DOI: 10.33193/JALHSS.70.2021.556
ISSN online: 2414 - 3383
ISSN print: 2616- 3810
مجلة الفنون والأدب وعلوم الإنسانيات والاجتماع
Journal of Arts, Literature, Humanities and Social Sciences
www.jalhss.com
Volume (70) August 2021
العدد (70) أغسطس 2021

Utilizing of Digital Printing Techniques to Create Customize Designs for Textile Floor Covering

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ABSTRACT

Industry researchers estimate that the global Textile covering flooring market size was estimated at USD 84.49 billion in 2018 and expected to register a CAGR of 3.2% from 2020 to 2025. Rising demand for carpet tiles on account of availability in a range of colors, patters, and textures is expected to drive the growth. Textile covering flooring manufacturers are involved into production of different products including carpets and area rugs which such as roll goods, carpet tiles, bath mates, and broadlooms among others. Carpet tiles and broadloom are the majorly used Textile covering floorings on account of superior attributes, such as flexibility and dimensional stability. While tufting covering floor about 90% share of this volume, and 7% needle punch covering floor 50% of tufting and needle punch covering floor printed.

While digital printing currently amounts to about 2% share of this volume, digital printing continues to expand with the movement from mass-production to mass customization of printed goods. Offset/gravure to inkjet/laser printing technology, digital carpet printing offers new creative possibilities for printing over traditional screen-printing. As a result, digital printing enables a shift from printing in large scale manufacturing facilities to smaller cottage businesses focusing on specialty printing Applications. In today's digital technology age, there is greater demand for better technology and faster turnaround cycles in terms of mass production, mass customization and cost effectiveness for the textile, apparel and printing sectors, and will be in carpet also. (THE FUTURE OF PRINTING @ ITMA 2019).

Some reasons for why digital printed is suitable for carpet customize.

1. **Short run printing advantage:** Digital Textile floor covering printing efficiently produces designs at run lengths as low as one yard of carpet without the need for screen changes.
2. Lower water and power consumption: Digital Textile floor covering printing eliminates the substantial amount of water and electrical energy one requires for rotary screen or chromo jet preparation, printing and cleanup. Even greater water and power savings can be achieved with disperse/sublimation and pigment Digital Textile floor covering inks, which only require a heat-fixation step for post treatment.

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3. **Less chemical waste:** Digital Textile floor covering printing results in significantly less ink usage and waste Relative to screen and chromo jet -printing. Taking into account the additional chemistry and chemical waste from Screen production, printing digitally offers a greener advantage for printing.
4. **Large repeat sizes:** Digital textile printers can print large designs (e.g. cartoon characters on Runners and Area Rug) on roll wall to wall carpet without the usual rotary screen-printing limitation in pattern repeat size.
5. **Reduced production space requirements:** By not having to prepare and store customer screens for future use, the production footprint for digital printing is a fraction of the size one requires for a rotary screen print facility.
6. **Less printed inventory needed:** Digital Textile floor covering printing permits the option to print a design at will. This means that manufacturers with an integrated digital printing system in their production chain can keep a stock of unprinted textiles on hand to print as required. This reduces the need for pre-printed inventory of Textile floor covering that may or may not be used.
7. **Sampling and production done on same printer:** By being able to print samples (strike-offs) on the same printer one uses for production, digital Textile floor covering print shops can present their customers with proof samples of designs that will exactly match the final printed material.
8. **Print flexibility:** Printing houses utilizing all-digital, chromo jet and screen technologies can choose to print a small quantity of designs with different color combinations (colorways) first with their digital Textile floor covering printing solutions for test the market. They can later opt to print higher volumes of the most desired color designs using chromo jet or rotary screen technology.
9. **Variety of creative design choices for printing:** Digital Textile floor covering printing provides the option to print photographic/continuous tone images, spot color pattern designs or a combination of both. This expands the creative printing alternatives for carpet and interior designers.
10. **Low capital investment:** The relatively low capital investment to setup a digital Textile floor covering print shop, especially compared to rotary screen-printing production, makes it possible to start small and expand as business grows special in scatter rug, bath mat and tiles.

The research deals with the following axes:

1. Definition of digital printing and its uses.
2. Comparison between traditional and digital printing methods
3. Conducting many technical experiments of digital printing on different types of textile floor covering.
4. The use of digital printing of textile floor covering in the field of small industries

Keywords: Textile Floor covering, Tufting carpet, Textile digital printing, carpet printing, carpet digital printing, Tufting, velvet.

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INTRODUCTION

The development of carpet fabric printing began in the early tuft carpet industry. Since the beginning of the 1950s, this industry has made great progress with the United States as the head. After more than half a century of development, there are basically three types of printing carpets used by printing carpet manufacturers: 1 flat screen printing machine; 2 rotary screen printing machine; 3 microcomputer controlled inkjet printing machine. The digital inkjet printing used by our company began in the 1970s with the aim of developing a contactless printing system and applying digital technology to produce multicolor patterns. The technology developed rapidly in the 1990s, completing the transition from technical models to production applications. At the 1999 International Textile Machinery Exhibition in Paris, the digital jet printing system received wide attention and application in the industry. What is the working principle of the inkjet printer? The inkjet printing machine is actually an enlarged version (the latest version) of a color printer. It is controlled by a computer, and the designed pattern is printed on the carpet by a program control solenoid valve to form a pattern. It can print carpets with a maximum width of 4m and a maximum of 16 colors. The inkjet printer has an initial resolution of 16 dpi and 25 dpi. The so-called 16dpi and 25dpi are the number of dots per inch. The analogy of the image is the pixel of the camera. The base carpet is similar to the photo paper.

What is the difference between 16dpi and 25dpi? The smallest point printed at 25dpi can be slightly larger at 1mm, and the smallest point at 16dpi is slightly larger at 1.6mm. The 25dpi pattern is finer than the 16dpi. But it also has a certain relationship with the flatness of the carpet and the velvet. Therefore, high-resolution carpets rarely have high-velvet-high carpets. If the pile is high and the weight is low, the flame retardant effect is poor, and it is difficult to meet the fire protection requirements. The pattern printed on the 16dpi is brighter and fuller than 25dpi. The new technology. Accuracy, carpet manufacture launched the fine-printed carpet, using color digital printing technology, the pattern is realistic and delicate, the local details are up to 600DPI printing, 24 times the traditional precision, making the pattern appear on the carpet surface, the stereo image is more prominent, and the carpet color reaches the photo quality.

color, fine print carpet manufacturing process can print any photos, breaking the traditional process limits up to 24 colors, natural color transition, allow a personalized custom carpet more pure, more thorough;

it is environmental protection, the fine print carpet washing-free printing technology , no printing and dyeing sewage discharge, environmentally friendly, making people and nature more harmonious;

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The research problem: is the current method used in the production of carpet factories limited response for customer demand for various reasons, including:

1- Colors number of design, Traditional machine is limited colors, as example max. Colors is 12 on chromo jet machine , 6 colors on rotary screen printing, but customer need more than 12 colors for his designs.

2- Resolution of designs, Traditional printing machine with max. 25 DPI and customers need more resolutions as example 75 DPI.

3- Photo design, Traditional printing machine can't print photo designs.

4- 3D designs, Traditional printing machine limited in print 3D designs, and that is will depending on designer skill.

5- Size of design, Rotary printing is limited in length of design, the max. Length of design equal the circumference of the circle of the screen, carpet printer have max. 91cm nearly

6- The time of implementation of the order, Traditional printing machine like Rotary screen need very long time to preparing design , reach to 2 weeks at least if you have department of engraving screen , if not have it take more than 2 months abroad , for chromo jet take at least 1 week to prepare design , but for digital max. One day according designer skill.

7- Cost of design, it is very expensive for rotary screen printing, set of rotary screen consists of 6 colors around 20000 USD if you make out of factory.

8- Quantity of order design , in rotary screen printing , Minimum order quantity are 5000 meter square , and for chromo jet around 500 meter square and that is big quantity for customer especially who need customize order .

9- Impact on the environment, rotary scream printing and chromo jet have some bad effect for environment due to remaining dyes, washing water and evaporations.

The problem of the study is formulated in the following questions:

1. What's the possibility of produce carpet with different category multi colors and different effect of viewing with Approaches to Minimizing the quantity of Carpet Manufacture?

2. What's the possibility of creating a different type of textile floor covering with digital printing type?

3. What's the possibility of Contribution digital carpet printing to the development of small industries?

The importance of search to:

1- Identify the ways which have decrease the cost of carpet production, with a high specification.

2- Development of Scientific and Technical Approaches to Minimizing time Implementation of order.

3- Development of Scientific and Technical Approaches to Minimizing the quantity of order, and at the lowest possible cost.

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4- Identify the way for small business industry to produce carpet with low investment, cost, area, operators and materials in short time with high quality suitable for market demand.

Research objectives: the aims to

1- Study the various methods used in the production of Textile Floor covering printing and comparison between them.

2- Formulation vocabulary and technology of the Textile floor covering printing industry (which are exclusive to this day, and secrets of the those who hold them) In the form of a scientific reference for those interested in this field In an attempt to link the research centers and centers of industry to prepare a generation able to deal with the technology of this industry Graduates from colleges and specialized institutes and those who want to invest in this field.

3- Development of a method to minimizing the time waste of printing Carpet Manufacture.

4- Development of a new method to produce Textile floor covering printing.

5- Open scope for small industries to invest in this field.

6- Create new employment opportunities to solve the problem of unemployment.

Theoretical study

Different shapes and uses of textile floor coverings:

Textile floor covering are produced according to the type of use required, and are classified into the following types:

1- Wall – to – Wall Textile Floor Coverings
2- Tile Textile Floor Coverings
3- Carpet or Rug Textile floor coverings
4- Stair Mat Textile Floor Coverings
5- Bath Mat Textile Floor Coverings
6- Kitchen Mat Textile Floor Coverings
7- Runners Mat Textile Floor Coverings
8- Children Mat

Divided to next:

- Education children mat
- Play Children mat
- Shape and characters Children mat

9- Door Mat

10. - Sports Rug

There are different type as example:

- Club Logo Mat
- Carpet forms of sports stadiums and tools

11.- Advertising Carpet

12. - Car Mat

13. - Mosque carpets and prayer rugs

CARPET FABRIC CONSTRUCTION

The primary carpet fabric construction methods include

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1. Tufting Technique.
2. Weaving Technique.
3. Needle Felt technique.
4. Flocking technique.
5. Knitting technique.
6. Bonded technique.

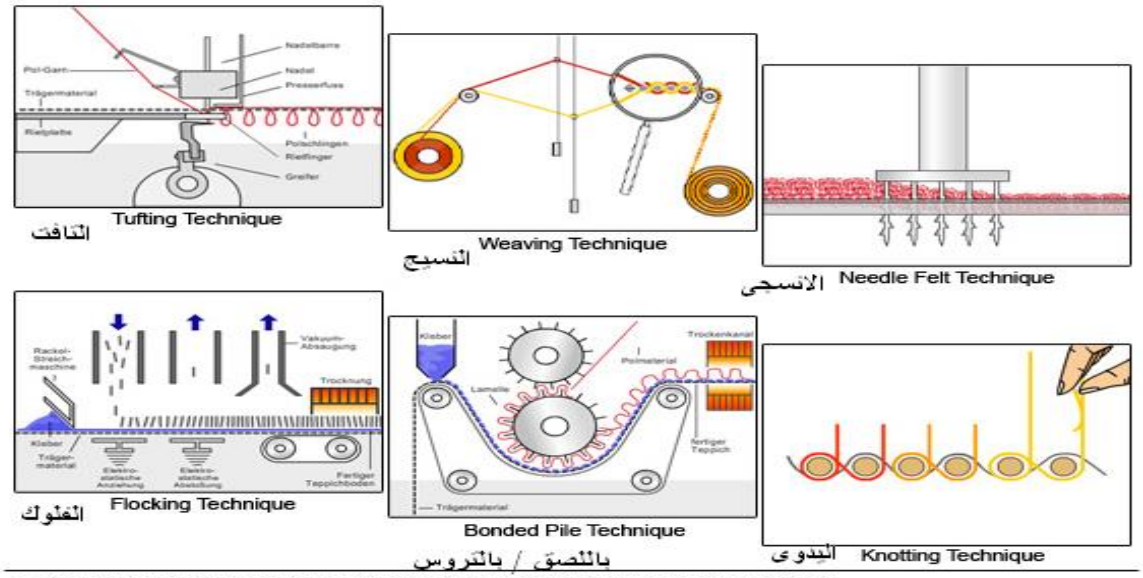

Illustration of the different production techniques for textiles floor coverings

Fig (1) Production Methods for Textile floor coverings

TUFTING

- Over 90% of carpet produced is tufted, the most prevalent carpet construction method. Tufting machines are similar to giant sewing machines, using hundreds of threaded needles in a row across the width of the machine. Today's machines are increasingly complex and sophisticated, providing a wide variety of styles and constructions.

