Co-funded by the
Erasmus+ Programme
of the European Union

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

Topic 2: MASHINERY, BASICIC TOOLS and CAD/CAM in TEXTILE PRINTING

- Aspects of flat and rotary screen printing, squeegee description and selection, the introduction of CAD/CAM in textile printing.

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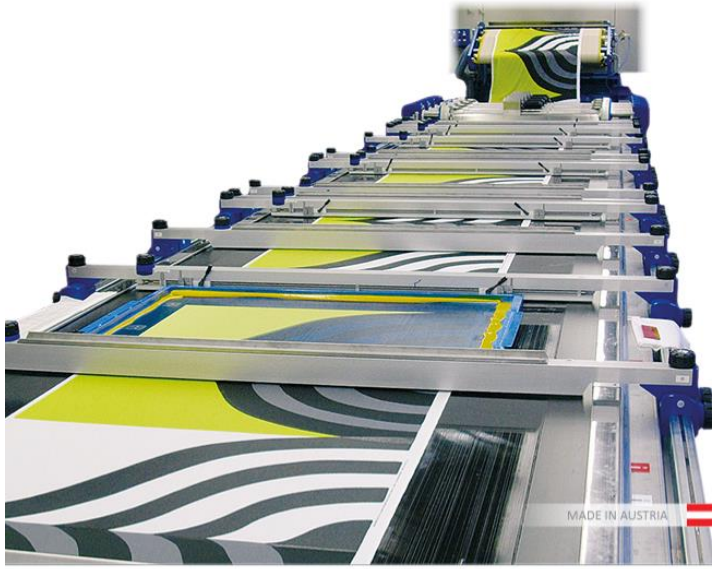
- ✓ Historical overview (from 50-es till up to date development)
- ✓ Industrial settings wit automation, CAD/CAM
- ✓ Computer control settings



❑ BASIC PRINTING TECHNIQUES

Stock printing

Flat screen printing

Rotary printing

Digital (Ink Jet) printing

❑ FLAT SCREEN PRINTING

- The exact origins of the first true screen prints are unknown. Most historians agree that **they came from China** during the **Song Dynasty (960-1279 AD)**, a period of great artistic advancement. Their technique used a finely woven mesh and block stencils to transfer intricate designs onto fabric. Screen printing soon spread to neighboring Asian countries. In Japan, artists wove the mesh out of human hairs and used stiff-bristled brushes to apply paint. Silk mesh later became the fabric of choice, and the technique was named "silkscreen printing."
- The technique of **screen printing came to Europe in the 18th Century** but did not immediately become largely accepted. France, Lyon, began using silk screens to print on to fabric earlier in the 17th Century, although they still used stiff brushes to push it through the mesh. But it eventually led to the practice of stretching silk over a frame to support the stencils. And in the 19th Century when silk mesh was more available to be traded from Asia, it proved to be a profitable outlet for the medium.
- **The first "modern" screen printing system was patented in 1907 by an Englishman named Samuel Simon**. His method used a stencil drawn onto bolting cloth that was then stretched across a wooden frame. While his method became the standard across Europe, the products were still only available to the wealthy.

- The development of screen printing to its modern, highly productive form went parallel with improvements in the screens production. Precise reproduction of the desired design with silk screen requires a stable screen first. At the beginning of development, natural fibers such as cotton or silk, which are characterized by high hydrophilicity, were used to make meshes or screens. This caused significant absorption of water from the water based printing pastes, resulting in stretch and deformation of the pattern, and thus errors in the printing process.
- The introduction of hydrophobic synthetic fibers such as nylon and, especially, polyester, made it possible to produce stable screens that maintained dimension stability and tension while wet. Their high tensile strength allowed the fabric to be stretched more tightly over the screen frame, thus improving the accuracy of the pattern reproduction.
- Further improvement came with the metal screen frames to replace the wooden ones which were also unstable due to a constant change of dry and wet state.

Wooden frame printing screens

Metal frame printing screens with carriage

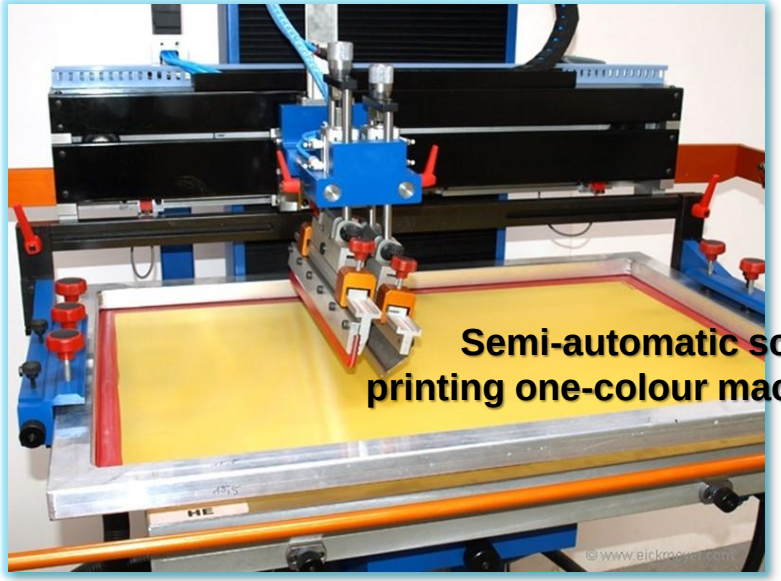
- **Strong, stable screens enabled the hand screen-printing process to e mechanized**. The first development was the introduction of a movable carriage, in which the screens are moved one at the time. The squeegee (a flexible rubber blade used to spread the printing paste across and force it through the open areas) was driven across the screen by a motor attached to a carriage.
- **Full automation of screen printing with flat stencils began in the 1950s**. The companies Buser, Stork and Johannes Zimmer were among the first to produce automated industrial machines for printing with flat screens, on the principle of simultaneous printing of all pattern effects along the endless belt. During the printing, the screens and the belt are stationary, and in the next stage, in order to continue the printing, the screens are lifted while the textile is moved by the endless belt. Thus the fabric is moved in steps according to the needs of the print. This is not continuous printing, real continuous printing was achieved only by rotary screens.

