WiReTEX
Rescuing traditional knowledge of skilled textile workers

WireTEX

RESCUING TRADITIONAL KNOWLEDGE OF SKILLED TEXTILE WORKERS

SUPPORTING DOCUMENTATION FOR 1st PODCAST

Complementary documentation for result 2 - Producing video training material.

Peggy Wunderlich, Texulting GmbH

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Foreword

Dear reader, welcome to the Knowledge Database document linked to the second Podcast. Each podcast we created has a supporting document that further explains and elaborates on the topics stated in the podcast video.

As a reader, you are invited to listen to the podcast and search for important information related to the podcast topic in this document. We will focus on some basic terminology and explain better some procedures and skills stated in the third Podcast. This document also contains some interesting links and websites to help you explore the topic further.

To further explain how to navigate this document.

The podcast video is available on the YouTube channel Wiretex and the Udemy platform. This makes it easier to follow the Podcast and this document. At the end of each chapter, external links are provided to explore further and expand the interest in specific topics. Links provide interesting examples from the areas of operations, presented in the 1st Podcast.

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The origin and history of weaving: a fast overlook

Weaving is a craft deeply rooted in human history. It is one of the oldest techniques practised by humans. Here are some interesting facts about the history of weaving.

Origins of Weaving:

- The exact start of the weaving process is not fully known. What is certain is that weaving is one of the most important inventions of mankind. The oldest known textile remains come from the Caucasus (Georgia) and are approximately 30,000 years old. It was the discovery of flax fibres, which the archaeologists believed to have been used to make rope[1].
- The origins of weaving date back to the Neolithic period (Younger Stone Age), when people began to interweave grasses, stems and branches to make baskets and shelters. The fabrics found at Çatalhöyük, a Turkish archaeological site, testify to simple textile weaving dating back to around 7000 BC[2].

Development of Weaving Techniques:

In ancient Egypt, people had already mastered weaving[3]. The Assyrians, Babylonians and Phoenicians also traded in woven carpets, gaining great wealth. Weaving was also known in ancient Greece, where weaving was a typical craft practised by women[4].

Looms and Automation:

- Archaeological findings have shown that people in the Early Stone Age used weaving frames, in addition to which they used clay weights for weighing in the weaving textile in the weaving process.[5],[6]
- Before the Industrial Revolution, weaving was a craft carried out on hand looms in the homes of weavers. During the Industrial Revolution, weaving moved to the factories. In the 18th century, weaving became increasingly automated with mechanical looms. During the Industrial Revolution, hand-loom weaving was eventually replaced by the mechanical loom. This was an important moment in the history of weaving, bringing remarkable improvements in precision and speed of production.[7]

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[1] Oldest-known fibers to be used by humans discovered — Harvard Gazette
[2] Plants to textiles: Local bast fiber textiles at Pre-Pottery Neolithic Çatalhöyük - ScienceDirect
[3] Unraveling the (Production) Secrets of an Egyptian Textile | Index Magazine | Harvard Art Museums
[4] Spinning and Weaving in Ancient Greece – Women in Antiquity (wordpress.com)
[5] 5. How were the loom weights used? (trc-leiden.nl)
[6] Understanding the Archaeological Record: Reconstructing a Warp-Weighted Loom | EXARC
[7] The Textile Industry in the British Industrial Revolution - World History Encyclopedia

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Famous textile artists who used weaving as a form of art

SHEILA HICKS

- Sheila Hicks started weaving in the 1950s. She travelled from Chile to Morocco to India, studying and learning weaving techniques from[8].
- In her artistic work she created three-dimensional tactile objects and used various materials to make them[9].
- Known for large-format and miniature installations[10].