WEAVING

- While there are several methods of weaving and several types of looms, there are basic similarities to all. In general, woven carpet is formed by the interweaving of warp and weft yarns. The warp yarns are wound from parallel or heavy beams that unwind slowly as weaving progresses. Two main types of warp yarns form the carpet back: chain and stuffer. Chain yarns provide structure and stability while stuffer warp yarns increase bulk and stiffness of the fabric. The face yarns of woven carpet are pre-dyed warp yarns or Raw white for printing yarn ,that are normally fed into the loom from a yarn creel.

KNITTING

- A carpet knitting machine, known as a double needle bar knitter, has a row arrangement of hundreds of latch needles that move in an up-and-down motion in

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conjunction with yarn guide bars. Yarn guide tubes are attached to a guide bar that passes the yarns between and about the needles, thus laying down the pile face yarns and weft backing yarns. Separate sets of guide bars control each of the yarns– knitting, backing and face yarns. Additional bars may be used for color and design variety.

NEEDLEPUNCHING

- In the needle punching process, several webs of staple fibers are superimposed to create a thick, loose batting. The batting is then tacked, or lightly needled, to reduce its thickness before it is fed into the machine. As the batting is fed into the machine, it passes between two plates. The stationary lower plate contains many holes, while the upper plate, or headboard, and contains several rows of barbed needles. The batting passes between the plates and the headboard moves up and down, passing the barbed needles through the fibers. As the needles pass through the fibers, they carry fiber ends from the top of the batting to the bottom, and when they are withdrawn, vice versa. The needles are passed repeatedly through the batting as it moves through the machine to form the carpet.

BONDING

- Fusion bonded carpet is produced by implanting the pile yarn directly into a liquid polymer, usually PVC, which fastens it directly to the backing. This results in very little buried yarn compared to other processes. The yarns can be closely packed, producing very high densities suitable for high-use areas. This process is used most frequently to produce carpet to be cut into carpet tiles or modules. Fusion bonded carpet may be loop construction, but most often is a cut pile product, made by a two-back process, slicing apart two simultaneously made carpets that are mirror images.

Carpet Printing

- Carpet printing uses machinery that essentially is enlarged, modified textile printing equipment. Traditional printing (Flatbed and rotary screen printers) and computerized printing (chromo jet and Digital printers) are common. Printed carpet is available in a wide variety of patterns or textures that can simulate woven patterns at a much lower cost.

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Method of carpet printing

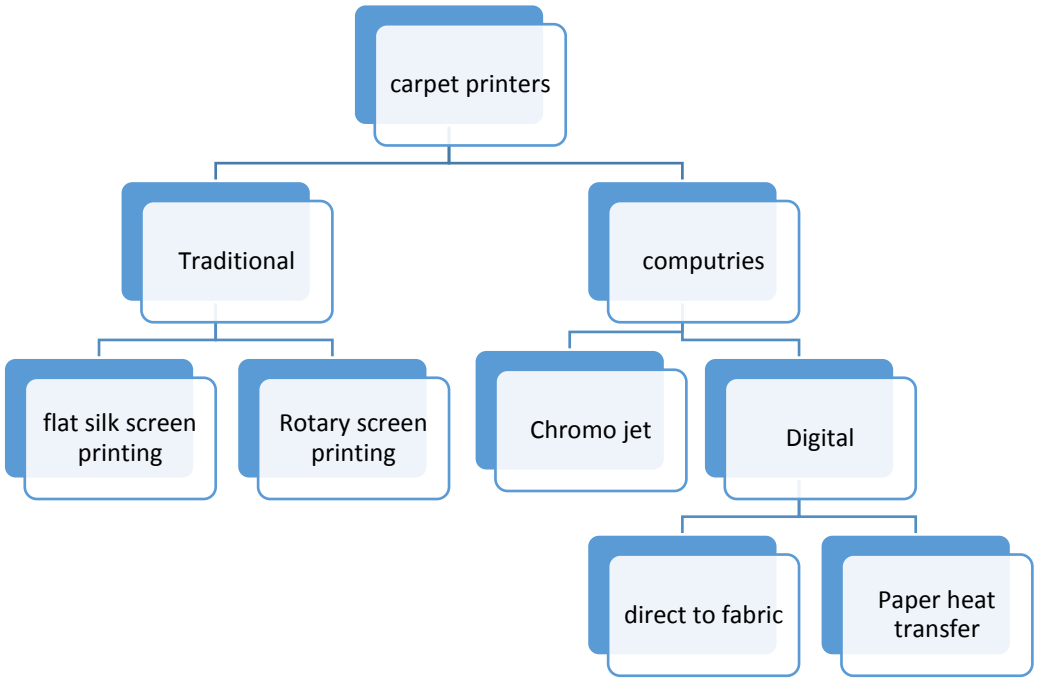

Fig (2) Method of carpet printing

Flat-Screen Printer

- The first flat screen printer for carpet – the legendary TDA62 - was developed by Peter Zimmer and put into operation in 1962 at Barwick, Lafayette, Georgia, and USA. This machine was for a long time the workhorse of the industry. Still today some of these machines are in operation.

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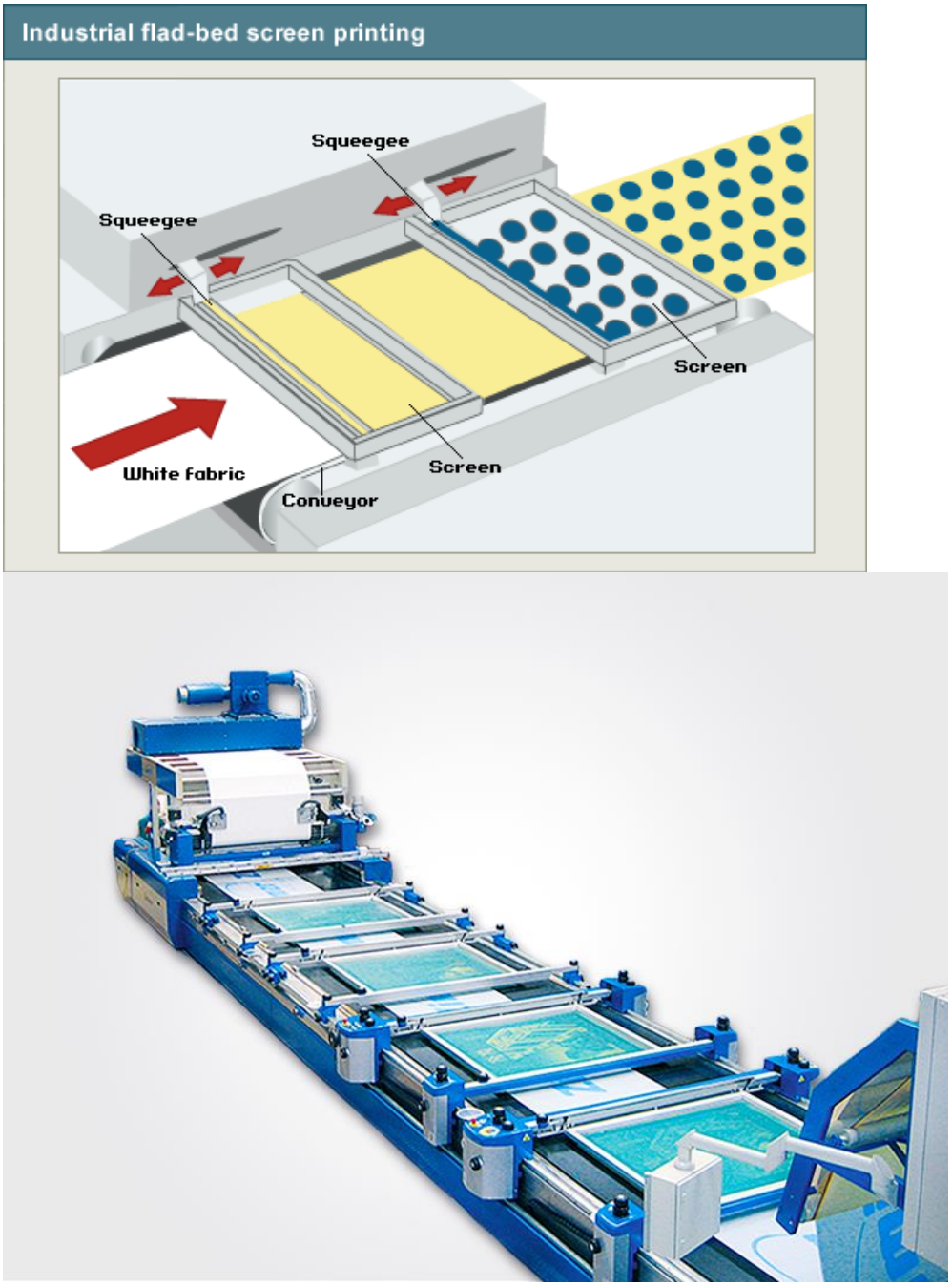

Fig (3) flat screen printing

In Flat Screen Printing Technology the screen is flat and moves up and down. The Squeeze is used. Small width fabric (45-50″) is printed on Flat Screen Printing. There are only 6 to 8 colors printing patterns.

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Screen frame making process

Fig (4) Screen frame making process

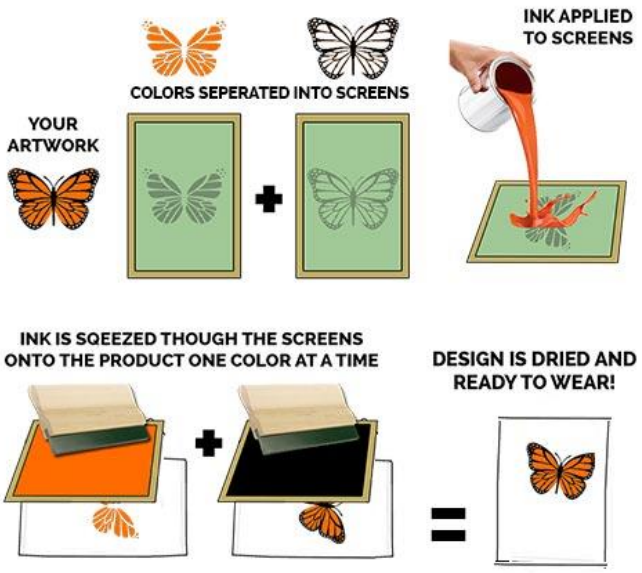

Fig (5) Silk screen printing Process

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Rotary Printer

- This type of printer brought production costs down on the long runs. Speeds up to 30 m per minute is possible and nowadays most of printed carpet is produced on screen printing machines. The first rotary printer for the carpet industry was shipped to the USA in 1969 from Zimmer.