Buser flat screens printing machines

❑ Automation of flat screen printing

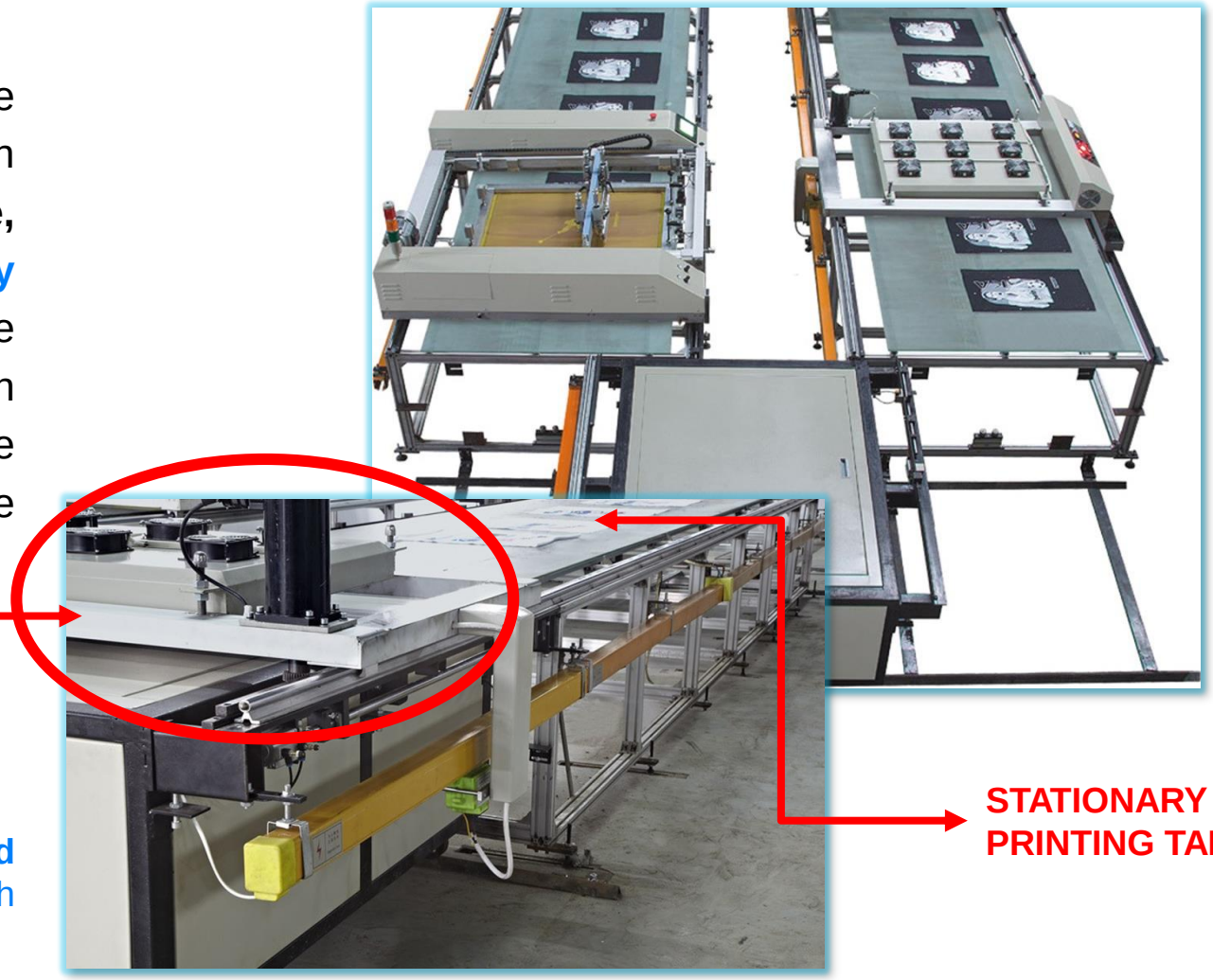
- The manual process of flat-screen printing has been semi-automated by introduction of a screen carriage and driving the squeegee mechanically across the screen. Long tables, mostly 20 till 60m long are used. Semi-automated flat-screen printing is still very popular for lower-scale production and for production of small, individualized series or uniques.
- In both hand and semi-automatic flat-screen printing, the colours are printed one after another, with short time for drying, so the principle is called the *wet-on-dry* printing. With this type of printing, since partial drying occurs between the printing of individual effects of the same pattern, errors can occur, ie the contours of the pattern may be unclear or the individual effect may be displaced outside the given position.

Hand printing equipment with mechanical screen carriage



Semi-automatic screen printing one-colour machine

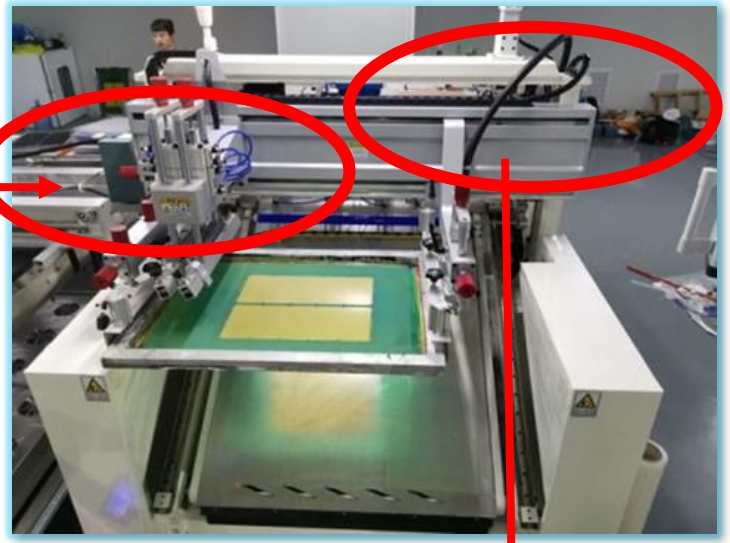
- **One of the most important steps** in the development and automation of industrial screen printing was **the introduction of a movable, endless blanket**, **instead of a stationary printing table**. Here, good adhesion of the textile material to the movable blanket is necessary, in order to prevent premature separation of the textile from the blanket, which would cause errors in the quality of pattern reproduction.



- **Examples** of **automatized** and **computerized flatbed screen printing machine** with **STATIONARY PRINTING TABLE.**

- Automated machines for flat-screen printing, for one colour printing with ***stationary printing table*** (*printing with one stencil at the time*).