Slika 1: Sheila Hicks; Silk Rainforest

ANNI ALBERS

- Albers was a pioneer of the Bauhaus movement and revolutionized weaving as an art form.
- Her geometric patterns and innovative techniques have influenced modern textile art.[11]

Figure 1: Anni Albers

[8] Sheila Hicks | MoMA
[9] Sheila Hicks - Wikipedia
[10] WORKS (sheilahicks.com)
[11] https://www.artsy.net/article/artsy-editorial-women-weavers-bauhaus-inspired-generations-textile-artists

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How to Start Weaving Yourself

Weaving is a wonderful creative activity! If you want to start weaving yourself, here are some steps to help you get started:

Understanding the Basics of Weaving:

- Learn about the different weaving techniques, materials, and tools. There are various types of looms, such as hand looms, high looms, and frame looms.
- Familiarize yourself with basic terms like warp, weft, selvedge, and weave pattern.

Gathering Materials and Tools:

- You will need yarn or fibers for weaving. Cotton, wool, linen, and silk are common materials. A loom is helpful, but you can also weave on a frame or even with a simple cardboard.

Trying Simple Weaving Techniques:

- Start with simple techniques like plain weave or tabby weave. Alternate the warp and weft threads over and under each other. Experiment with different colors and patterns.

Using Books and Online Resources:

- There are many books and online tutorials that can help you step by step with weaving. Look for guides and videos to learn the techniques.

Patience and Practice:

Weaving requires patience and practice. Start with small projects like a scarf or a coaster. The more you practice, the better you will become.

Enjoy weaving! It is a wonderful way to express your creativity and create unique textiles.

A simple weaveing project you can try

WOVEN COASTER

1. **Materials and Tools:**

- A small loom or a simple piece of cardboard
- Yarn or cotton threads in various colors
- A blunt needle or a weaving needle set
- Scissors

2. **Instructions:**

- Cut the cardboard into a square shape to create a small loom.

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- Attach the warp threads (vertical threads) to the frame. You can fix them with tape or nails.
- Use different colors of weft threads (horizontal threads) to weave simple patterns. You can try stripes, checks, or diagonal lines.
- Pass the weft threads alternately over and under the warp threads.
- Press the woven rows together firmly with a comb or your fingers to compact the coaster.
- Once you have reached the desired size, tie the ends of the threads together and cut them off.

3. **Decoration:**

- You can add fringes to the coaster by knotting and cutting the ends of the threads on the back.
- Or you can add beads, buttons, or small pieces of fabric to customize your coaster.

4. **Finishing:**

- Carefully remove the coaster from the frame and lightly iron it to smooth the threads.

This is a simple project that is fun and practical at the same time! Happy weaving! [12]

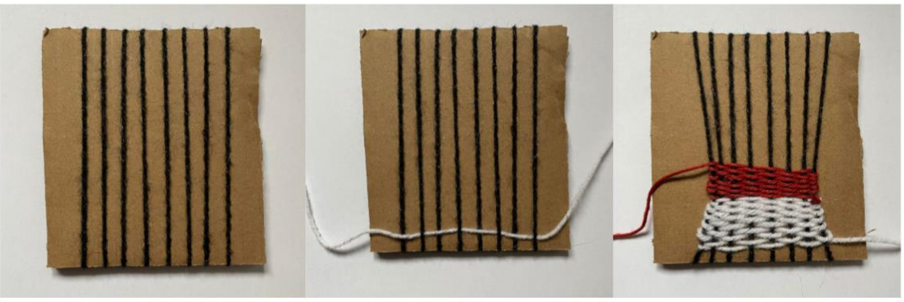

Figure 2: Example of woven coaster.

For a woven coaster, various yarns are suitable depending on your taste and the desired texture. Here are some options.

Cotton:

- Cotton yarn is soft, durable, and easy to handle.
- It is well-suited for coasters as it is heat-resistant and feels pleasant to the touch.

Linen:

- Linen yarn has a natural texture and is also heat-resistant.
- It gives your coaster a rustic look.

[12] https://www.talu.de/wp-content/uploads/2023/06/weben-mit-kindern-04.jpg

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Wool:

- Wool is warm and insulating.
- If you want a cozy coaster, wool is a good choice.

Blended Yarns:

- You can also use blended yarns that combine cotton, wool, or other fibers.
- Experiment with different materials to achieve the desired effect.

Remember that the yarn thickness and weaving technique also influence the final result.

