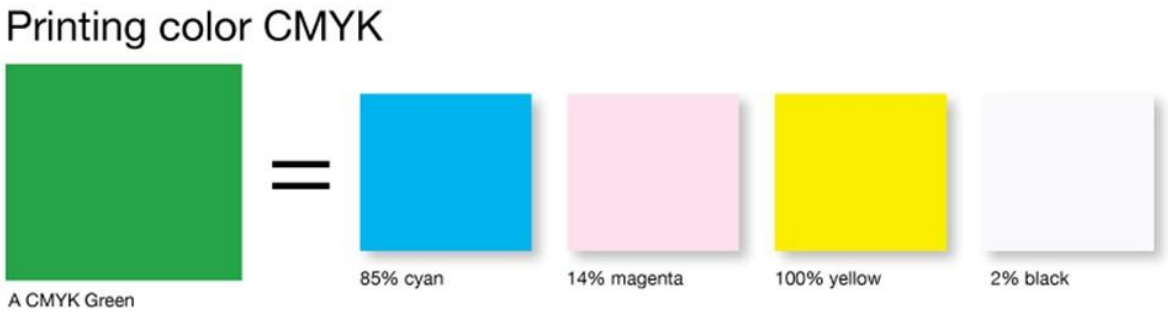

DETAIL VIEW

https://printingsolutions.com/cmyk-printing/

- Image preparation for half tone screen printing is performed by raster colour separation. CAD (Computer Aided Design) software packages (including Adobe Photoshop or similar) are usually used for defining the ratio of cyan, magenta, yellow and black in one given image. Afterwards, the defined ratios are extracted as separate, black and white raster image for each processs colour. Raster assumes dotted structure of different densities, depending on image characteristics.

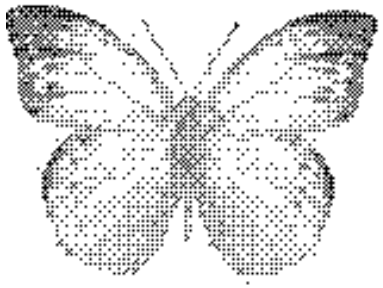


- **For example:** To print the green showed, it needs to broke it down into four different parts



- In this way, each colour and shade represented in the cause will be defined by certain proportions of the primary CMYK process colours. This ratio, which is given in this example for the reproduction of green colour, is defined precisely by the density of the raster and the size of the raster element (usually a dot).

- The motif that belongs to the complex images is shown. This means that the number of colours (effects) cannot be determined nor can the boundaries between the effects be defined. For such motifs, raster colour separation and later four-color printing or the so-called halftone printing is always carried out.



Cyan

Magenta

Yellow

Black

- After the colour separation process and screens preparation, in printing process the mixing of 4 process colours (CMYK) must result in print similar to its original. Raster as preparation for halftone printing are made, exclusively, by computer. The quality of printed image (quality of colour mixing, textile surface coverage by colours and image resolution and sharpness) will depend on raster density and resolution - DPI.

The CMYK *Process*

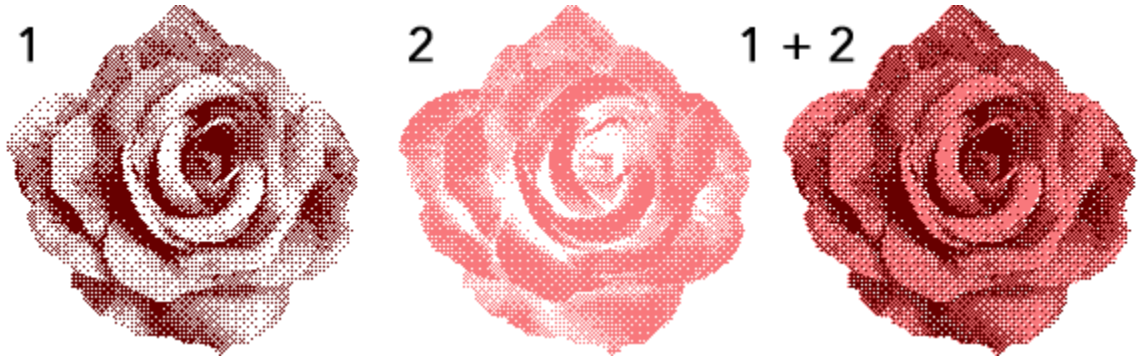
To reproduce full-colour photographic images, typical printing presses use 4 colours of ink. The four inks are placed on the paper in layers of dots that combine to create the illusion of many more colours. CMYK refers to the 4 ink colours used by the printing press:

- C is Cyan
- M is Magenta
- Y is Yellow
- K is a pure Black ink

notice when each colour is combined it produces the final image.

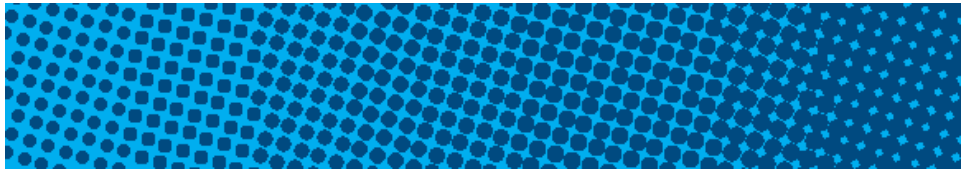
https://www.colourfast.com/resources/artwork/cmyk/

- Rasterization of an multi coloured or one coloured image (converting an vector graphic format into a raster image), is called ***halftone process***, while reproduction of prepared rasterized image by 4 coloured or 1 coloured screen printing technique is called ***halftone printing.***
- **Halftone** simulates continuous shade of colour through the use of dots, varying either in size (amplitude modulation) or in spacing (frequency modulation), thus generating a gradient-like effect of one or full tone range. This effect relies on a basic optical illusion: the tiny halftone dots are blended into smooth tones by the human eye.
- Classic, conventional colour separation and screen printing technique, are suitable for achieving the full colour coverage of and surface, in strictly defined pattern and boundaries, without fine gradients and shades. In cases of complex images consisting of numerous colour gradients, the effect of tone scales similar to those in digital printing, is only possible by technique of halftone process and printing.



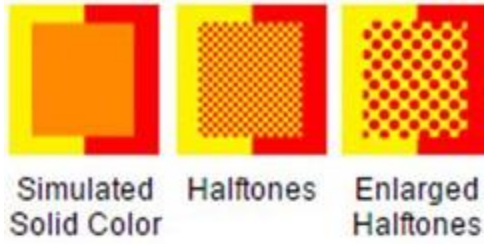
Example of tone scale in digital printing:

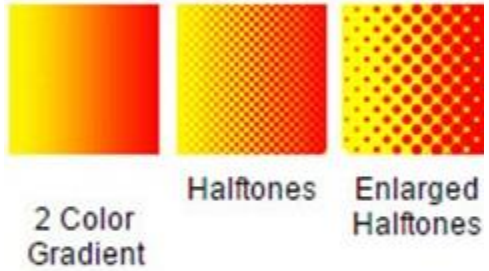
- Digital printing technique allows perfect continuous gradient flow of one colour or gradient merging of two colours.



Example of tone scale in screen half tone printing:

- In conventional, analogue, screen printing techniques, such gradient flows are possible only by half toning and rasterization of an image. The forming of lighter, medium or darker areas (shades) is consisted of multiple dots series.