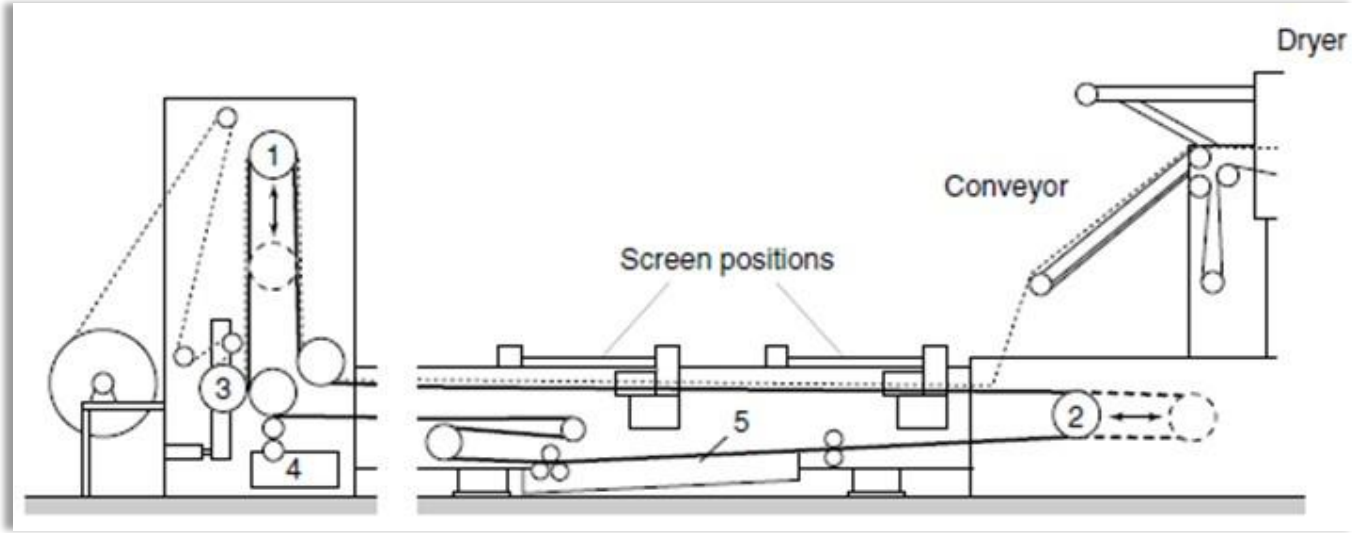
Squeegee holder



Computer-controlled motor for automatic squeegee starting

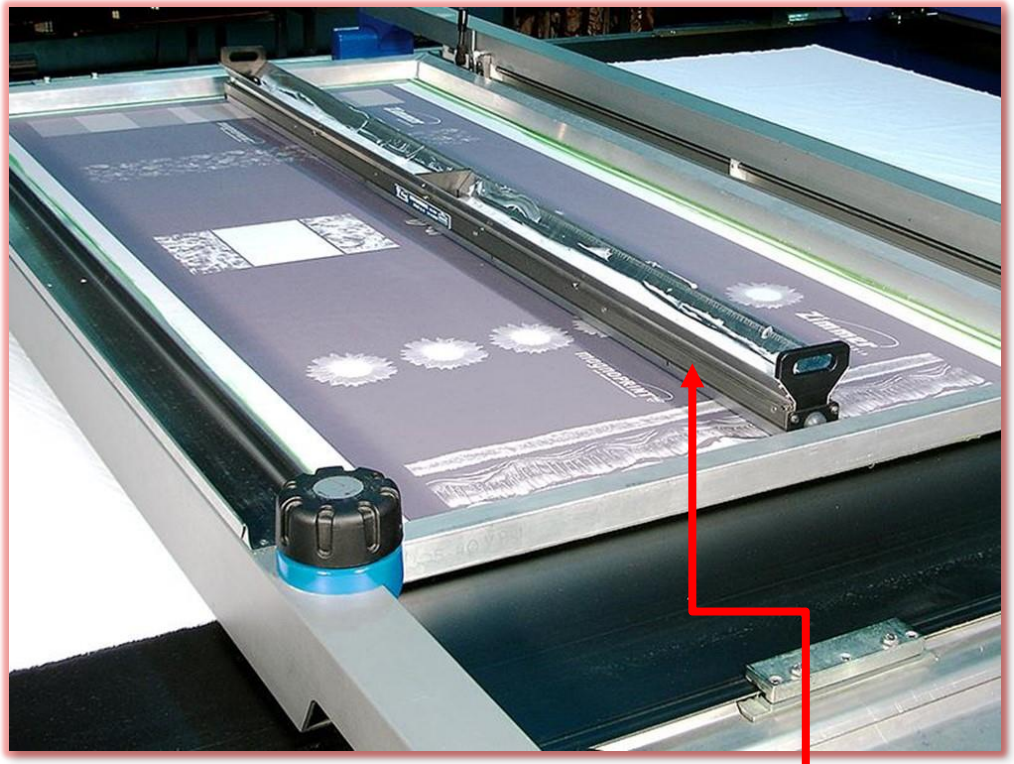
Pneumatic system for raising and lowering the screen

- The scheme shows the basic settings of an automated flat-screen machine with **movable, endless blanket**. All the screens needed to make the design are placed exactly along the top of the long endless belt. The fabric is fixed at the starting point of the belt with adhesives and moves along the belt in an intermittent mode, one screen-repeat distance at the time. All design colours are printed simultaneously while the fabric is stationary. Then the screens are lifted and the fabric and belt are moved. When the printed fabric reaches the turning point of the belt, it peels off and passes further into the dryer. When returning to the underside of the machine, the belt is washed and dried.