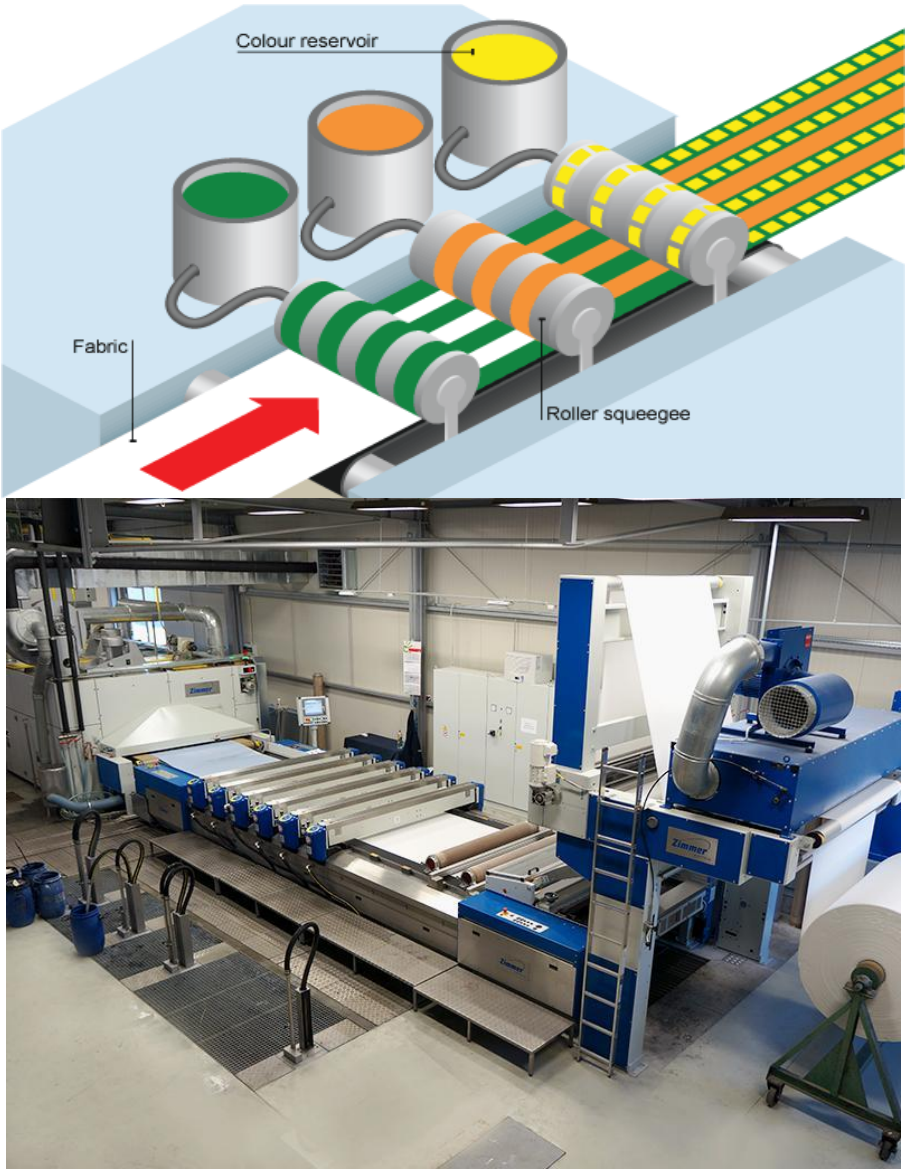

Fig (6) Rotary Screen Printing

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ROTARY SCREEN EXPOSING PLANT....
Screen length 4560 mm
Repeat: only 926 mm.

[1] EXPOSING MACHINE [Film type]
With sturdy m.s fabrication PLC with HMI operated Pneumatic Air filling system with u.v Tube light trolley with cone and perfect Marking device. Machine has no any rubber tube and any other mandrill Refer photo

[2] CURING OVEN
M.sfabricated insulatedcuring oven with high speed BlowerfanAnd ElectricHeater and digital controlled Temperature controller with perfect Locking system 926 mm X 8 nos screen Capacity.

[3] LACQURE COATING MACHINE
926 mm x4560mm screen lacquer coating machine with PLC HMIControlled and variable speed drive Allocating Cone 2 Pic, of 926 mm repeats.

[4] CLIMATIZER BOX
M.s Fabricated and Plywood with insulated structed climatizer box With heater and Air circulation blower fan Assembly with electrical Panel Board {With Out Air Conditioner}

[5] COATING EQUIEPMENT FOR MANUAL HAND COATING
With aluminum Coating Cone Set With Aluminum Rubber coating Ring Handle and Stand.

[6] SCREEN HOLDING CLAMP fiber
Use for heated screen caring

[7] SCREEN CARRING CLAMP
S.s material clamps for screen caring

[8] SCREEN UNPACKING TROUGHT
S.S Material screen packing and unpacking table 4560 x2 repeats 926 mm

[9] RINGS SET
S.S SHAPPING RING 8 NOS
TENSION RINGS 8 NOS

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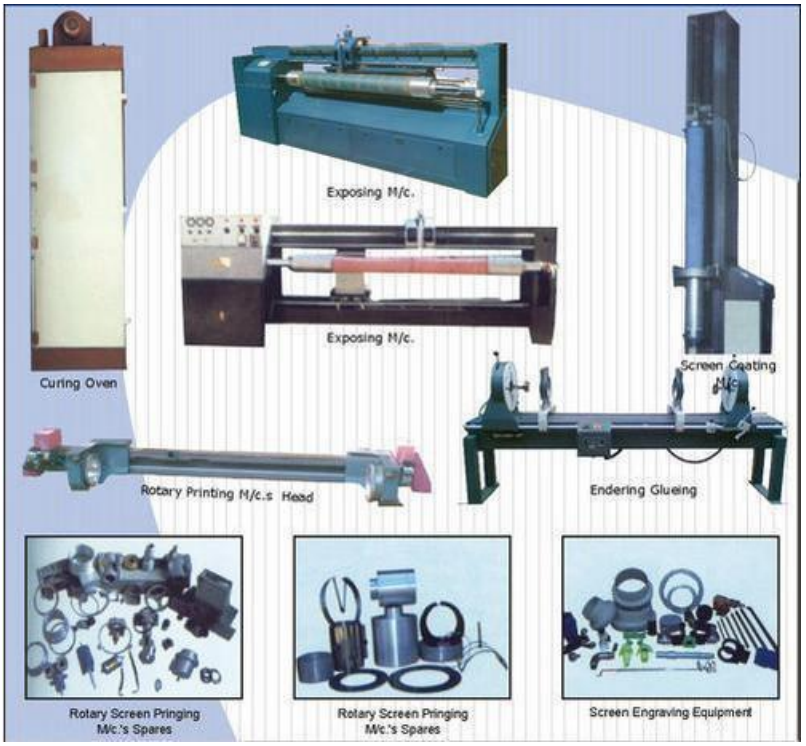

Fig (7) Equipment needed for making rotary screen design

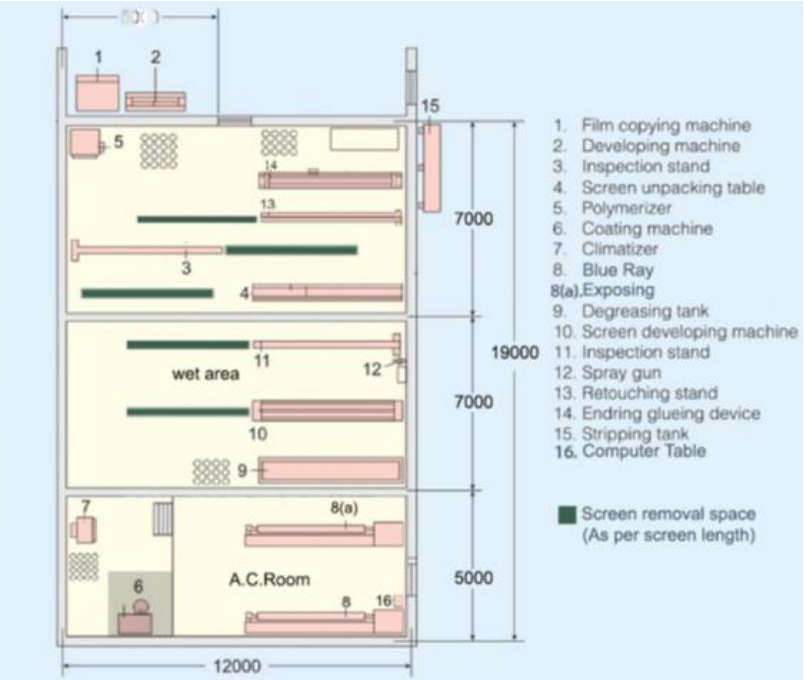

Fig (8) Engraving shop area needed for making rotary screen design

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Fig (9) rotary screen designs store

The Rotary screen is round in size and it rotates. , just Roller is used. Large width fabric is printed on Rotary screen printing. Able to use 16 to 24 colors in a pattern. The initial cost of investment in Rotary screen printing is too high; so, it's expensive.

Chromo-Jet

In the 70's another important technological development by Zimmer arrived, the Chromo-Tronic Carpet Printing Machine. For the first time, computer controlled jets – not traditional Screens – were used to print a pattern. This was the first digital jet printer from Zimmer. Three Units were in operation. The problem at this time was the computer control but also the chemistry and other components were not ready yet. The unit was ahead of its time.

Chromo-Jet was developed and brought to its success under Johannes Zimmer. The basic concept was taken from the Chromo-Tronic, but a number of improvements and new technologies were implemented. Since the beginning of the 80's Chromo-jet is constantly developed further and improved and more than 600 units have been sold since then. Chromo-Jet is now the number one production method for individual carpet worldwide. Digital printing has a great future in the carpet and textile market.

Zimmer developed High speed magnetic valves in-house are controlled with up to1000 cycles per second and inject pressurized color deeply into the carpet pile. Today Chromo JET is the leading printing system for wall-to-wall carpets, individually sized carpets, mats and carpet tiles. A wide range of machine models is available, featuring printing widths from 2 to 5 meters and production speeds from 1 to 10 meters per minute at a resolution of 25 dpi.

The companies provides the carpet industry with a complete production lines with fabric feeding system, Chromo JET printer,

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Steamer, washer, dryer, fabric discharge, color kitchen, SupraMIX and SupraFOAM in-line mixer.

What is Chromo-JET?

Jets are electromagnetically opened and closed, Dye-jet is formed by a nozzle. Different nozzles for different applications. Color is pressurized (1-3 bar) and supplied from a pump- and filter-system directly to the jets. Jets are arranged in groups on a moving print-head which traverses the carpet – like a shuttle. Number of jets per group determine the production speed Up to 16 color-groups are arranged per print-head

ChromoJET400 Basics

Function

ChromoJET is a printing system using high speed valves which are computer controlled. The pre-mixed pressurized spot colors are injected with high precision deep into the face of the pile without any machine parts touching the fabric. Deepest color penetration and excellent print definition are the result.

Print Speed

Production speed is almost proportional to the number of jets used per color. More jets offer higher production speed.

Modes of Operation

Single Speed Mode (SSM)

Each group of jets is used for one individual color.

Double Speed Mode (DSM)

Two groups of jets are combined and filled with the same color. The linear production speed is almost doubled in comparison to single speed mode.