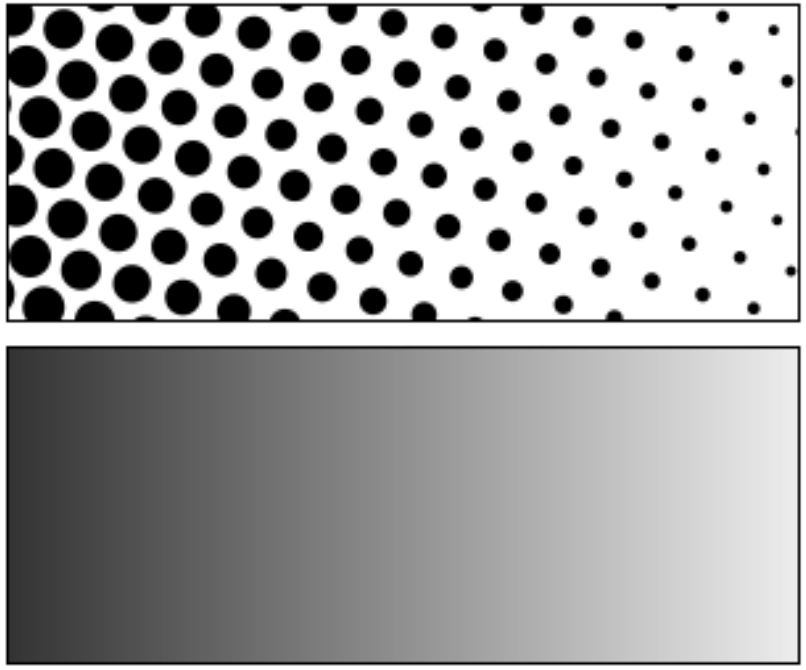


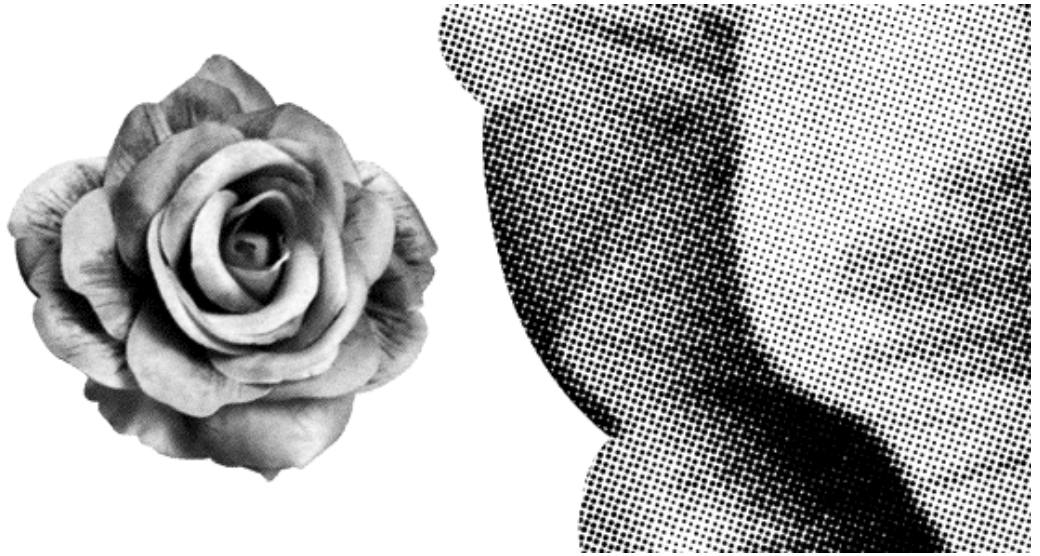


- Resolution of an raster structure is defined as *lines per inch* - ***lpi***. As higher is the resolution of an raster, the greater is the possibility to achieve a finer details of an image. In screen printing, the resolution of an raster mesh be adjust to a fineness of an screen (high fineness of an raster – higher fineness of and screen).

- The effect of gradient flow, achieved by halftone printing, is an optical illusion based on optical resolution of an human eye. The distance is the key parameter, which allows for human eye to perceive the effect as gradient flow from the defined distance. For achieving the „*perfect optical illusion",* the practical distance will depend on final application of an printed material. If the estimated distance of an observer from the image would be 20 – 30 cm (news paper or clothing made from the printed textiles), the image will not require the same resolution for gradient flow effect achieving, as one that will be observed from the larger distance (billboards for example).