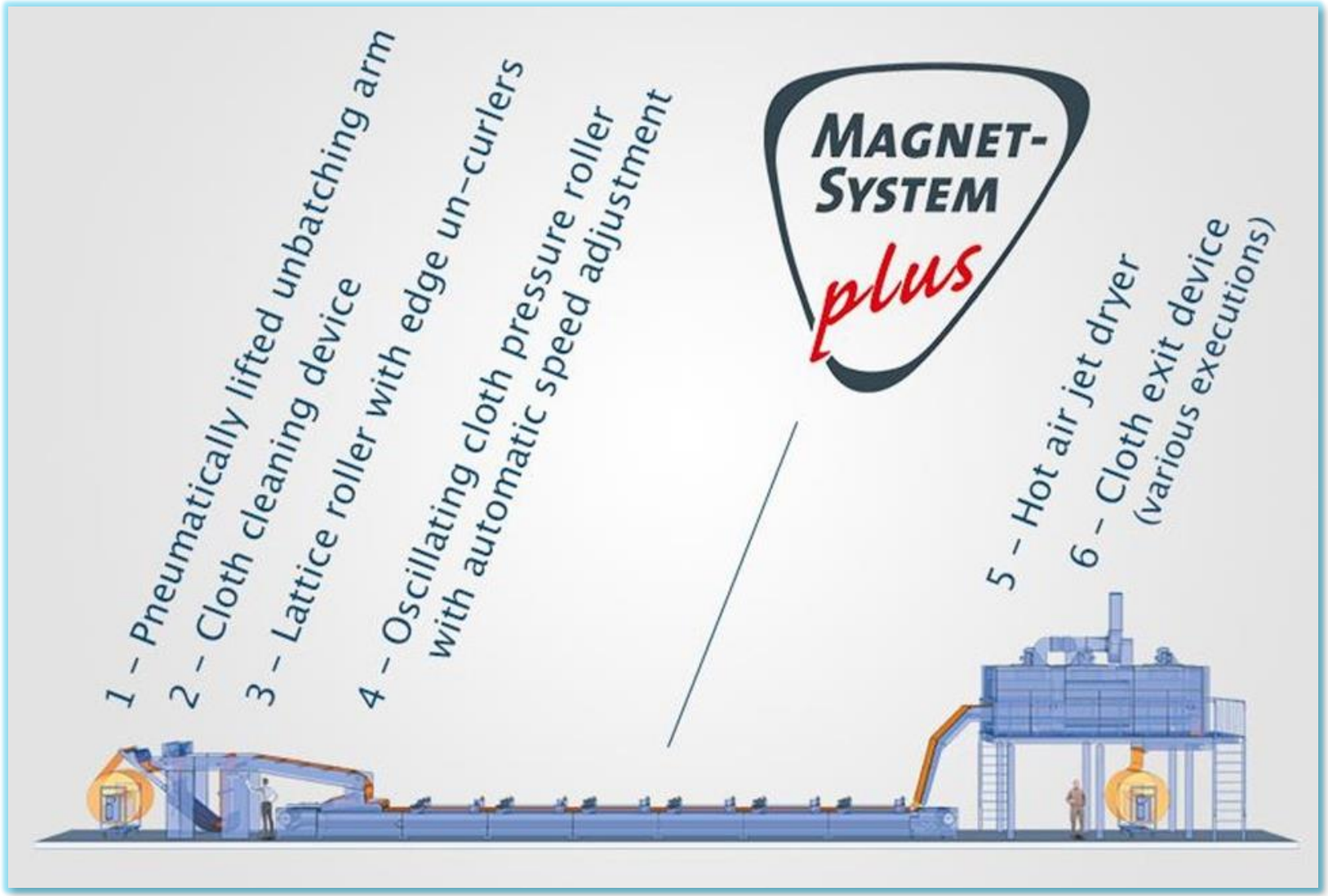


- 1-2 rollers that maintain the belt in constant movement
- 3 – pressure rollers
- 4 – adhesive applicator
- 5 – belt washer

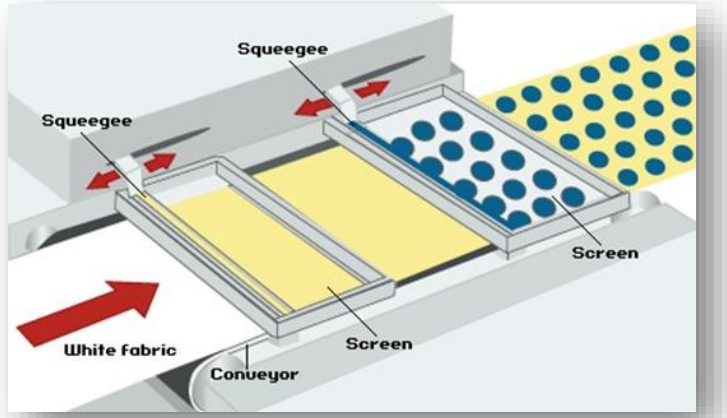
https://www.zimmer-klagenfurt.com/en/content/magnoprint



- Movable, endless belt that moves the fabric with the appropriate shift, while the screens holders are stationary and only lift up and down, depending on the needs of the print.
- Screens holders
- Magnetic squeegee system

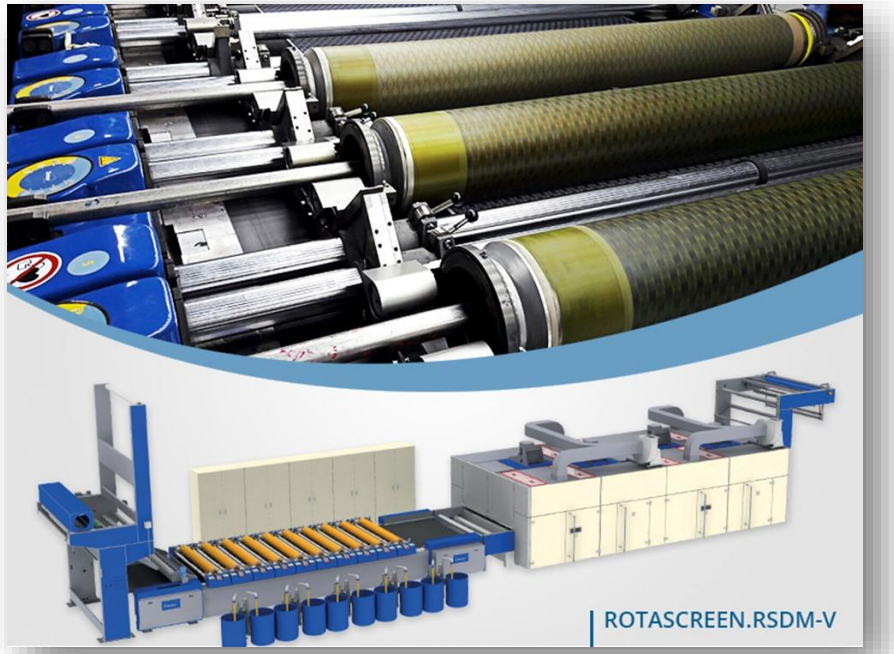


- Schematic representation of a flat-bed screen printing machine



❑ ROTARY SCREEN PRINTING

- Fully automatic flat-screen machines cannot be described as operating continuously, because their printing action is intermittent. Continuous movement of the fabric has been achieved by moving the screens along with the fabric during printing, which was achieved by use of rotary-screens machines. In rotary-screen printing, continuous rotation of a cylindrical screens while in contact with the fabric ensure continuous printing.
- The printing paste is fed inside a cylindrical screen and during printing, due to rotation, it is pressed through the permeable parts of the screen, using a stationary squeegee.



https://www.zimmer-klagenfurt.com/en/content/rotaryscreen-printing

❑ Short history of development

- As early as the early 20th century, rotary printing was carried out with engraved metal rollers. Ever since Thomas Bell patented the rotary printing press in 1793, it can be said that continuous printing has been established. But in the first half of the 20th century, due to the complexity of changing the pattern for printing and the superior economic viability of flat screens, flat-screen printing was widely accepted in Europe and the United States.
- What encouraged investment in the development of rotary printing was the inability to establish fully continuous flat screen printing. U.S. patents, issued as early as 1899, proposed a continuous movement of goods through or under a rotating screen. Others around the world, also, investigated the possibilities, but rotary screen machines were not commercialized until Jaime de Barros, a Portuguese printer and inventor, introduced the Aljaba, a rotary screen machine based on his 1954 British patent.
- During the second half of the 1950s and the first half of the 1960s, the development and production of commercially available industrial rotary printing machines began. During this period, companies Zimmer (Germany) and Stork (Netherlands) began to produce rotary printing machines almost simultaneously, with a difference in the production of rotary screens.