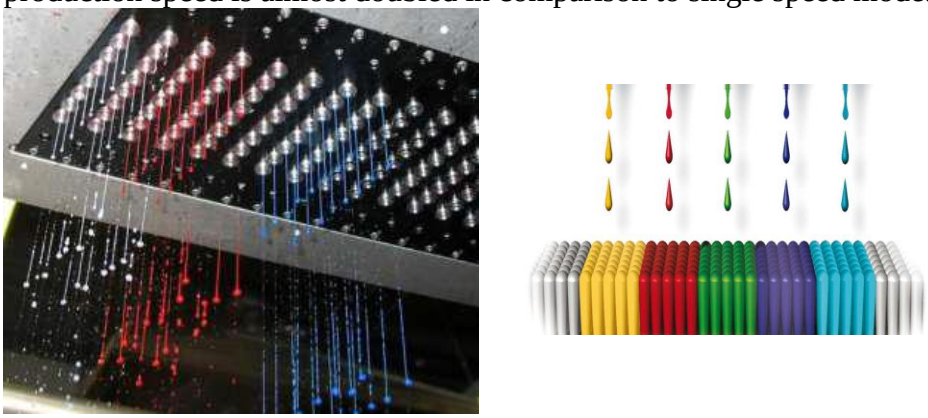

Fig (10) chromo jet nozzles

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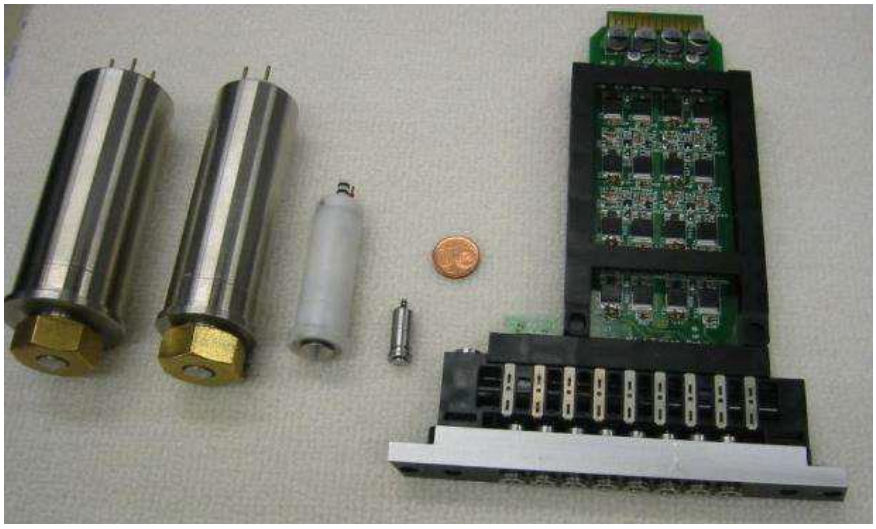


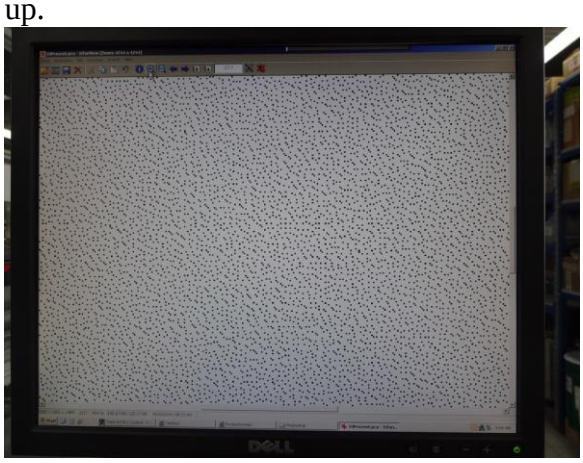
Fig (11) Jet Generations

VALVE-JET.TECHNOLOGY
CONTROLLING.PICK-UP

There are a number of parameters which influence dropsize, ejection speed, coverage and total pick-up.

The easiest way to control pick-up is to rasterize the coverage.

This raster can be in a range between 10% and 100% - depending on fabric and pick-up.



This is a 10% coverage of a pre-coat

this is a 75% coverage of a pre-coat

Fig (12) Pick up % covering

The next is

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Calculation of possible pick-up ranges using CHROMOJET800 jets			
Parameter	**min**	**max**	**pick-up range**
Pressure	1.0 bar	3.5 bar	5
Head speed (1 m/sec = 100%)	40%	100%	2.5
Coverage by raster	25%	100%	4.0
Variation by pressure, head-speed and coverage			**50**
Viscosity (root function)	50 cps	200 cps	2
Variation by pressure, head-speed, coverage and viscosity			**100**
Nozzle diameter (square function)	120 µm	280 µm	5
Theoretical variation and range of pick-up			**1 : 500**

Fig (13) Pick-up Ranges using in chromojet printer

Advantages of ChromoJET400

• No screens – no limitation in pattern repeats
• Design change „on the fly“
• Full penetration
• Pile weight from 250 up to 1,500 g/m2
• For polyamide, wool, acrylic and (up to a certain extent)
Polyester yarns
• Complete print line from one supplier
• High Resolution

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Selector | ChromoJET^{400} printer with 25.4 dpi resolution					
Production per year at 2 shift operation (16 h)	Piece by Piece operation		Roll to Roll operation		
	Mats	Carpet tiles	2 m print lines	4 m print lines	5 m print lines
0 - 25.000	CHR^{400} 2000 16 c x 8 jets				
25.000 - 50.000	CHR^{400} 2500 16/32 c x 16 jets	CHR^{400} 2000 8/12/16 c x 32 jets			
50.000 - 100.000	CHR^{400} 2500 32/48 c x 48 jets	CHR^{400} 2000 8/12/16 c x 64 jets	CHR^{400} 2000 8/12/16 c x 32 jets		
100.000 - 250.000		CHR^{400} 2000 8/12/16 c x 128 jets	CHR^{400} 2000 8/12/16 c x 64 jets		
250.000 - 500.000		CHR^{400} 2000 8/12/16 c x 256 jets	CHR^{400} 2000 8/12/16 c x 128 jets	CHR^{400} 4000 8/12/16 c x 128 jets	
0.5 - 1 mio m²			CHR^{400} 2000 8/12/16 c x 256 jets	CHR^{400} 4000 8/12/16 c x 256 jets	
1 - 2.5 mio m²				CHR^{400} 4000 8/12/16 c x 512 jets	CHR^{400} 5000 8/12/16 c x 512 jets
2.5 - 5 mio m²				CHR^{400} 4000 8/12/16 c x 1280 jets	CHR^{400} 5000 8/12/16 c x 1280 jets

Fig (14) Chromo jet production, width, number of color and jets per color

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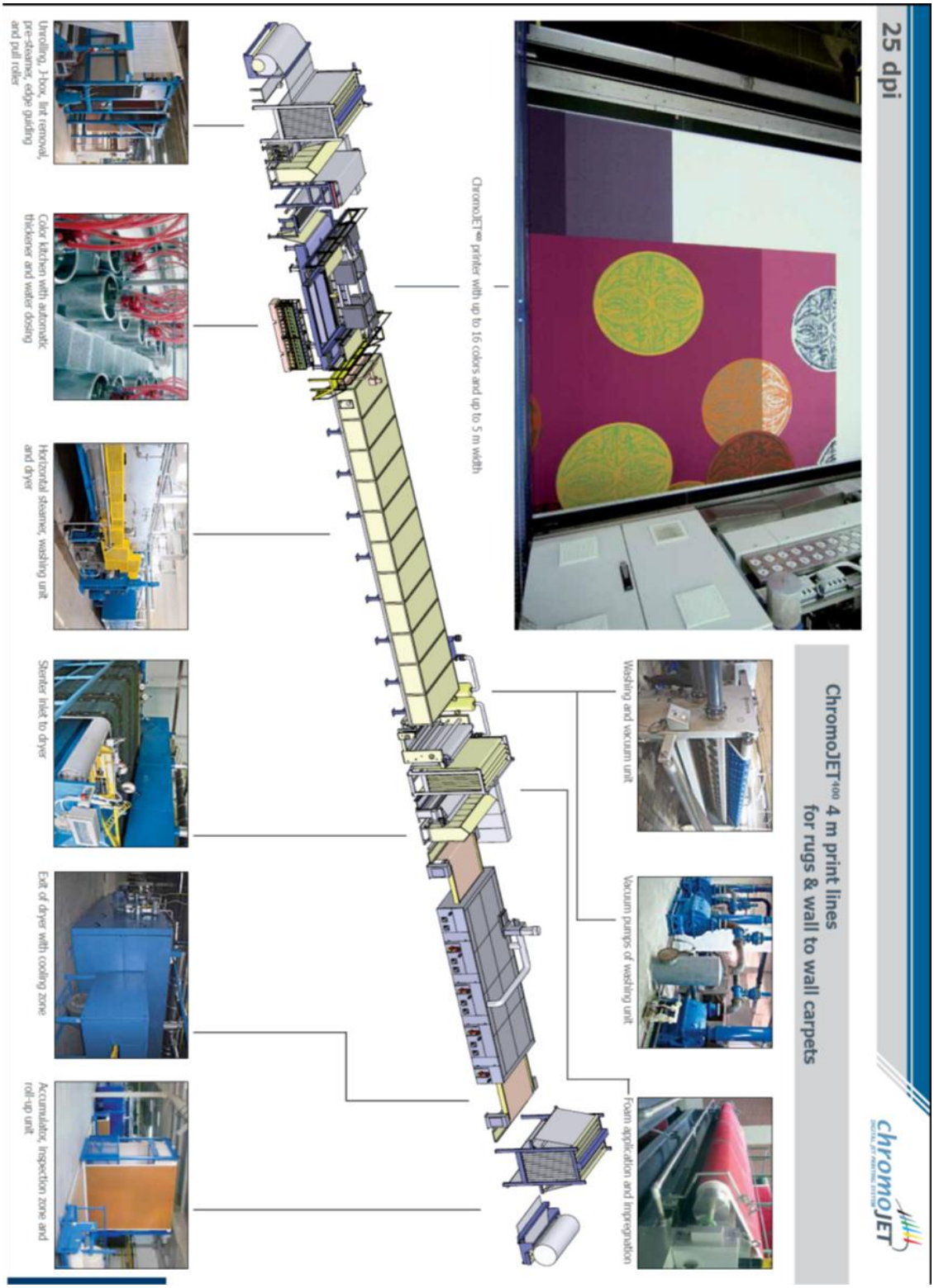

Fig (15) full line chromo-jet carpet printer

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The next is chromojet machine process parts

Washing and vacuum unit

Vacuum pumps of washing unit

Unrolling, J-box, lint removal, pre-steamer, edge guiding and pull roller

Color kitchen with automatic thickener and water dosing

Horizontal steamer, washing unit and dryer

Stenter inlet to dryer

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Stenter inlet to dryer

Exit of dryer with cooling zone

Accumulator, inspection zone and roll-up unit

Foam application and impregnation

Spot color printing with pre-mixed dyes:

Dye shades are pre-mixed according to the recipes. One tank for each color shade used in the print. Amount of dye paste must match the actual consumption. System must be washed for a color change

DESIGN PREPARATION

The design done by using graphic design program by computer and one of the famous design program use

Adobe Photoshop, NedGraphics, Adobe Illustrator; Corel Draw

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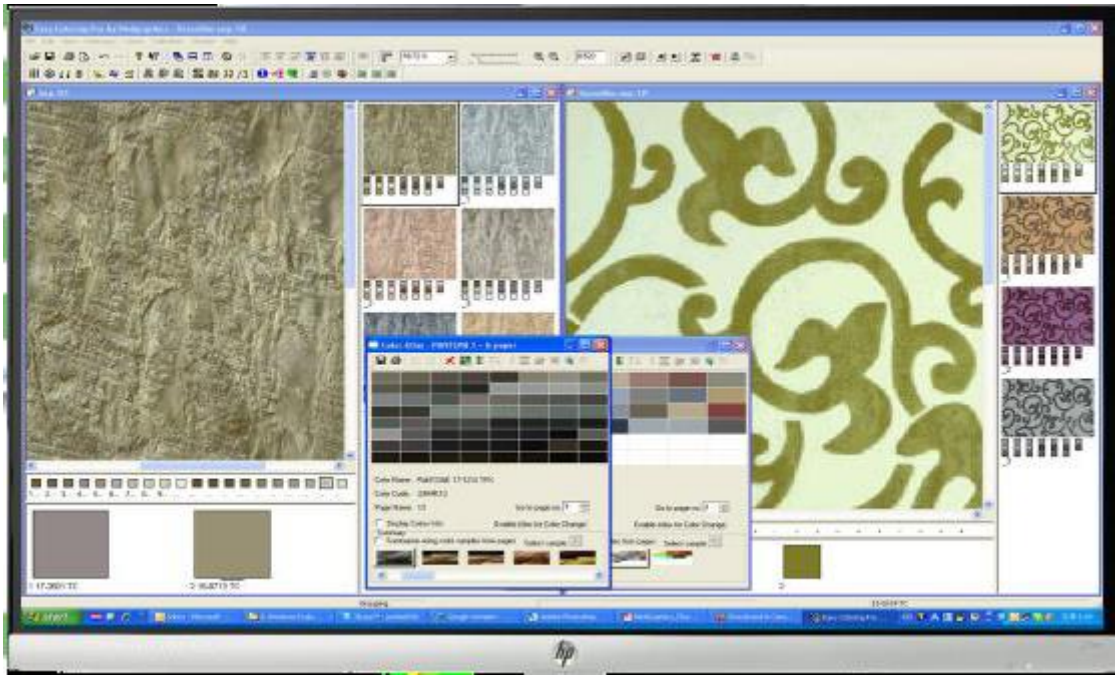

Fig (16) Screenshot NedGraphics

The design system has these basic functions:

- Create, match and combine patterns and designs
- Bring patterns into repeat
- Reduce number of colors
- Coloration - to show a design in several colorways

RASTER- OR **VECTOR-** FORMAT?