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Everything about the most popular textile weaves

The fabrics produced on looms are characterized by the different crossings of two thread systems. The system of these right-angled thread crossings is called weave. The vertical thread is called the "warp thread" and the horizontal thread is called the "weft thread". A distinction is made between three basic weaves: the plain weave, the twill weave and the satin weave.

PLAIN WEAVE

Derivations of plain weave are: Cross-rib, longitudinal rib, and Panama weave. Plain weave fabrics include: batiste, cretonne, renforcé, linon, canvas, muslin, percale, voile, pongee, honan silk, chiffon.

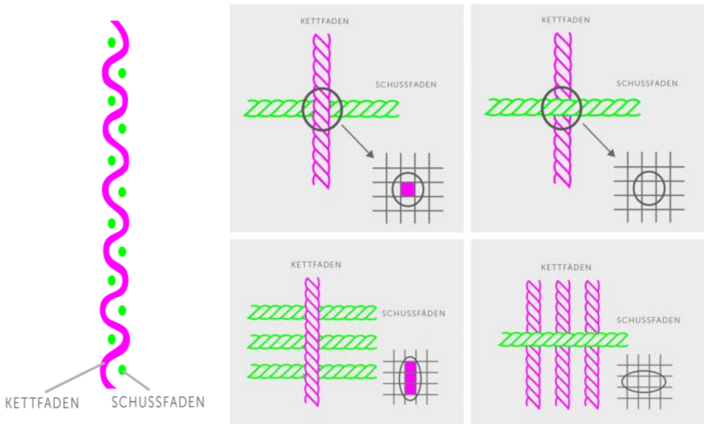

Figure 3: Schematic depiction of warp and weft threads and how to present them on a weaving scheme

RIB WEAVE

Rib weave is a derivative of plain weave: It is characterized by the visible ribs created by the weaving process. A longitudinal or transverse ribbed surface structure can be produced. A distinction is made between transverse ribs (warp ribs) and longitudinal ribs (weft ribs). In warp ribs, the number of warp lifts is increased so that the weft threads disappear underneath. The fabric appearance is therefore determined only by the warp material (e.g., color and thread thickness), and the fabric shows the typical transverse ribbing.

In weft ribs, the fabric appearance in color and material is determined only by the weft material, the transverse threads. This is achieved in true weft ribs by raising the weft points. The fabric is always characterized by a longitudinal rib.

Advantages: Abrasion and tear-resistant

Disadvantages: Often very firm, highly profiled, directionally emphasized longitudinally or transversely

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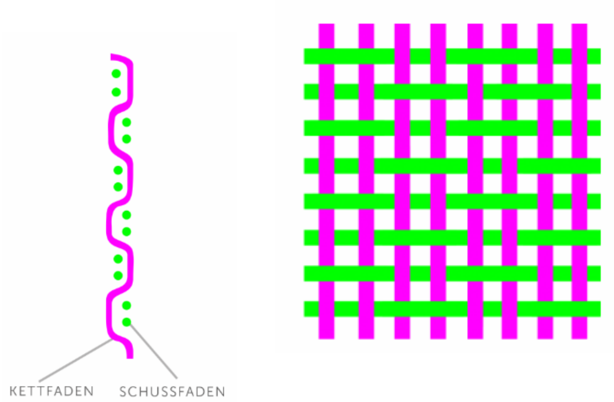

Figure 4:Schematic depiction of warp and weft threads.

PANAMA WEAVE

Panama weave, also known as cube canvas or natté, is a derivative of plain weave. To achieve the typical checkerboard, look, two warp threads float over two or more weft threads before they are tied in again. Each warp thread is tied in a checkerboard pattern, creating the image of an enlarged plain weave.

The Panama weave is preferably used for heavy fabrics with thicker yarns (twist) to avoid excessive puckering. Fabrics in Panama weave include natté, crépe romain, monk's robes, canvas, tent fabric. A classic Panama weave (almost) always has the same number of warp and weft threads per cm. Examples include tea towels, pit towels, or embroidery grounds. Panama weaves are open, air-porous, and, depending on the material, cool in summer.