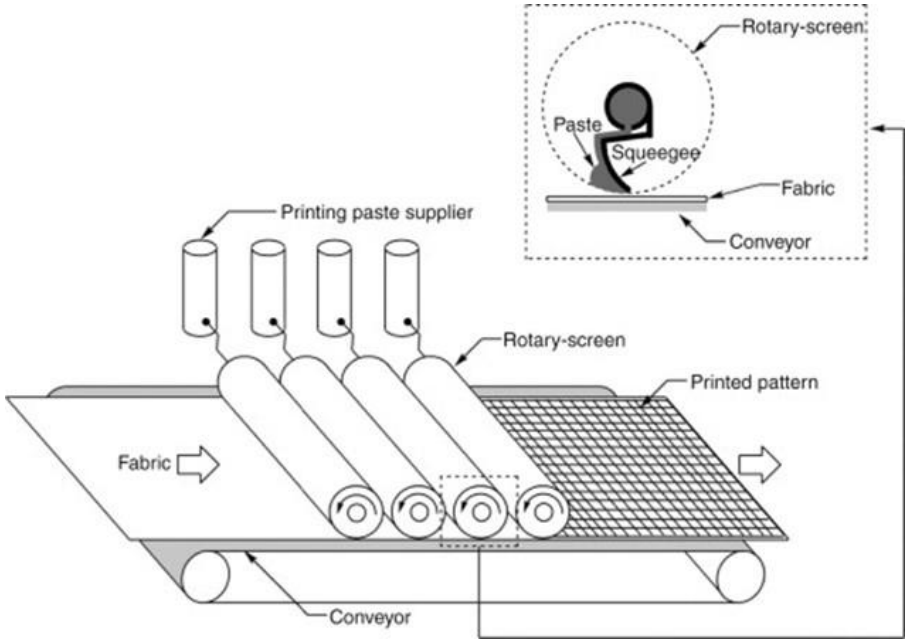
- In 1959, *Zimmer* designed and commercialized a machine that could print six colors continuously using rotating stencils. The machine used the *galvano* screens (the type of rotary nickel screens manufactured by Robert Zimmer).

- In 1963, the lacquer screens were introduced by Stork (the types of rotary screens made from thin, fine nickel mesh produced by the process of electroforming, and which are in later stage of the process, coated with a photoresist lacquer and the pattern is produced by standard photoresist techniques. Alternatively, the patterns can be produced by a computer controlled laser engraving technique.

https://www.spgprints.com/spgprints-group/history

✓ „Stork" presenting the new rotary screen printing machine RD 1, together with the world's first seamless screen, on ITMA exhibition in 1963. For the first time, high-speed printing of popular textile designs was made possible. These innovations would greatly influence the development of both the company and printing as a whole.

- The basic settings of the machine follow the already established design of automated flat-bed machines: endless blanket (belt belt), rotary screens position along the top of the belt, belt washing and drying unit located at the bottom at the return pathway of the belt.



From the book: Process Control in Textile Manufacturing
Editors: Abhijit Majumdar; Apurba Das; R. Alagirusamy; V.K. Kothari

Woodhead Publishingg, 2013. ISBN 978-0-85709-027-0

The basic setting of the machine

https://www.achievementlearn.com/rotary-screen-making-procedure/

- ✓ Flexible tube system for delivering and dosing printing paste into a rotary screen: then operation of pouring printing paste into cylindrical screen is fully automated. Printing paste is pumped into the screen through flexible tubes and pipes, from the container at the side of the machine.

❑ BASIC TOOLS in TEXTILE PRINTING

- ✓ ***Printing table*** must be formed as firm trail that can be static or movable. Mostly those are the rubber blankets. It must firmly hold the textile material in fixed position, must be washable, it must not absorb water or printing paste and must be stable during maintenance. To prevent the undesirable movement of textile, the printing table plate is usually sprayed with specific adhesives that are easily washable and which holds the textile material with weak but sufficient forces, in uniform, fixed position.

https://www.indiamart.com/proddetail/screen-printing-table-22413879255.html

a)

https://www.indiamart.com/proddetail/glass-top-screen-printing-table-21365142712.html

b)

✓ *Stationary printing tables for hand (a) and semi-automatic flat screen printing*

https://www.indiamart.com/proddetail/printing-rubber-blanket-8766691612.html

https://www.indiamart.com/proddetail/ag-derco-textile-printing-blanket-8961836312.html

✓ Textile Printing Rubber Blanket For Flat-bed Printing Machine (a) and rotary printing machine (b)

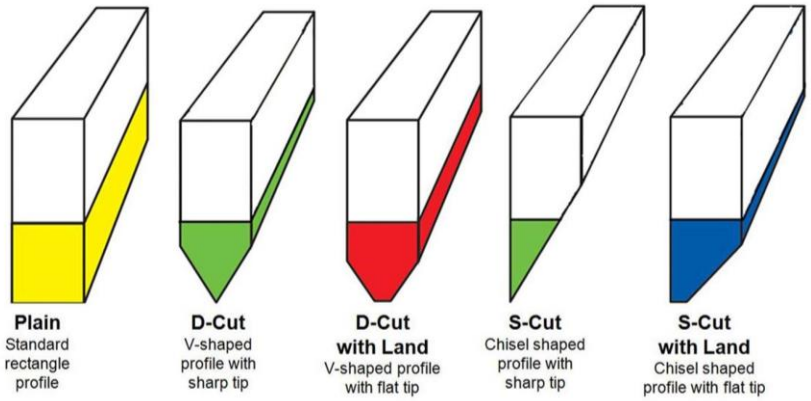
- ✓ **Squeegee (blade)** is moved across the screen and pushes the printing ink through the mesh of a screen onto a fabric surface. **Classic squeegee** that is used also in hand screen printing is a rubber blade, contained in a wooden or metal support (handle). It must be drown steadily across the screen at a constant angle and pressure.
- ✓ Pressure of blade and its size (sharpness and thickness) will depend on characteristics (fineness) of pattern.

❑ Classic rubber blade (squeegee) with wooden or metallic holder

https://blog.mclogan.com/choosing-a-squeegee/

https://www.macrokun.com/product/screen-printing-squeegee-handles/1090.html

✓ Squeegee blades come in different shapes and it is very important to choose the right shape to get the best result:

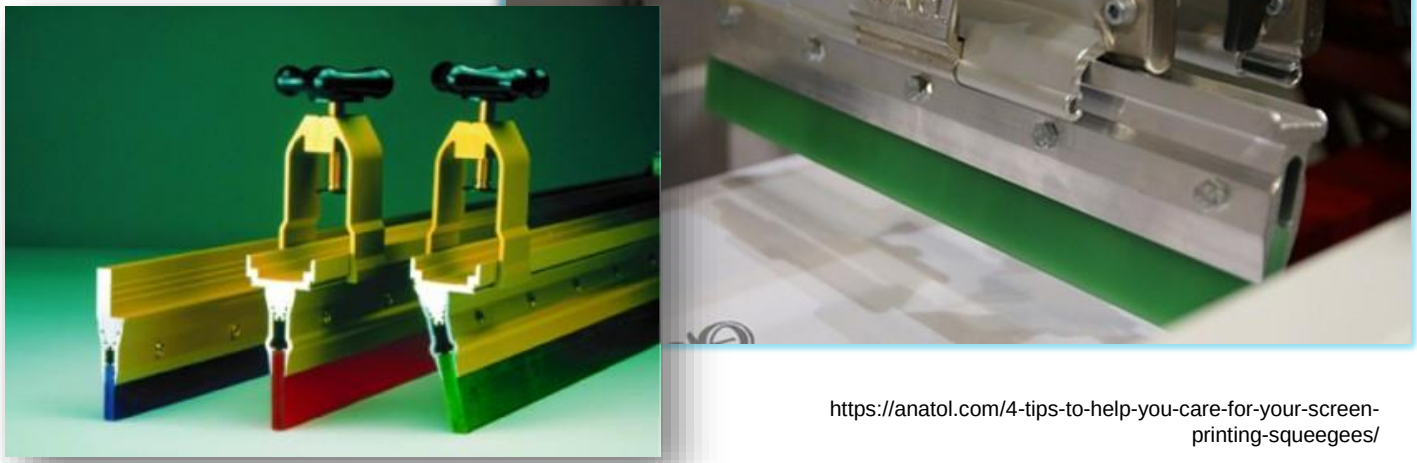


https://www.macrokun.com/templets/macrokun/static/picture/screen-printing-squeegee2-1200x800.jpg

- *V-Shaped*: This shape is used for printing on uneven or cylindrical-shaped substrates
- *Square*: The most often used by screen printers is square-edge squeegee blade. It works well for standard or regular ink applications
- *Round*: The round blade is used for a heavy deposit when printing special-effects inks. The round shape of the blade passes more ink through the screen and is often used for printing gel or puff inks.

- ✓ **Double-blade** squeegee, is a pair of parallel rubber-blade squeegees, driven across the screen with the print paste in the gap between them. Only the rare squeegee is makes contact with the screen, the leading squeegee being raised slightly above it. Within the next pass, the leading squeegee from the previous pass becomes the rare one, for the reverse direction.

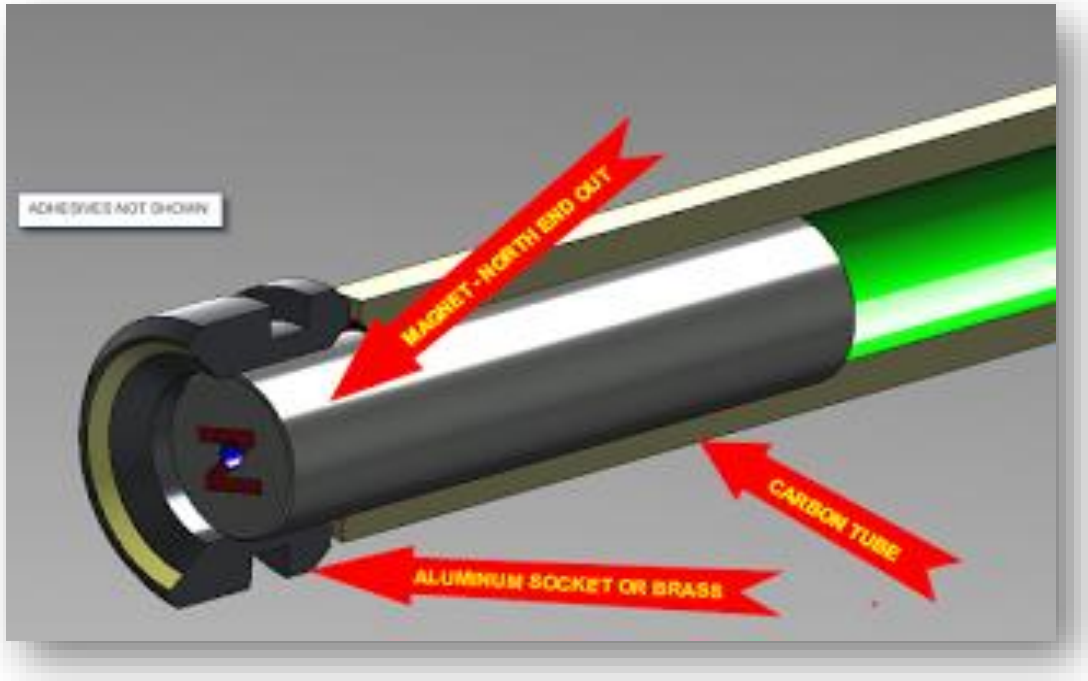
https://screenprintworld.co.uk/double-blade-squeegee

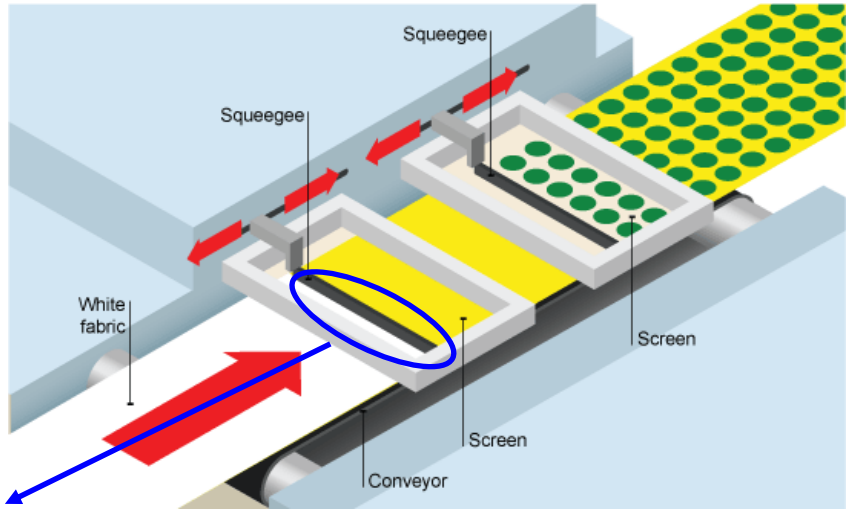


https://anatol.com/4-tips-to-help-you-care-for-your-screen-printing-squeegees/

- ✓ An industrial squeegee with a metal holder adapted to the carrier on a printing machine, and an example of a squeegee mounted for a carrier and an automatic guide on a printing machine.