Each file format has its pros and cons:

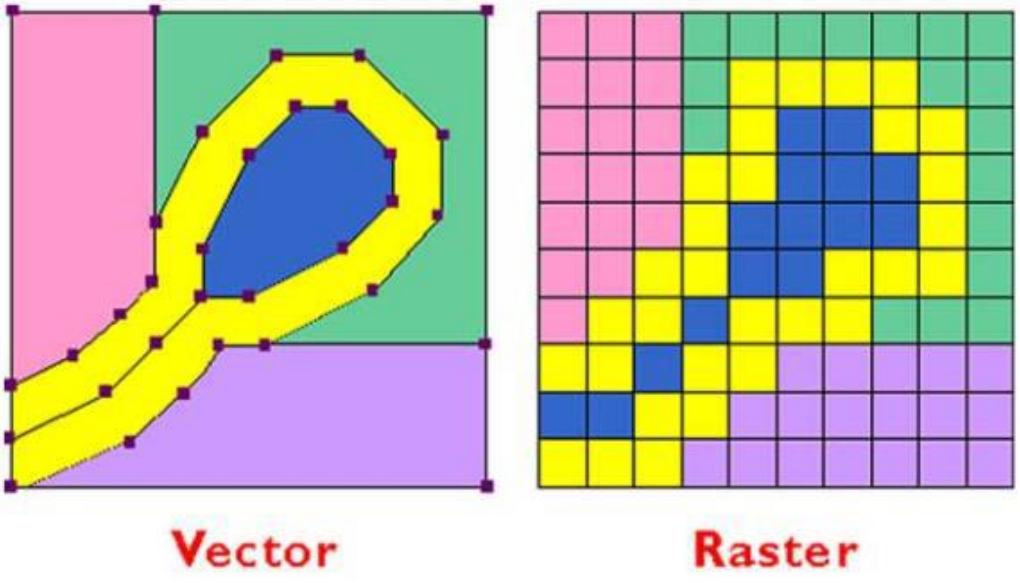

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Fig (17) RASTER and VECTOR- FORMAT

RASTER or Pixel Format can show more details and is the most common format in the carpet industry. The disadvantage is its high memory demand and its limited scalability.it save format EG – JPEG – PNG – GIF – BMP.
Common platforms: Adobe Photoshop, NedGraphics.
VECTOR Format has the advantage that the memory demand is much lower and the designs can be zoomed and scaled without losing details. It save format EG – EPS – AI.
Common platforms: Adobe Illustrator; Corel Draw.
COMBINED **RASTER** AND **VECTOR** FORMATS There are also programs available which combine raster and vector files.
Typical software platform: Adobe InDesign.

Digital Printing
Digital Textile floor coverings printing is a process of printing on carpet fabric using inkjet technology to print colorants onto fabric. This process allows for single pieces, mid to small-run cycle production and even long-runs as an alternative option to screen printed fabric. The first step in digital textile printing is to pretreat the fabric with liquid solutions that prepare it to accept the dye and better absorb the color. Then it is fed through the printer, which sprays the dye onto the textile with tiny droplets. The final step is fixing the fabric, a process that ensures the permanency of the design. Depending on the type of textile and type of dye, fixing may involve steam, dry heat, or pressure. Sometimes it requires a combination of two or more of those. Now Manufactures printing solutions provide a quick and easy digital printing process, requiring no pre or post treatment. Makes printing so simple. Zimmer's DTG printing solutions allow for unparalleled printing quality, speed and performance.
There are two types of Digital printing process
- Direct to Fabric printing
  - Roll to roll

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- Piece printing
- Paper Heat transfer printing
- Roll to roll
- Piece printing

Direct to Fabric printing, Roll to roll

The next direct printed carpet line from Zimmer

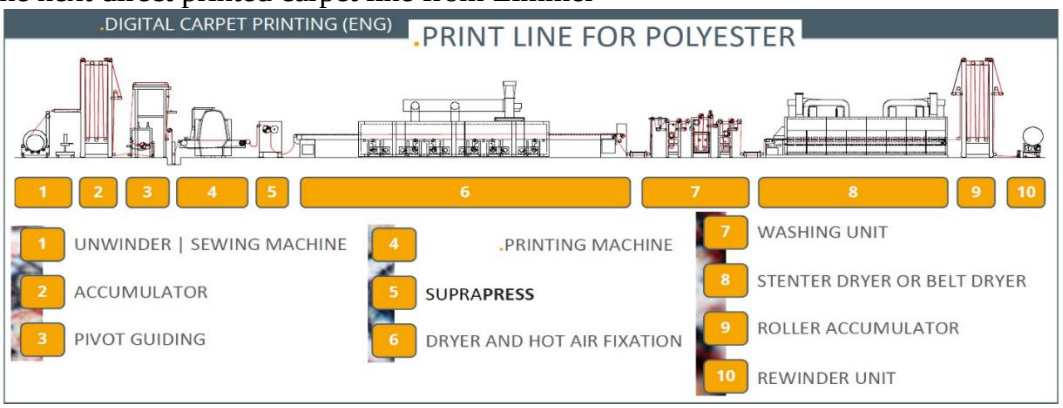

Fig (18) Zimmer digital carpet printing line.

China manufactures carpet printer line for Polyester

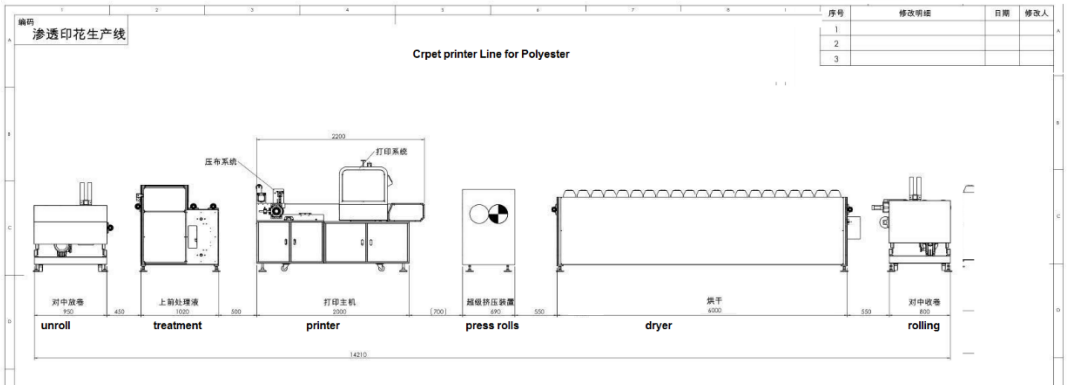

Fig (19) China manufactures carpet printer line for Polyester

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Photo (20) roll to roll direct printing to fabric

Direct to Fabric printing, Pieces printing

Found different type different size according customer carpet size and price of machine Small, medium and large flatbed printing machine

Photo (18) Direct to Fabric printing Pieces carpet printing machine

Piece printing dryer

After printing need to fix color by steaming or heating use for that different type of dryers for piece printing, the next one of this type

Photo (21) Pieces textile dryer

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Inkjet Print head Technology Overview

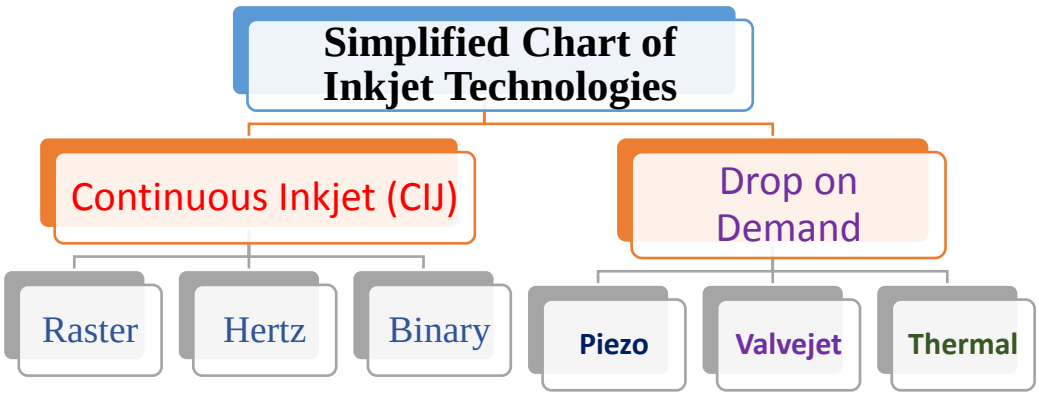

Fig (22) Simplified Chart of Inkjet Technologies

There are many sub-categories of ink jet and some other technologies, but this presentation will
–Provide an overview of technologies and terminology of inkjet
–Concentrate on key technologies being used today in production systems
– Primarily drop on demand piezo inkjet

The inkjet use in carpet printing are

- Drop on Demand – velvet jet
- Drop on Demand – Piezo

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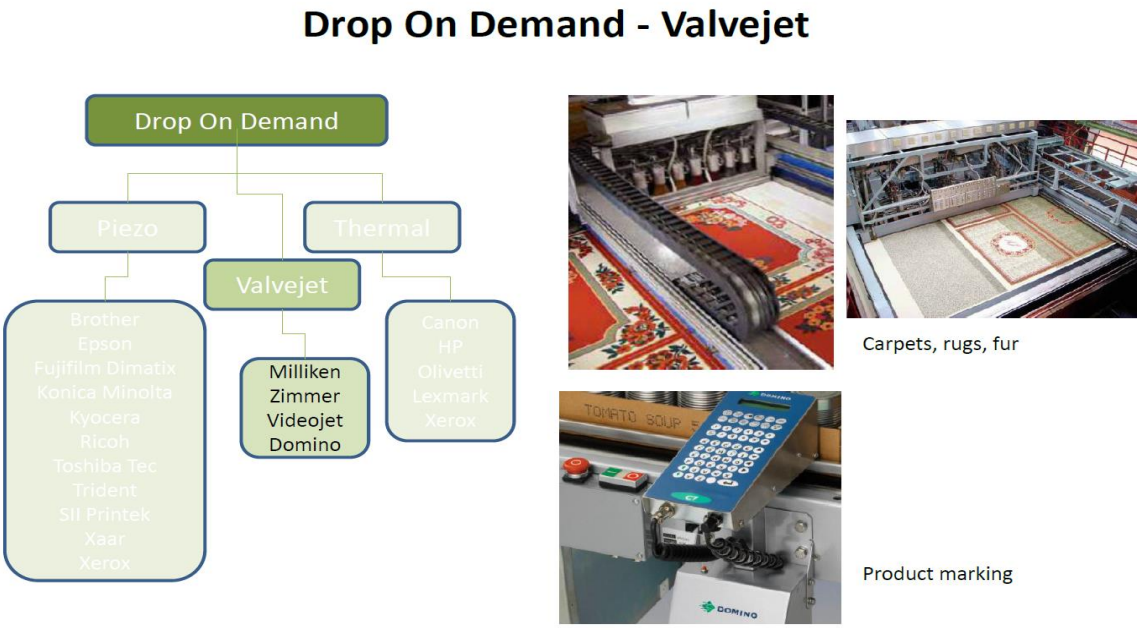