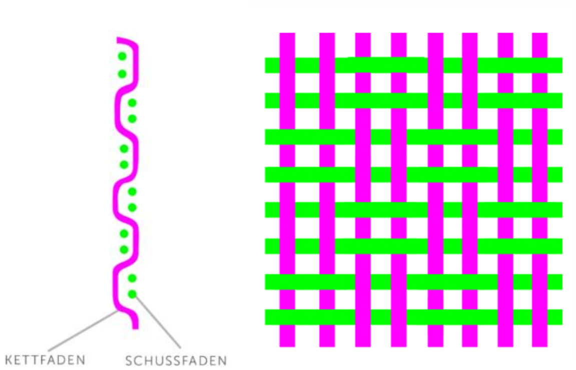

Figure 5: Schematic depiction of warp and weft threads.

CREPE WEAVE

The special crepe weave (false crepe) is mainly derived from plain weave and rib weave. These fabrics are distinguished between so-called true and false crepes. In false crepe fabrics, the warp and weft threads are irregularly interwoven, added, omitted, or rearranged during weaving (e.g., combined plain and rib weaves (crepe weave)).

For the desired irregularity of the fabric surface, neither transverse nor longitudinal stripes should appear during weaving, meaning they should not "pattern." This construction provides material properties very similar to true crepe fabric.

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There are true crepe fabrics (yarn crepe), such as crepe georgette and chiffon, or semi-crepe fabrics like crepe marocain, satin, crepe de chine, and crepe satin. These are woven in taffeta or plain weave, with smooth warp yarns and crepe yarns in the weft. The nature of the yarn is crucial for the crinkled structure of the fabric. Crepes get their characteristic appearance solely through the over-twisting of the yarns or the crepe weave.

Crepe georgette is light and airy and has a somewhat translucent appearance. Crepe marocain is a heavy, luxurious crepe fabric with a beautiful drape. Crepe de chine is a silk fabric made from crepe-twisted silk yarn in a special weaving process. Crepe satin/doubleside fabric is a fabric in satin weave, where the warp threads are made of smooth greige or organzine threads, and the weft threads are made of highly twisted crepe yarns. The fabric's surface is dominated by the weft threads.

Note: Both spellings are common for crepe: crepe or crêpe.

Figure 6: Example of crepe weave

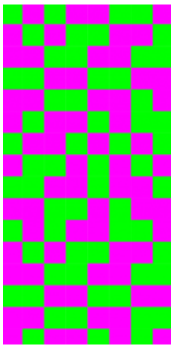

Figure 7: Cartrige image

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TWILL, SERGE

The twill weave is a weave with diagonal, parallel lines (twill ridge), which is created by the stepped arrangement of the weave points. Depending on the direction of the diagonal, one speaks of Z twill or right hand (from bottom left to top right) or S twill, left hand (from bottom right to top left).

The twill weave is the most commonly used construction for fabrics. The twill weave enables the production of equilateral fabrics K 2/2 as well as warp or weft-emphasized weaves (e.g. herringbone, pointed twill, gabardine and multi-ridge twill). Whether a fabric in twill weave is tight or open depends on the corresponding thread density. The best-known fabric with twill weave is densely set than the weft.

In most twill weaves, the warp is denser than the weft.

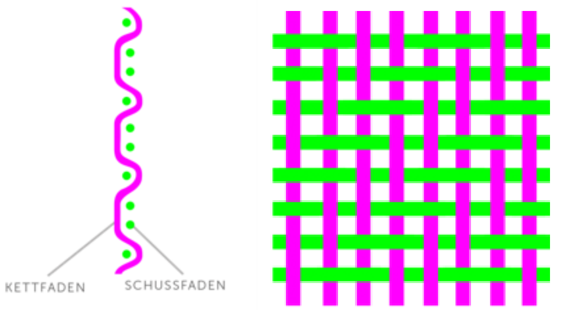

Figure 8: Schematic depiction of warp and weft threads.