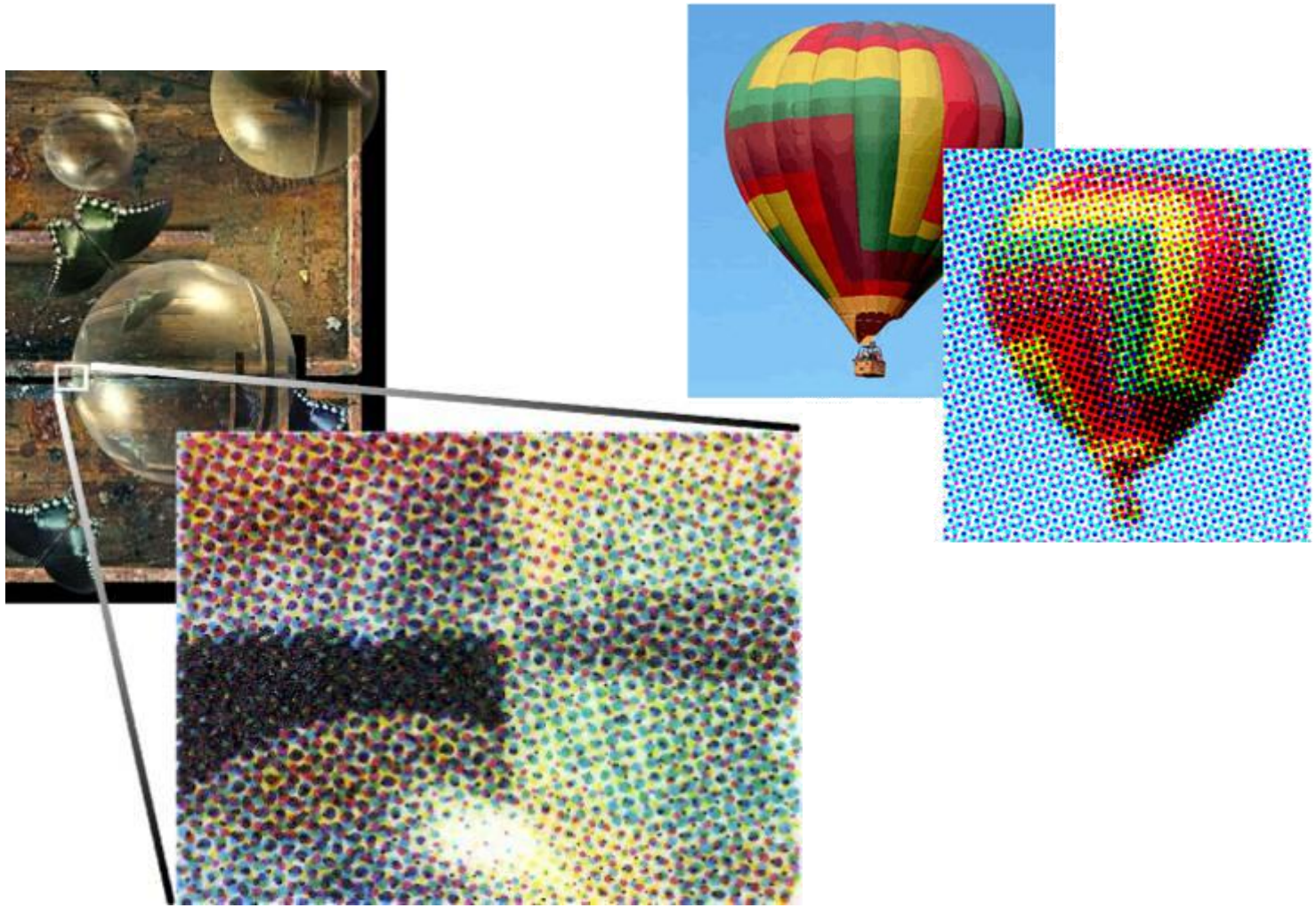
- Recommended resolution for the print that will be observed on the approximate distance of 20 – 30 cm, is 150 lpi (*lines per inch*), due to the characteristic of human eye which does not recognize the rasterized structure on that distance up to resolution of 120 lpi. Large formats of commercials which are usually observed on much higher distance can be formatted in lower resolution.