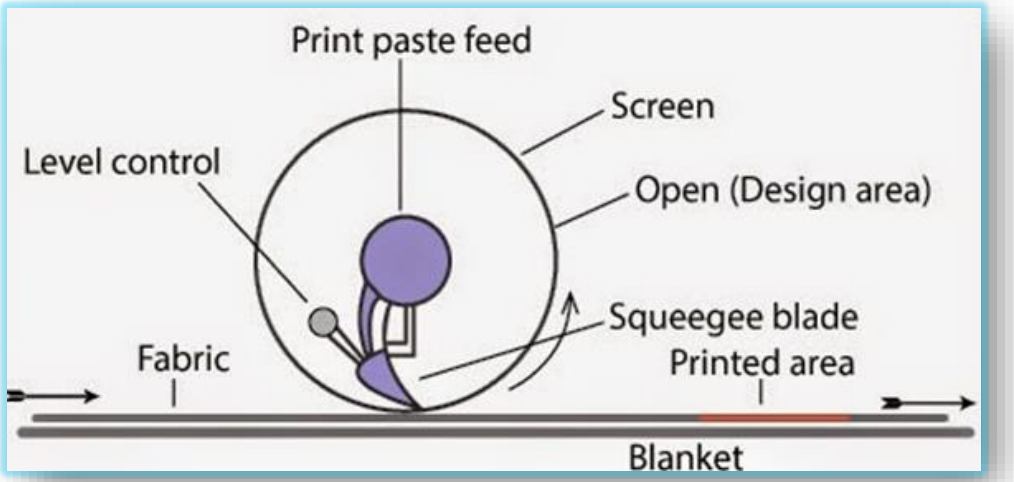
- ✓ ***Magnetic-rod squeegee***, invented by Zimmer, is a rolling-rod squeegee moved by an electromagnet, driven intermittently under the blanket. It is applicable in both, flat and rotary screen printing, except that the electromagnet is stationary in the latter case. In fully automatic flat-screen machines the rod rolls in the lengthwise direction and one passage is usually all that is required for adequate cover and uniformity.

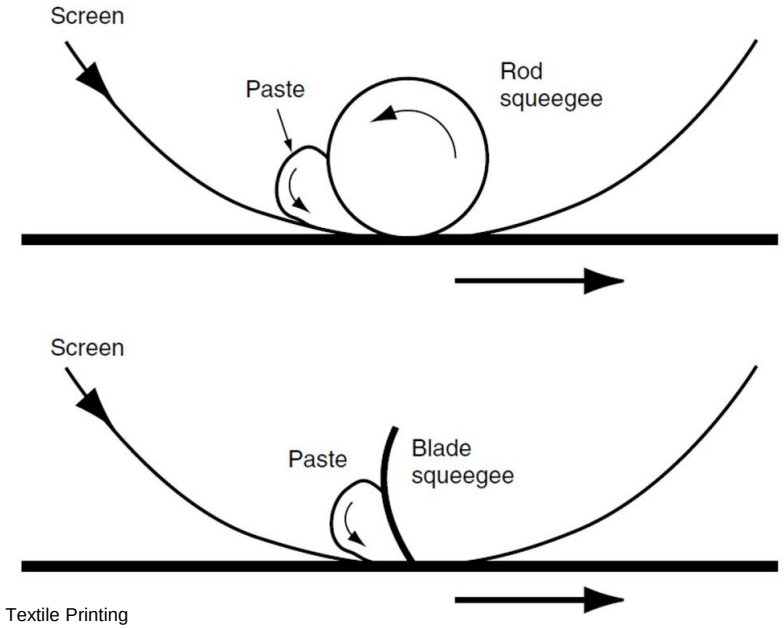




Magnetic blade

- In rotary screen printing, the first type of squeegee that was used firstly by Stork company, was traditional rubber type, which was, in time, replaced with flexible, stainless steel squeegee. The reason was the excessive wear of the rubber due to the continuous movement.

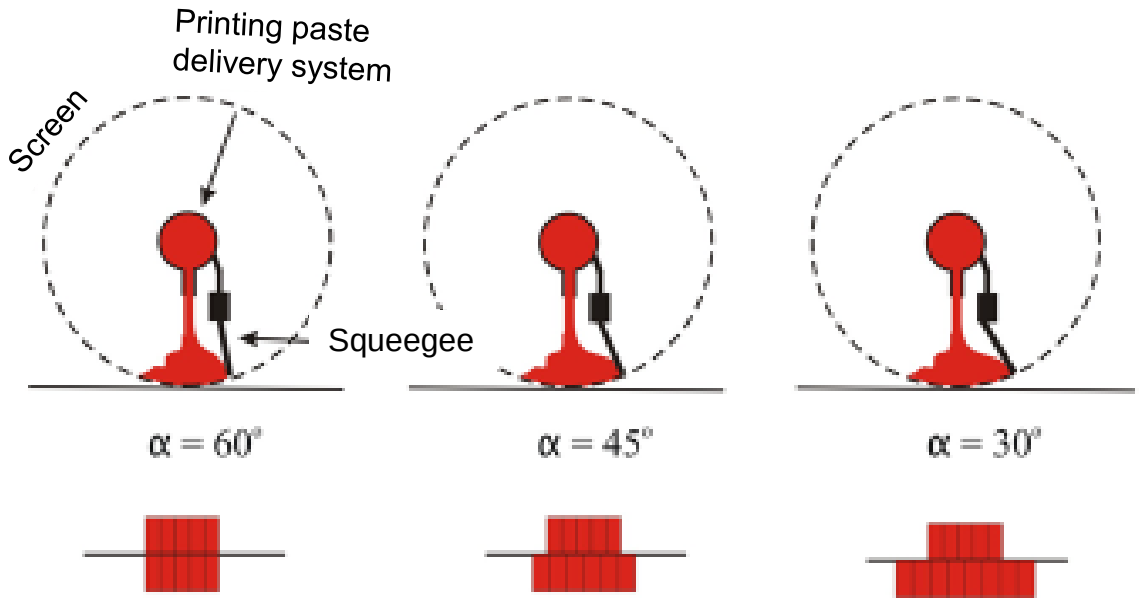




From the book: Textile Printing
Editor: Leslie W. C. Miles
 ISBN 0 901956 79 1

- On machines with flexible-blade squeegee, one boundary of the pressure wedge between the squeegee and the screen is fixed. When magnetic-rod squeegee is used, than both boundaries are moved (on figure).

- ✓ Although magnetic-rod squeegees are widely used in rotary screen printing, sometimes, when the high magnetic-field is set or when large rods are used, due to the distortion of screen that happens in such settings, the contact area of rod and screen increase and the amount of paste being forced through the screen also increase. That is why, when, for example the light weighted fabrics are printed, such as synthetic, a metal blade is preferred.