Fig (23) drop on demand – velvet jet

Which are manufacture and used by:

Milliken - Zimmer - Videojet - Domino

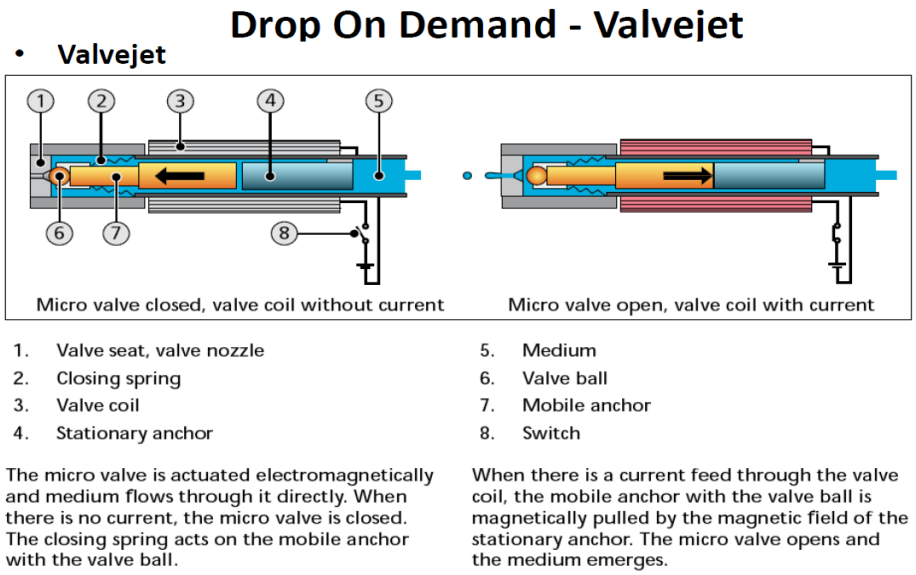

Fig (24) velvet jet

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Fig (25) drop on demand – Piezo

Piezo

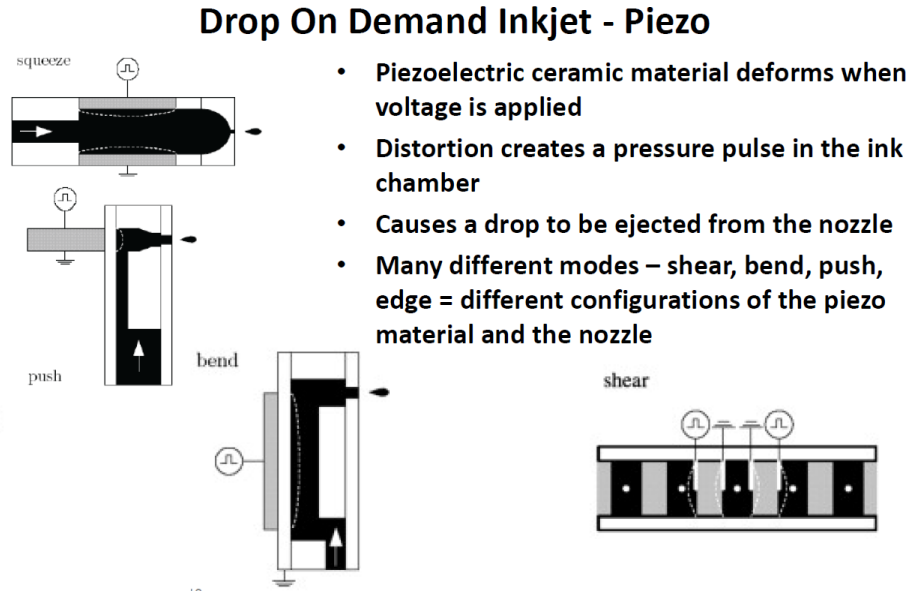

Fig (26) Piezo

Which are manufacture and used by

Brother - Epson - Fujifilm - Dimatix - Konica - Minolta - Kyocera Panasonic - Ricoh - SII Printek - Toshiba Tec - Trident - Xaar – Xerox

Ink Jet Technologies - Summary

•Continuous (CIJ) = continuous flow of ink

- Method to produce drops

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- Method to select drops
- Method to recover and control the ink

➢ High speed capability

➢ Typically low resolution, but high resolution capable

•Drop On Demand (DOD) = drop of ink only generated when needed

- No drop selection or deflection required
- Each nozzle fires only as required – nozzles can be inactive

➢ Nozzle maintenance and good ink formulation required

- Actuation mechanism required with enough energy to generate drop at required velocity to eject and reach substrate successfully

➢ Actuation methods – most common are thermal and piezo

- **Piezo dominant technology in textile printers**

Binary vs. Greyscale

- **Binary**

- One drop size
- On or off

- **Multi-pulse binary**

- Special mode offered by some printheads
- Ability to create larger drops (all same size)

- Greyscale

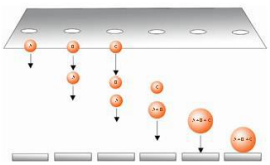
- Variable number of drops

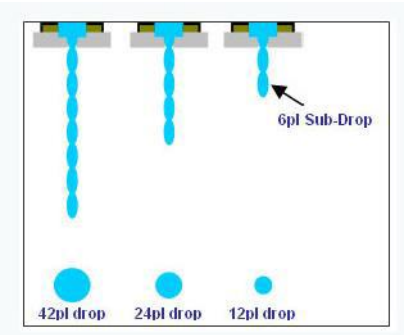
- Drops coalesce in flight or at nozzle plate

- Directly vary drop volume

- Vary waveform according to drop size required

- Apply different waveforms to each bank of piezo





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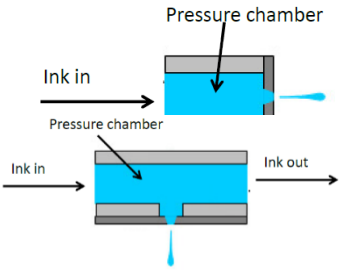
Greyscale Printing

Fig (27) Greyscale Printing

Ink Flow



- End shooter/single ended
- Ink flows into the channel and exits only through the nozzle
- Recirculating/through flow
- Ink flows continuously through the channel and exits the nozzle only when required

Piezo Inkjet Print heads for Textile floor coverings printing

- **Fujifilm Dimatix Q-Class Polaris Series**
  - 512 nozzles - 4 rows of nozzles
  - 200 dpi one-color (all 4 rows)
  - 100 dpi two-color (2 rows per color)
  - Versa Drop binary jetting capability
- 15pl drop (40kHz) & up to 30pl (25kHz)
- 35pl drop (30kHz) & up to 90pl (13kHz)
- 85pl drop (20kHz) & up to 150pl (10kHz)
-

- **Fujifilm Dimatix Star Fire SG1024 Series**
  - 1024 nozzles
  - 400dpi 4 grey levels
  - Incorporates Versa Drop binary and greyscale jetting
  - RediJet – continuous ink circulation at the nozzle

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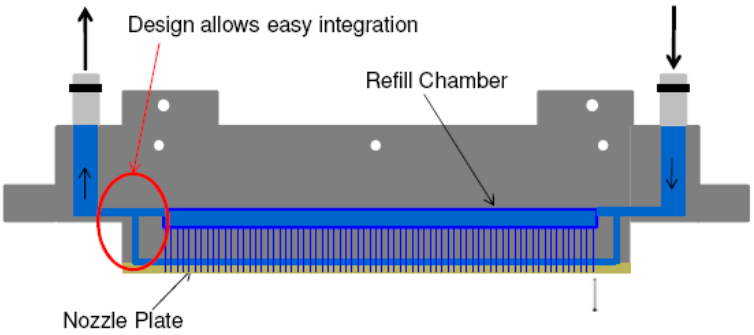

➢ Removable/replaceable coated metal nozzle plate
➢ Precise registration points
- Allows multiple printheads to be accurately arrayed into print bars
- Reduces set-up and alignment costs during nozzle replacement or printhead exchange

Carpet solution

Table (1) ink used and carpet material solution

Fiber type	Polyamide/Nylon	Wool	Polyester	Cotton
Acid	Steaming 3~6m/100°C spraying vacuuming spraying vacuuming drying	Steaming 8~10m/100°C spraying vacuuming spraying vacuuming drying		
Disperse			Drying hot air fix 1min from 170~190°C spraying vacuuming reductive washing	

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			vacuuming cold washing vacuuming drying	
Reactive	Steaming 6~8m at 100°C spraying vacuuming spraying vacuuming drying	Steaming 6~8m/100°C spraying vacuuming spraying vacuuming drying		Steaming 6~8m/100°C spraying vacuuming spraying vacuuming drying

Guidelines for preparing your artwork and files for production

1. Provide all files in one of the appropriate formats listed below, including all support files used.
2. Layout all files in the correct resolution, proportions or scale (usually ¼ scale) to the final carpet size. Your page size must exactly match your final carpet size or scale.
3. Convert all fonts to Outlines and remove any stray text that has not been converted. If using Photoshop Rasterize* all text and remove any text layers not rasterized.
4. A Hard Copy Color proof MUST be submitted with the electronic files. Also any indications for PMS Color Match, size, and FPO's must be clearly marked on the hard copy. Color proofs accepted are: Iris print, Kodak Approval, Match print and similar calibrated quality proofs. Color lasers are not acceptable.

Applications Supported

- Adobe Illustrator 10 or Greater

(Saved in AI or EPS Formats) PC or Mac

- Adobe Photoshop 7.0 or Greater

(Saved in PSD, TIFF, or EPS Formats) PC or Mac

- Adobe Freehand 8.0 or Greater

(MUST be saved in EPS Format) PC or Mac

Formats Supported

Vector:

- **AI** - (Adobe Illustrator native format) this is the Adobe Illustrator native format. This type of file is usually created in Adobe Illustrator 10 or greater. All fonts used must be converted to outlines. Please provide support files for any embedded graphics used in your design. Illustrator should be used when combining Text, Logos, Illustrations, and Photographic Images in your design.
- **EPS-** (Encapsulated Post Script) also known as Vector Files or Outline Files. This type of file is usually created in Adobe Illustrator 10 or greater. All fonts used must be converted to outlines. Please provide support files for any embedded

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graphics used in your design. Designs that use text and logos reproduce much better when produced from EPS Outline files.

Raster:

- **PSD**- (Photoshop Layered Files) also known as Layered Files. This type of file is created in Adobe Photoshop 7.0 or greater, and has all layers intact. This can be helpful if the design ever needs to be edited or changed. All fonts used must be *rasterized (converted to pixels) in your design. Remove any text layers that have not been rasterized. *Rasterize – Convers text layers into pixel images so font support files are not necessary.
- **TIFF**- (Tagged Image File Format) This type of file is created in Adobe Photoshop 7.0 or greater. Typically a single layer (or Flattened) file. Photographic Images can be saved in this format.
- **EPS**- (Encapsulated Post Script) this type of file is created in Adobe Photoshop 7.0 or greater. Photographic Images can be saved as EPS files as well.
- **JPEG**- (compressed file) this format is not recommended for final production files.

Color Mode

- **CMYK**- (Cyan, Magenta, Yellow, Black). Please set up all files for CMYK color mode. Illustrator files must have all colors used converted to CMYK. All photographic support files used in Illustrator must be CMYK and prepared to the proper resolution and format for the project.
- **BLACK**- (in Illustrator) All Blacks should be composed of 85c, 70m, 75y, and 100k. This will produce a richer shade of black when your design is ink jetted onto the carpet surface.

Resolution

All photographic (pixel) graphics MUST be designed to have 72 DPI of resolution at final finish size, and in CMYK Mode. Images MUST not be interpolated (sized up); this will greatly affect the resolution and quality of the final printed carpet. Example: A 10ft. x 10ft. carpet at 72 DPI = 284mb file

Converting Fonts to Outlines

Converting Fonts to Outlines eliminates the need to provide support fonts. It also reduces the risk of having a font re-wrap or change appearance when opened on different computer platforms (PC, MAC) and software versions.