- Left image is the enlarged image of raster structure, while right image shows how human eye would see that sort of arrangement when it is observed from the certain distance.

- **Left:** rose in half tone flow of gray and black shades
- **Right:** enlarged detail with visible raster structure

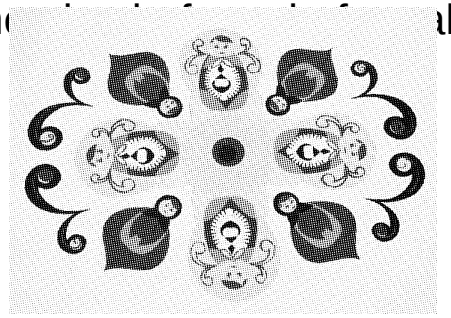


Examples of halftone prints in CMYK technique

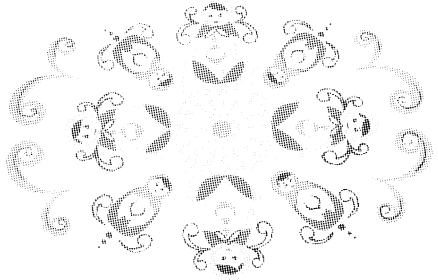
❑ Frequency of halftone printing

Fineness of the screen (***Mesh***) is defined by number of threads on one unit of screen width (***inch***). This number defines also the fineness of raster which will be formed on that screen. The [illegible] screen fineness and optimal raster fineness is: **M / 3.5 = LPI**

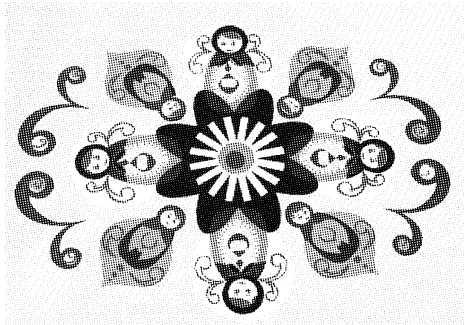
For example, if we have the screen of fineness 220 M and divide that number with 3.5, the result is 63. That is the number that defines the fineness of the raster for that specific fineness of the screen. So the optimal fineness of the raster for that specific screen will be 63 lpi.