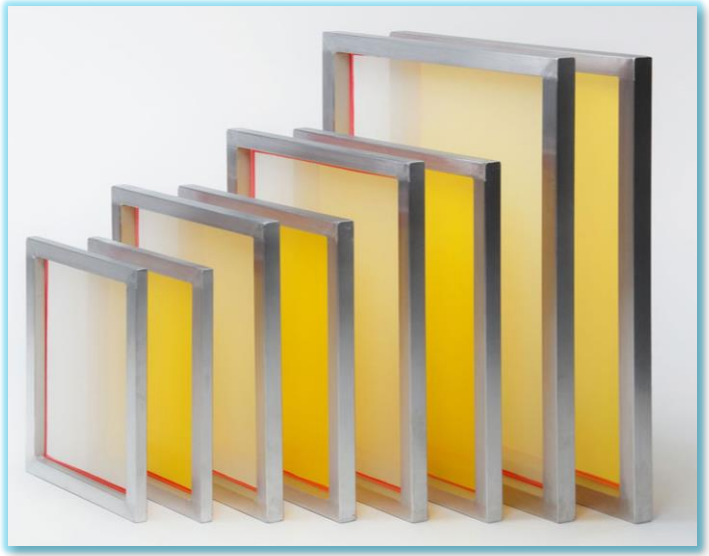


- ✓ The amount of printed paste will depend on the angle of inclination of the squeegee and the strength of the pressure of the squeegee on the screen.
- ✓ The figure shows the dependence of the amount of printed paste on the substrate, depending on the angle of inclination of the squeegee.

SCREENS

- A ***screen*** is a piece of mesh stretched over a frame. The mesh could be made of a synthetic polymer, such as PA or PES. Mesh must be mounted on a frame and it must be under tension. The frame which holds the mesh could be made of wood or aluminum. Fineness of mesh is defined as number of threads/1 inch.

- ***Stencil*** is a printing form defined by its design (pattern). While applying printing paste on a stencil, defined design will be transferred on textile material.



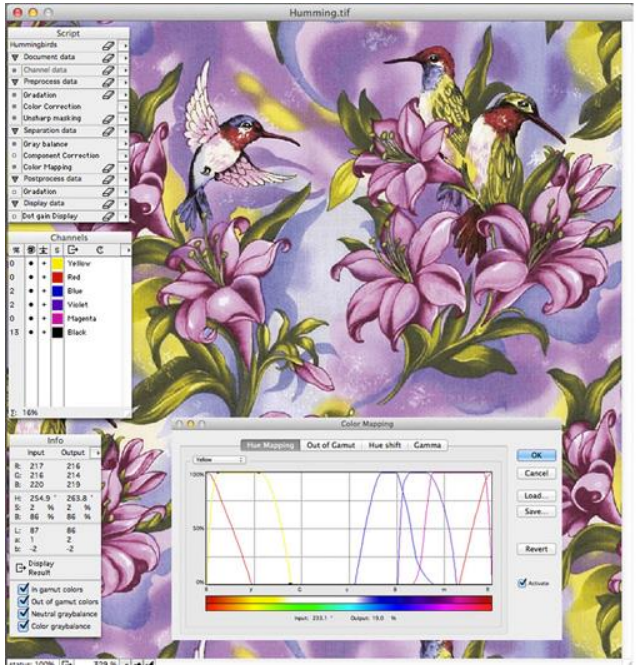
- **Screens**

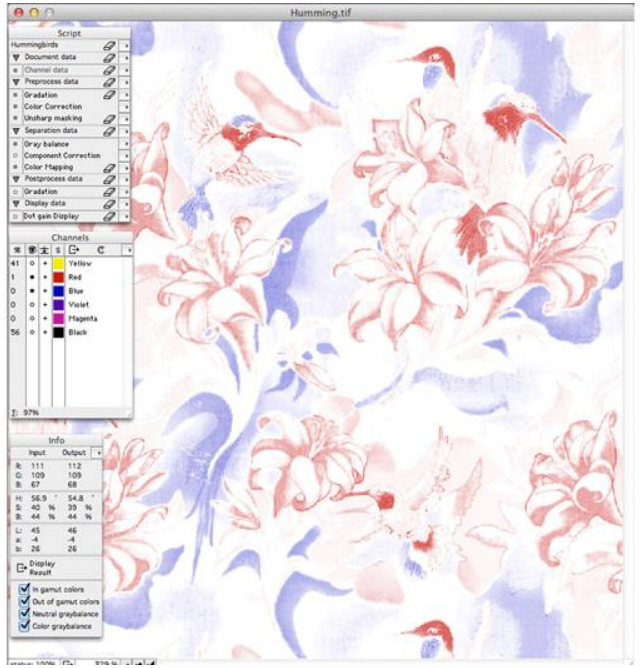
- **Stencil (screen with pattern)**

❑ CAD/CAM a UNIQUE FEATURE of MODERN PRINTING TECHNIQUES

CAD (computer aided design)/***CAM*** (computer aided manufacture)

- One of the most significant advances in textile printing technology is considered to be the introduction of CAD/CAM modules. These are systems that provide complete computer support from design to production process and control of the final product. In CAD/CAM modules, the entire production of the finished product can be computer-assisted, from the design of the initial idea and the development of the idea, to the computer control of the production process of the desired product.
- From the aspect of textile printing and textile design, the introduction of CAD/CAM enabled not only digital pattern making, computer colour separation or definition of the report unit by effects, but guided screen production and automation of printing machines, which increased productivity and reduced production process time. It has already enabled artistic freedom to designers in their creative expression, very often constrained by the limitations of available technology.





http://atticsp.com/en/what-we-do/

- The revolutionary point in the development of conventional screen printing was marked by the introduction of the CAD module into the preparatory phase of printing, which includes design, colour separation and preparation for template production.
- CAD modules enable digital design, but also the preparation of a printing unit with high precision and in a significantly shorter time. This makes the process of the preparation phase cheaper, simpler and shorter.

- Precise color separation is one of the key parameters of print quality. By applying computer programs, the desired precision is achieved. Also, objectification of color, creation of computer databases of patterns with objective data on colors and precise communication based on objectification of preparation parameters, between designers and production, are enabled.

ICT in textile printing machinery

- In this lesson, the application of IC technology is presented in the context of managing the operation of the printing machine and harmonizing the dynamics of individual phases of the printing process.
- Computer control of machinery processes includes:
  - ✓ Software adjustment of the speed and rhythm of movement of the printing screen carrier, if it is a machine with a stationary printing table, as well as the adjustment of the endless belt movement if it is the movable belt printing machine.
  - ✓ Computer-controlled synchronization of lowering and raising of the flat printing screen carrier.
  - ✓ Computer optimization and control of the squeegee pressure, the passage speed of the squeegee and the angle of inclination of the squeegee, if it is a squeegee with a knife.

- ✓ Establishing the magnetic field required to move the squeegee, in the case of a magnetic squeegee, and also, the speed of its movement and pressure.
- ✓ Computer-controlled system of dosing and delivery of printing paste (optimization of the amount of printing paste supplied to the printing screen, depending on the needs of the print).

❑ **Fully automatic computer control screen-printing machine**

https://m.made-in-china.com/product/Fully-Automatic-Computer-Control-Care-Labels-Automatic-Screen-Printing-Machine-799293625.html

❑ **The example of the high-speed screen printing machine for multicolor printing.**

https://www.sinolabelexpo.com/LAB21/ExhibitorMutiExhInfo/eng/?c=265656

- Computer control of flat-bed screen printing machine, fully automated

- Computer control of delivering and dosing of printing pastes into the rotary printing screens