Practical experiments

1-We choose customize items Textile floor covering as next table.

Ser.	**Textile floor covering Type**	Size Width x length	Number of colors	Number of mt2
1	Wall to Wall			
2	Area rug			
3	Bath Mat			
4	Kitchen Mat			
5	Children mat			

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6	Door Mat			
7	Sports Mat			
8	Advertising Carpet			
9	Car Mat			
10	prayer mat			

2- We sent order of this designs to 10 manufacture printed Textile floor

3- Collect reply from each supplier if can printed this designs or not.

Design number	Number of colors	Size Width cm x length cm	Number of mt2	Final result
	Yes / No	Yes / No	Yes / No	Yes / No

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Design sent to Manufacture of printed textile floor covering

Item Type	Design number	Number of colors	Size Width cm x length cm	Number of mt2
1- Wall to wall designs	1-1	5	97.54 x 97,54	12
	1-2	2	400 x 350	14
	1-3	256	400 x 350	14
2- Area Rug	2-1	4	160 x 230	18.4
	2-2	12	180 x 235	18.8
	2-3	256	200 x 300	12
3- Bath Mat	3-1	8	50 x 80 + 50 x 45	13.6
	3-2	8	60 x 90 + 60 x 45	14.4
	3-3	256	60 x 90 + 60 x 45	14.4
4- Kitchen Mat	4-1	8	57 x 120 + 57 x 200	12.8
	4-2	13	57 x 120 + 57 x 200	12.8
	4-3	256	57 x 120 + 57 x 200	12.8
5- Children Mat	5-1	12	100 x 150	12
	5-2	10	133 x 190	15.2
	5-3	256	133 x 190	15.2
6- Door Mat	6-1	8	50 x 80	12.8
	6-2	8	57 x 90	14.4
	6-3	256	57 x 90	14.4
7- Sports Mat	7-1	6	80 x 120	14.4
	7-2	4	160 x 230	18.4
	7-3	256	160 x 230	18.4
8- Advertising Carpet	8-1	6	80 x 120	14.4
	8-2	4	133 x 400	12
	8-3	256	133 x 400	12
9- Car Mat	9-1	3	2(44 x 68) +2(44 x 34)	14.4
	9-2	12	2(44 x 68) +2(44 x 34)	12.69
	9-3	256	2(44 x 68) +2(44 x 34)	12.69
10- prayer mat	10-1	9	67 x 113	13.56
	10-2	7	67 x 113	13.56
	10-3	256	80 x 120	14.4

DOI: 10.33193/JALHSS.70.2021.556
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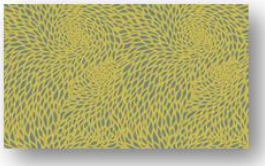
1-1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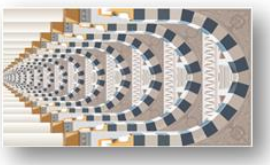
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RESULTS AND DISCUSSION:

Table (2) show capability produce each design on printing machine type

We will give (Yes) 5 points and (NO) 0 Point and submet total point for each design as next

Rotary Printing					chromo jet Printing					Digital Printing				
Design number	Number of colors	Size	Number of mt2	Final result	Design number	Number of colors	Size	Number of mt2	Final result	Design number	Number of colors	Size	Number of mt2	Final result
	Yes / No	Width cm x length cm	Yes / No	Yes / No		Yes / No	Width cm x length cm	Yes / No	Yes / No		Yes / No	Width cm x length cm	Yes / No	Yes / No
1-1	Yes	Yes	No	No	1-1	Yes	Yes	No	No	1-1	Yes	Yes	No	Yes
1-2	Yes	No	No	No	1-2	Yes	Yes	No	No	1-2	Yes	Yes	No	Yes
1-3	No	No	No	No	1-3	No	Yes	No	No	1-3	Yes	Yes	No	Yes
2-1	Yes	No	No	No	2-1	Yes	Yes	No	No	2-1	Yes	Yes	No	Yes
2-2	Yes	No	No	No	2-2	Yes	Yes	No	No	2-2	Yes	Yes	No	Yes
2-3	No	No	No	No	2-3	No	Yes	No	No	2-3	Yes	Yes	No	Yes
3-1	Yes	No	No	No	3-1	Yes	Yes	No	No	3-1	Yes	Yes	No	Yes
3-2	Yes	No	No	No	3-2	Yes	Yes	No	No	3-2	Yes	Yes	No	Yes
3-3	No	No	No	No	3-3	No	Yes	No	No	3-3	Yes	Yes	No	Yes
4-1	Yes	No	No	No	4-1	Yes	Yes	No	No	4-1	Yes	Yes	No	Yes
4-2	No	No	No	No	4-2	No	Yes	No	No	4-2	Yes	Yes	No	Yes
4-3	No	No	No	No	4-3	No	Yes	No	No	4-3	Yes	Yes	No	Yes
5-1	Yes	No	No	No	5-1	Yes	Yes	No	No	5-1	Yes	Yes	No	Yes
5-2	Yes	No	No	No	5-2	Yes	Yes	No	No	5-2	Yes	Yes	No	Yes
5-3	No	No	No	No	5-3	No	yes	No	No	5-3	Yes	Yes	No	Yes
6-1	Yes	Yes	No	No	6-1	Yes	Yes	No	No	6-1	Yes	Yes	No	Yes
6-2	Yes	Yes	No	No	6-2	Yes	Yes	No	No	6-2	Yes	Yes	No	Yes
6-3	No	Yes	No	No	6-3	No	Yes	No	No	6-3	Yes	Yes	No	Yes
7-1	Yes	Yes	No	No	7-1	Yes	Yes	No	No	7-1	Yes	Yes	No	Yes
7-2	Yes	No	No	No	7-2	Yes	Yes	No	No	7-2	Yes	Yes	No	Yes
7-3	No	No	No	No	7-3	No	Yes	No	No	7-3	Yes	Yes	No	Yes
8-1	Yes	Yes	No	No	8-1	Yes	Yes	No	No	8-1	Yes	Yes	No	Yes
8-2	Yes	No	No	No	8-2	Yes	Yes	No	No	8-2	Yes	Yes	No	Yes
8-3	No	No	No	No	8-3	No	Yes	No	No	8-3	Yes	Yes	No	Yes
9-1	Yes	Yes	No	No	9-1	Yes	Yes	No	No	9-1	Yes	Yes	No	Yes
9-2	Yes	Yes	No	No	9-2	Yes	Yes	No	No	9-2	Yes	Yes	No	Yes
9-3	No	Yes	No	No	9-3	No	Yes	No	No	9-3	Yes	Yes	No	Yes
10-1	Yes	Yes	No	No	10-1	Yes	Yes	No	No	10-1	Yes	Yes	No	Yes
10-2	Yes	Yes	No	No	10-2	Yes	Yes	No	No	10-2	Yes	Yes	No	Yes
10-3	No	No	No	No	10-3	No	Yes	No	No	10-3	Yes	Yes	No	Yes

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Table (3) show capability produce each design on printing machine type

Rotary Printing					chromo jet Printing					Digital Printing				
Design number	Number of colors	Size Width cm x length cm	Number of mt2	Rotary	Design number	Number of colors	Size Width cm x length cm	Number of mt2	Chromo jet	Design number	Number of colors	Size Width cm x length cm	Number of mt2	Digital
1-1	5	5	0	10	1-1	5	5	0	10	1-1	5	5	5	15
1-2	5	0	0	5	1-2	5	5	0	10	1-2	5	5	5	15
1-3	0	0	0	0	1-3	0	5	0	5	1-3	5	5	5	15
2-1	5	0	0	5	2-1	5	5	0	10	2-1	5	5	5	15
2-2	5	0	0	5	2-2	5	5	0	10	2-2	5	5	5	15
2-3	0	0	0	0	2-3	0	5	0	5	2-3	5	5	5	15
3-1	5	0	0	5	3-1	5	5	0	10	3-1	5	5	5	15
3-2	5	0	0	5	3-2	5	5	0	10	3-2	5	5	5	15
3-3	0	0	0	0	3-3	0	5	0	5	3-3	5	5	5	15
4-1	5	0	0	5	4-1	5	5	0	10	4-1	5	5	5	15
4-2	0	0	0	0	4-2	0	5	0	5	4-2	5	5	5	15
4-3	0	0	0	0	4-3	0	5	0	5	4-3	5	5	5	15
5-1	5	0	0	5	5-1	5	5	0	10	5-1	5	5	5	15
5-2	5	0	0	5	5-2	5	5	0	10	5-2	5	5	5	15
5-3	0	0	0	0	5-3	0	5	0	5	5-3	5	5	5	15
6-1	5	5	0	10	6-1	5	5	0	10	6-1	5	5	5	15
6-2	5	5	0	10	6-2	5	5	0	10	6-2	5	5	5	15
6-3	0	5	0	5	6-3	0	5	0	5	6-3	5	5	5	15
7-1	5	5	0	10	7-1	5	5	0	10	7-1	5	5	5	15
7-2	5	0	0	5	7-2	5	5	0	10	7-2	5	5	5	15
7-3	0	0	0	0	7-3	0	5	0	5	7-3	5	5	5	15
8-1	5	5	0	10	8-1	5	5	0	10	8-1	5	5	5	15
8-2	5	0	0	5	8-2	5	5	0	10	8-2	5	5	5	15
8-3	0	0	0	0	8-3	0	5	0	5	8-3	5	5	5	15
9-1	5	5	0	10	9-1	5	5	0	10	9-1	5	5	5	15
9-2	5	5	0	10	9-2	5	5	0	10	9-2	5	5	5	15
9-3	0	5	0	5	9-3	0	5	0	5	9-3	5	5	5	15
10-1	5	5	0	10	10-1	5	5	0	10	10-1	5	5	5	15
10-2	5	5	0	10	10-2	5	5	0	10	10-2	5	5	5	15
10-3	0	0	0	0	10-3	0	5	0	5	10-3	5	5	5	15

The next Diagram show number of Points take for each design

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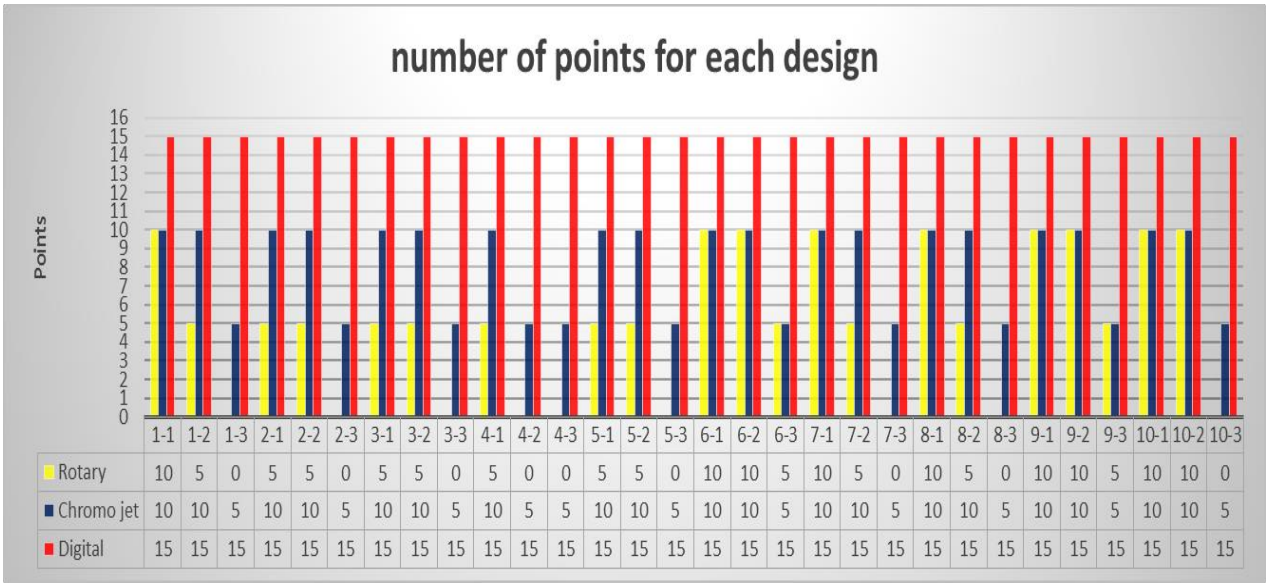
Diagram (1) points of each design on types of printing