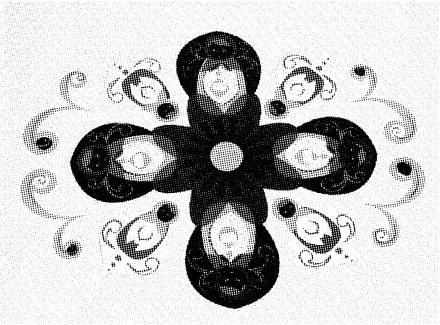
Raster Cyan



Raster Black

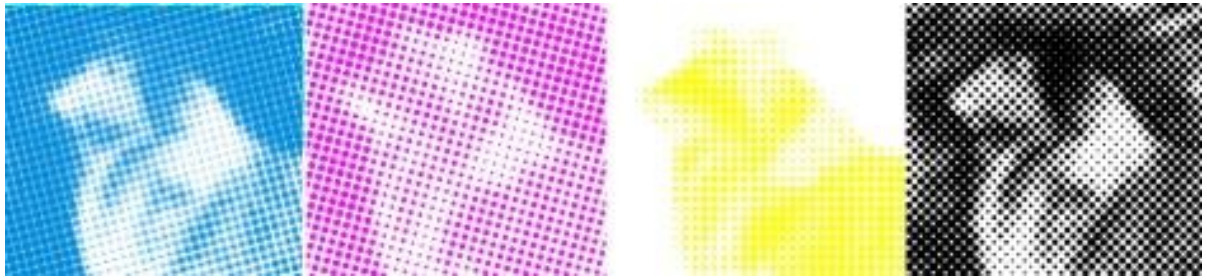


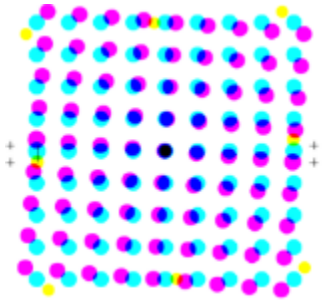
Raster Magenta



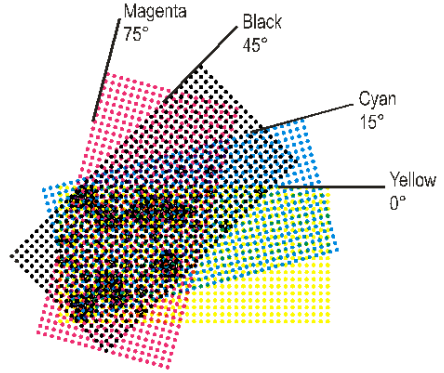
Raster Yellow

- For optimal quality of 4 coloured print (CMYK), during the raster colour separation certain ***angles of*** separation must be respected.



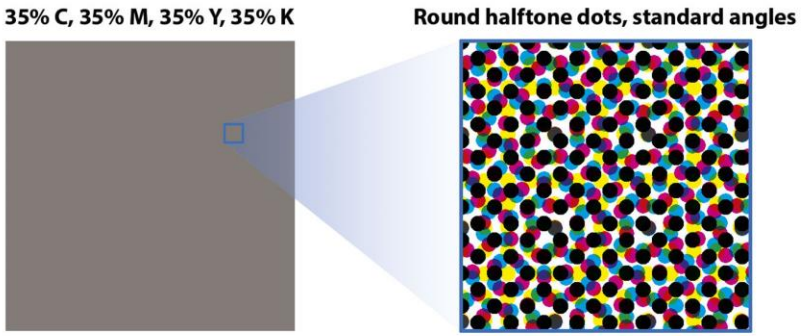


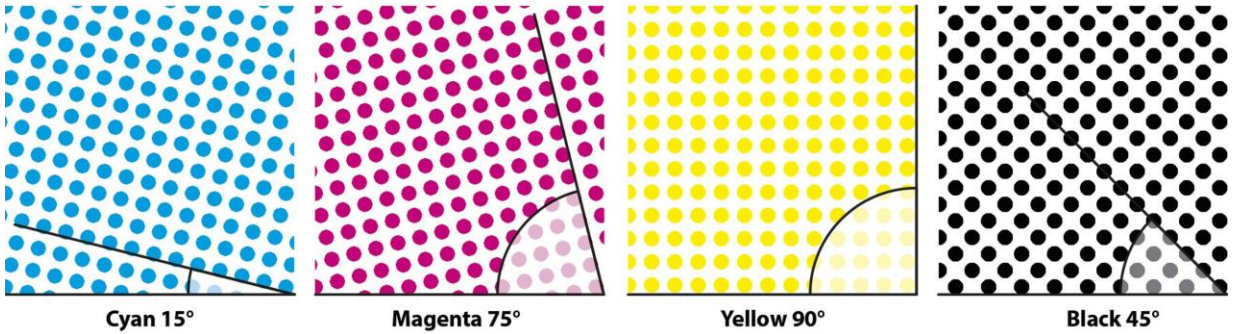
Separation angles, meaning the angle of overlapping the separate raster are defined as recommended values, which can be optimized, in dependence on image and textile surface characteristics.



Recommended angles:

Yellow: 0°
Cyan: 15 °
Magenta: 75°
Black: 45°





- Decades of experimentation with halftone angles, has found that ideally the dot angles should be at least 30° apart. Which is why a CMYK colour is with the angles run at 15° for the Cyan, 45° for the black, and 75° for Magenta.
- The Yellow however, is a problem, because if we add 30° to the Magenta angle we will end up with 105° – which is actually the same angle as the Cyan (remember, because the halftone dots are formed according to a strict grid, after 90° the angles are repeated).