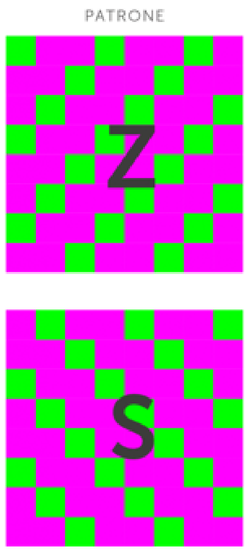

Figure 9: Left and right diagonals of the weave. Diagonal going in the right direction is marked with "Z", diagonal going in the left direction is marked with "S".

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SATIN WEAVE

The name Atlas is derived from the Arabic (Atlas = cool and smooth). The Atlas weave is very easy to recognize by the two-sided nature of the fabric. While the warp threads dominate on the top side of the fabric, the weft threads predominate on the back (hence the distinction between warp and weft atlas). The alternation between warp and weft atlas enables a variety of patterns on the fabric (see damask). The shine of the right side of the fabric is due to the long float of the warp threads and the tight setting of the warp.

Typical fabrics in Atlas weave are, for example, satin, duchesse, satinette. Disadvantage: Satins tend to slip due to the long float.

Sewing difficulties due to the light type of weave[13].

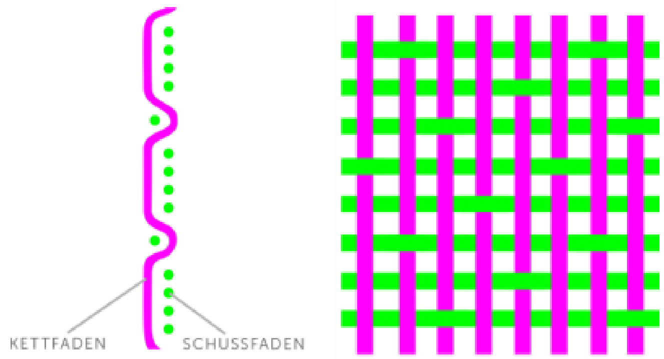

Figure 10: Schematic depiction of warp and weft threads.

[13] https://www.fashionmakery.com/makery/fabrics/textilbindungen/

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Figure 11: Example of diamond twill

The diamond twill - The lines that form the diamond are closed. They meet at all points, and a small diamond is clearly visible in the center

The diamond twill is called "Broken Diamond Twill" in English. And that's the mnemonic. Broken = Gebrochen - So, broken diamond twill.

The lines are offset from each other, forming a diamond that is open at the points, and only dots are visible in the center. [14]

[14] https://www.hannyrdi.de/

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How were textile patterns created in the 19th century?

By the 19th century, the Jacquard machine was already well established. Some schools trained individuals to develop and draw patterns for Jacquard machines. These schools existed in cities where the textile industry was well-developed. In England, the School of Design (London, Somerset House) existed as the most important institution for the education of jacquard pattern makers from 1837[15]. Thus, at the beginning of the creation of a woven jacquard pattern, there was once a designer who first designed the pattern on paper and followed a long and meticulous process before the pattern could be woven on a machine.

Before the pattern was ready to be woven, the designer had to follow several steps, which will be outlined below.

THE DESIGN OF A COLORFUL PATTERNON PAPER

The first step is to get an idea, follow the trends, consider the motifs and the purpose of the pattern and choose appropriate colours.

Figure 12: Example of hand drawn pattern

[15] The Government School of Design (victorianweb.org)

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CREATE A PATTERN WITH A REPEAT

A repeat in weaving is the smallest sequence unit of warp and weft threads which interconnect differently. A report repeats continuously in all directions. The same is true of a pattern. This pattern on the upper image above has been mapped onto the pattern paper used to draw weaving patterns. On this special paper, the proportions of the warp and weft are marked. Drawing the pattern in the repeat is a demanding, precise and time-consuming job.

Figure 13: Mirror table was used, meaning only 1/4 of the pattern had to be drawn, the rest was mirrored.

In the past, people who drew patterns by hand also used mirrors. The photo above shows how they did it. Only ¼ of the pattern is drawn on the paper on the table, but the mirrors on the table reflect the pattern in all directions. This way we can get a sense of the pattern as a whole. Nevertheless, the patterns have always been drawn in real size.