	1-1	1-2	1-3	2-1	2-2	2-3	3-1	3-2	3-3	4-1	4-2	4-3	5-1	5-2	5-3	6-1	6-2	6-3	7-1	7-2	7-3	8-1	8-2	8-3	9-1	9-2	9-3	10-1	10-2	10-3
Rotary	10	5	0	5	5	0	5	5	0	5	0	0	5	5	0	10	10	5	10	5	0	10	5	0	10	10	5	10	10	0
Chromo jet	10	10	5	10	10	5	10	10	5	10	5	5	10	10	5	10	10	5	10	10	5	10	10	5	10	10	5	10	10	5
Digital	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

Table (4) show points for each design according number of colors

Design number	Number of colors Rotary	Number of colors Chromo Jet	Number of colors Digital	Design number	Number of colors Rotary	Number of colors Chromo Jet	Number of colors Digital
1-1	5	5	5	2-1	5	5	5
1-2	5	5	5	2-2	5	5	5
1-3	0	0	5	2-3	0	0	5
3-1	5	5	5	4-1	5	5	5
3-2	5	5	5	4-2	0	0	5
3-3	0	0	5	4-3	0	0	5
5-1	5	5	5	6-1	5	5	5
5-2	5	5	5	6-2	5	5	5
5-3	0	0	5	6-3	0	0	5
7-1	5	5	5	8-1	5	5	5
7-2	5	5	5	8-2	5	5	5
7-3	0	0	5	8-3	0	0	5
9-1	5	5	5	10-1	5	5	5
9-2	5	5	5	10-2	5	5	5
9-3	0	0	5	10-3	0	0	5

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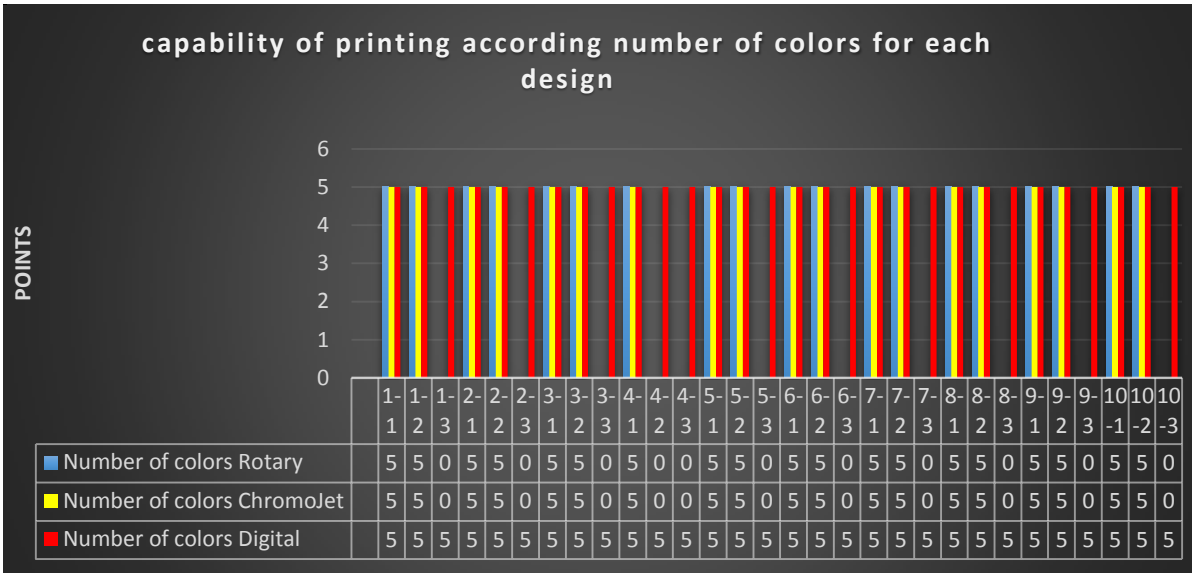

Diagram (2) capability of printing according number of colors for each design

Table (5) show points for each design according size of design

design #	Width cm x length cm Rotary	Width cm x length cm Chromo jet	Width cm x length cm digital	design #	Width cm x length cm Rotary	Width cm x length cm Chromo jet	Width cm x length cm digital
1-1	5	5	5	2-1	0	5	5
1-2	0	5	5	2-2	0	5	5
1-3	0	5	5	2-3	0	5	5
3-1	0	5	5	4-1	0	5	5
3-2	0	5	5	4-2	0	5	5
3-3	0	5	5	4-3	0	5	5
5-1	0	5	5	6-1	5	5	5
5-2	0	5	5	6-2	5	5	5
5-3	0	5	5	6-3	5	5	5
7-1	5	5	5	8-1	5	5	5
7-2	0	5	5	8-2	0	5	5
7-3	0	5	5	8-3	0	5	5
9-1	5	5	5	10-1	5	5	5
9-2	5	5	5	10-2	5	5	5
9-3	5	5	5	10-3	0	5	5

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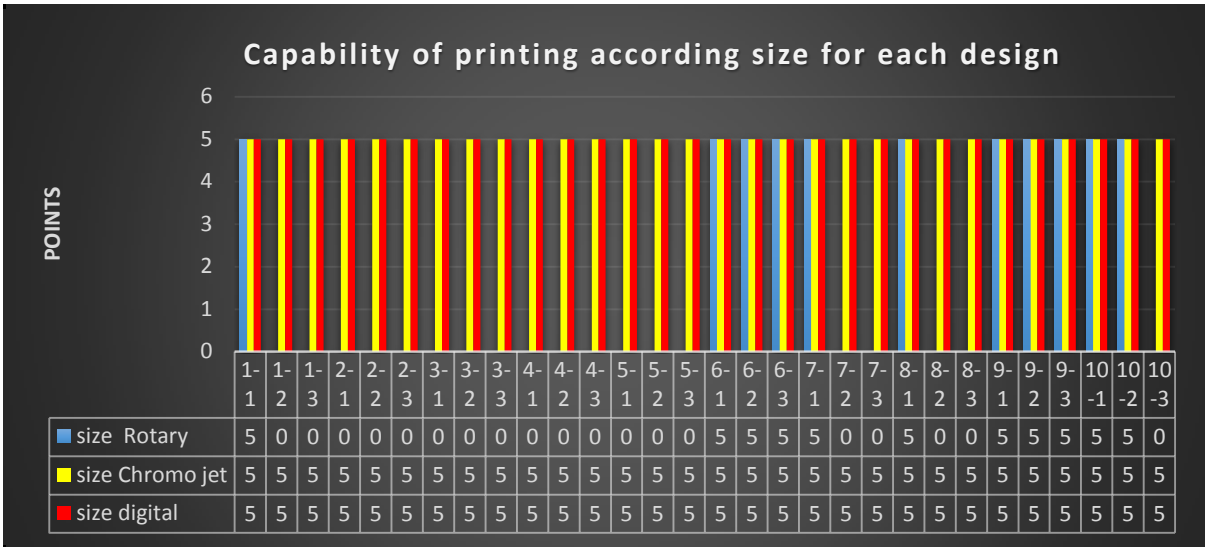

Diagram (3) capability of printing according size for each design

Table (6) show points for each design according quantity of design

Design number	quantity Rotary	quantity Chromo jet	quantity digital
1-1	0	0	5
1-2	0	0	5
1-3	0	0	5
3-1	0	0	5
3-2	0	0	5
3-3	0	0	5
5-1	0	0	5
5-2	0	0	5
5-3	0	0	5
7-1	0	0	5
7-2	0	0	5
7-3	0	0	5
9-1	0	0	5
9-2	0	0	5
9-3	0	0	5

Design number	quantity Rotary	quantity Chromo jet	quantity digital
2-1	0	0	5
2-2	0	0	5
2-3	0	0	5
4-1	0	0	5
4-2	0	0	5
4-3	0	0	5
6-1	0	0	5
6-2	0	0	5
6-3	0	0	5
8-1	0	0	5
8-2	0	0	5
8-3	0	0	5
10-1	0	0	5
10-2	0	0	5
10-3	0	0	5

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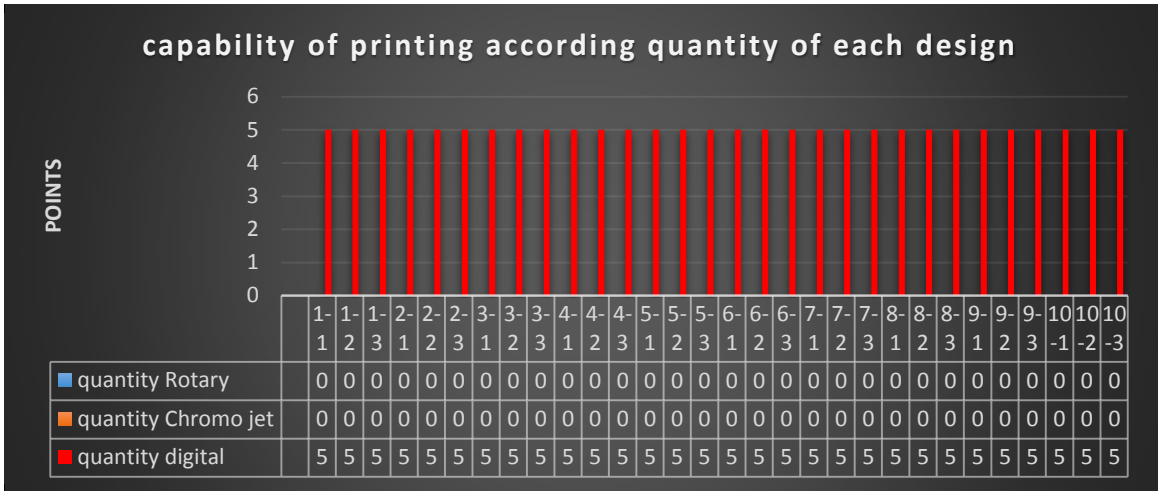

Diagram (4) capability of printing according quantity of each design

SIGNIFICANT RESULTS:

1- The Rotary Printing machine is very limited for printing different size, it is able only to print carpet length equal the circumference of the cylinder diameter .
2- The Chromo jet Printing machine can print any size of design which fit width of printing machine, and any length needed
3- The Digital Printing machine can print any size of design which fit width of printing machine, and any length needed
4- The Rotary Printing machine can't print design with more than 12 colors according numbers of rotary screens on machine, also can't print photo designs and 3D.
5- The Chromo Jet Printing machine can't print design with more than 12 colors according numbers of pump colors on machine, also can't print photo designs and 3D.
6- The Digital Printing machine can print any design with any format and any numbers of colors, also can print photo designs and 3D.
7- The Rotary Printing machine not suitable for making customer design with less than 50000 square meter , and customer can order standard design of factory which make as stock.
8- The Chromo Jet printing machine minimum customer order 500 square meter.
9- The digital printing machine print minimum customer order 20 square meter, but can print less than 1 square meter with little more price
10- The delivery time for customer order not less than 60 days
11- The delivery time for customer order not less than 30 days
12- The delivery time for customer order around 2 days.

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By Digital printing machine can do any size, numbers of colors with minimum quantity in short time , That mean digital printing techniques suitable for create customize designs for Textile floor covering

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DOI: 10.33193/JALHSS.70.2021.556
ISSN online: 2414 - 3383
ISSN print: 2616- 3810
مجلة الفنون والأدب وعلوم الإنسانيات والاجتماع
Journal of Arts, Literature, Humanities and Social Sciences
www.jalhss.com
Volume (70) August 2021
العدد (70) أغسطس 2021

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