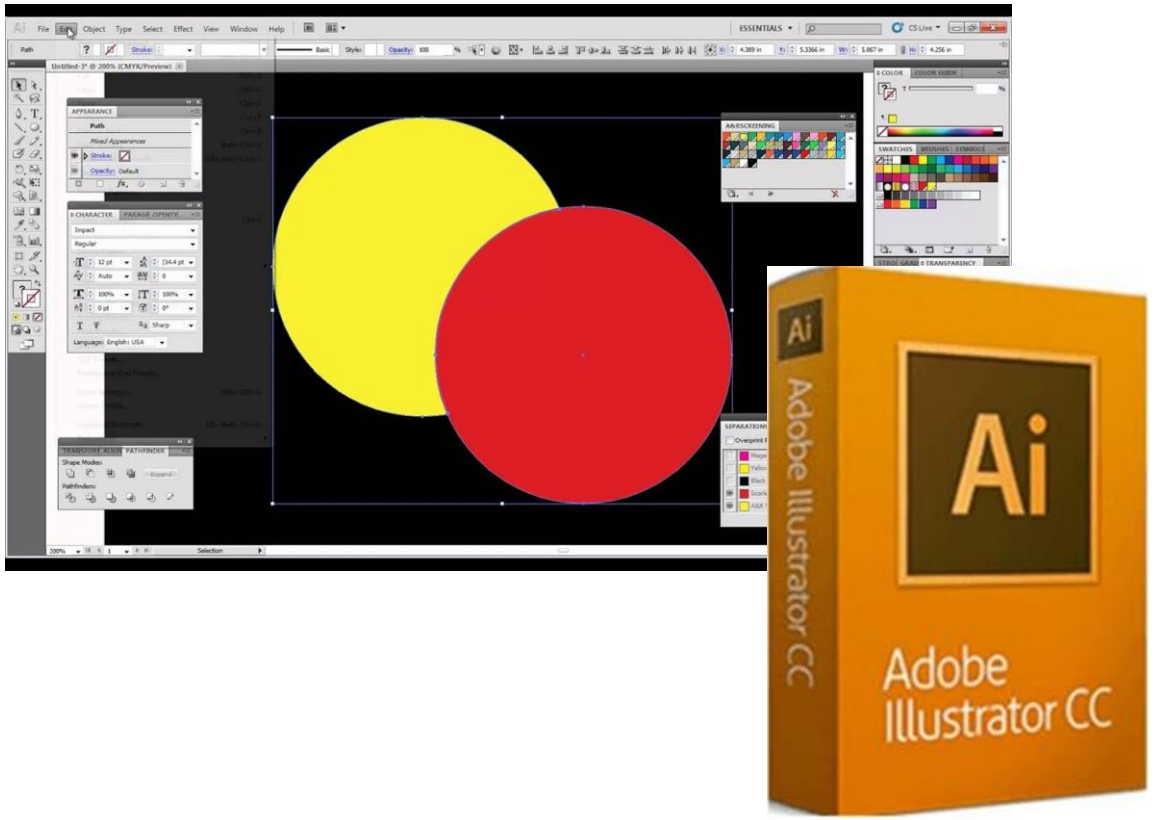
- So a compromise has to be reached, meaning that the Yellow halftone is generated at an angle of 90°, which is 15° away from the Cyan and Magenta halftones.

ICT in DESIGN Preparation for PRINTING

- The entry of information technology into the field of textile printing occurred long before the development of digital printing itself. Precisely in the preparatory phase, the adoption of CAD applications as a tool for design development and preparation of design for printing, marked a revolutionary shift in modernization, cheapening and shortening the entire process.
- Screen printing software helps artists design images and separate colors. Screen printing software offers functions like graphic design and color separation. Dozens of software tools, including Adobe Illustrator and CorelDraw are available today.
- For artist as well as for business owners, the screen printing software is essential. Graphic design software allow building a design from scratch or craft a professional design from provided templates. Color separation tools take that image and break it into individual colors so that can be print one color at a time.

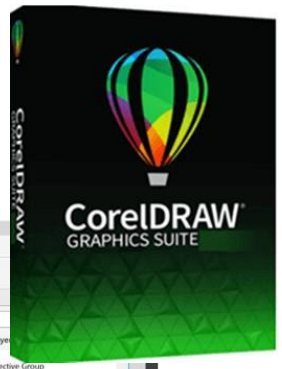
- Adobe Illustrator and CorelDraw are two of the most well-known and commercially widespread software packages used, among other things, in preparation for screen printing.