Figure 14: Cartridge / one repeat height

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CREATING JACQUARD CARDS

When the pattern sample was finished, it was handed over to the person in charge of the card punching, together with the instructions for punching the cards. Once the cards were finished, they were placed behind the Jacquard machine and the weaving process could begin.

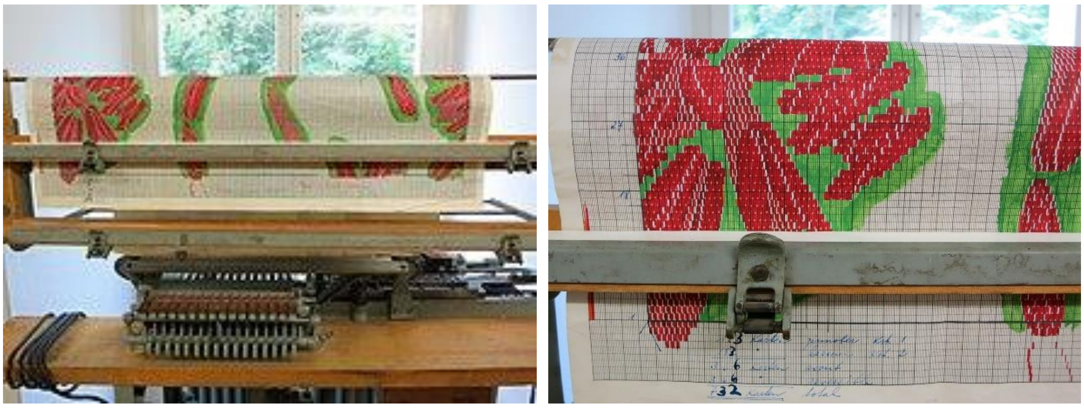

Figure 15: Cartridge mounted on card punching machine

Figure 16: Single punch cards /one punch card =one weft

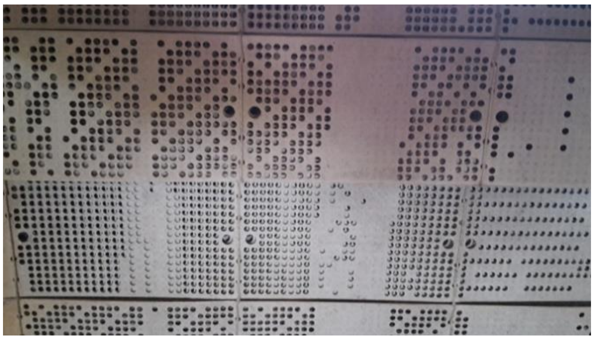

Figure 17: Transfer to a punch card

Figure 18: Finished fabric

Figure 19: Jacquard attachment

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TODAY, WOVEN FABRICS ARE SIMULATED ON THE PC

A fabric simulation is a computer-aided process used to recreate the appearance of a woven fabric. Colors, yarns and weaves are realistically applied so that excellent impressions of the expected fabric can be reproduced. Simulations are used to analyze complex problems, optimize designs, assess risks or develop new solutions. They allow different scenarios to be tested virtually before real weavings are carried out, which reduces time, costs and potential risks.

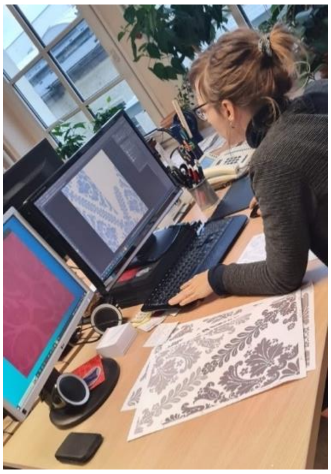

Figure 20: Computer simulation

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CALCULATIONS AND TABLES

Another important step after designing and creating binding patterns is the creation of a warping chart and/or weft chart. The warping chart is the design specification for the warping shop, which includes the color thread sequence, the yarn type, the yarn fineness, the repeat size, the total number of threads and the warping length. According to this information, the colored warps are warped and wound onto the weaving beams. At the same time, you can also write so-called weft charts for colored weft sequences so that you achieve a harmonious sequence when designing.