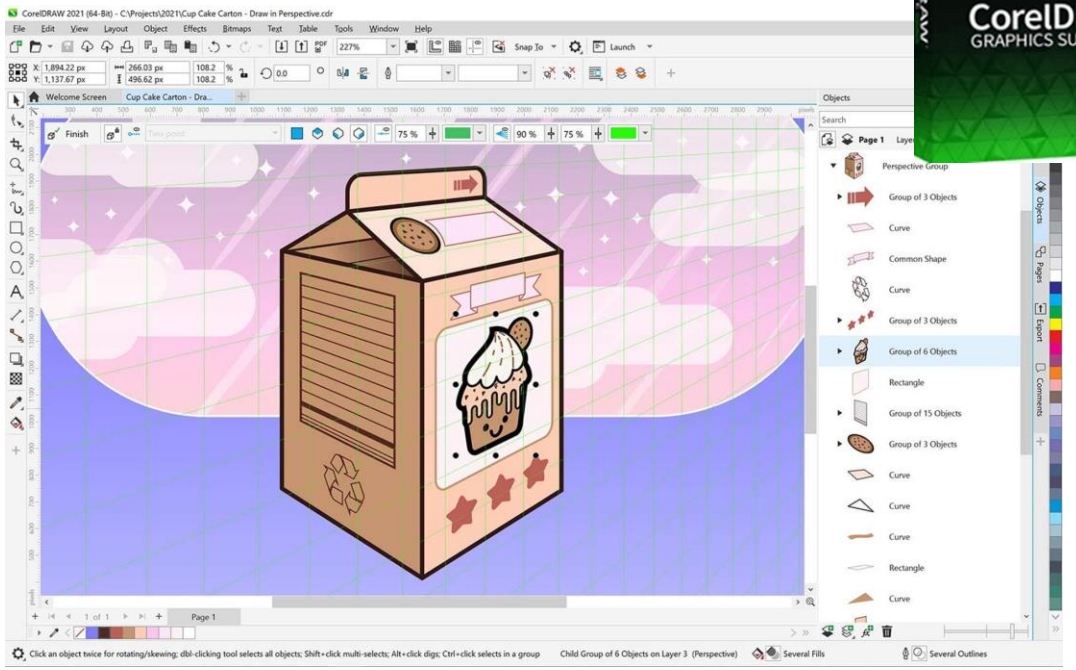
- **Adobe Illustrator** is the industry standard program for creating custom designs for screen printing. Designs made in Adobe Illustrator are scale able vector graphics, meaning the design is able to be resized and maintain crisp edges. There are certain practices inside Adobe Illustrator a screen printer or graphic designer can do in order to keep designs and workflow efficient. Once a design is made it is enabled to print each color in the design as a film positive for screen printing. The film positives will then be exposed onto a screen to make a stencil.



- **CorelDraw** Similar to the programs from the Adobe package, CorelDraw is a vector program that, in addition to design options, image processing and complete color management, enables precise preparation for printing with the options of classic color separation or raster.

- In addition to the above highly professional image manipulation and color management programs, lesser-known tools may be recommended, some of which are very simple web tools.





- **SEPARO** is an online production tool for screen printing that automatize the tasks required for printing an artwork. It detects the best ink colors for printing an image, along with PMS matching. Also, inks can be customized in accordance with stocked ones. Adding, removing or changing the colors as well as immediate print proofs visualization, are enabled. It creates production-ready color separations and upports a wide variety of image formats, including EPS, Adobe Illustrator AI, Adobe Photoshop PSD.

https://separo.io/features

- **Affinity designer** offers both a vector design program and raster image processing technology. This lets illustrators create advanced, complex images that work well either in physical form or on the screen. Features in the software are built for professional use. The program includes the ability to manage large images and control multiple projects at one time, as well as several different color control options.

https://affinity.serif.com/en-us/