Figure 21: Weft chart, production information

Fact! Getting confused: It is not an easy task to stretch the pieces of paper properly. The threads are long. It can happen that you "get confused" when stretching them. This means that the pieces of paper get mixed up and tangled up.

Warping is the parallel winding of threads in the thread density of the warp, usually with withdrawal from a creel. The warp is the total number of threads on a warp beam.

WARPING

Function of warp warping: Warp warping is an intermediate step between spinning and weaving. To form a textile surface, the individual threads must first be brought together in parallel to form a multitude, a warp. They form the so-called warp, which is then crossed with the weft threads during weaving. The production of the warp is the aim of warp warping. The threads of the warp are wound onto the so-called warp beam, which is then transported directly to the weaving mill. The work of the warp warper was relatively highly regarded, as a proper warp was a basic prerequisite for smooth running in the loom.

Structure of the warp warping machine: The warp warping machine includes the warping creel, the warping drum and a beaming device. The bobbins are attached to the warping creel. From there, the threads pass through a picker blade to the warping blade, which regulates the sliver density, and on to the warping drum, on which they are wound. Once all the required slivers have been warped, they are unwound onto a warp beam, which can then be attached to the loom.

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Figure 22: Warping machine

Figure 25: Historical warping gate

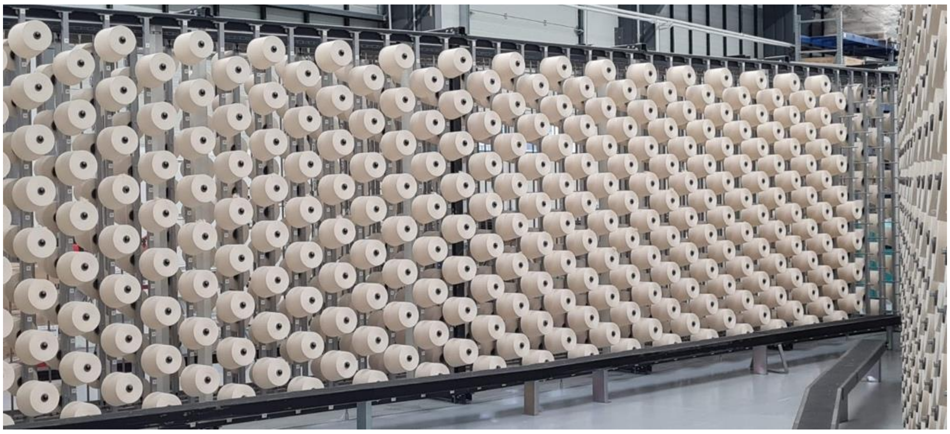

Figure 23: Modern gate example

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REED

A reed is a part of a weaving loom that looks like a comb or a frame with many vertical openings. It helps keep the vertical threads, known as warp, separated and evenly spaced. The reed also guides the shuttle, which carries the thread across the loom, and pushes the horizontal threads, called weft, into their correct position. In simple terms, the reed is essential for organizing and guiding the threads in weaving.

Figure 24: Reed examples

CALCULATION OF THE WARP

Before a worker started the actual work on the warping machine, he first had to observe the data supplied to him in the form of the warping certificate together with the yarn. The warping certificate contained information about the required properties of the warp:

- The warp length, which is determined by the length of fabric to be produced.
- The warp width, which is based on the required fabric width.
- The warp thread density, i.e. the number of warp threads per 10 cm width.
- The total warp thread count, which is calculated by multiplying the warp thread width by the warp thread density.
- The warp thread sequence or warping sequence, which depends on the fabric pattern.
- The warper now had to calculate the warp himself.

For Example:

The following warp calculation is taken from the "Description and Instructions for Operating the Cone Warping Machine Model KZ" by the company Sächsische Webstuhl-Fabrik Louis Schönherr. It was assumed that a warp with a total number of 4800 threads was to be warped.

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The total width of the warp should be 168 cm, and the total length of one piece should be 36 m. A total of six pieces of cloth were to be woven from this, so the entire warp would be 36x6 m, or 216 m long. It was further assumed that a spool creel with 400 pegs (as shown in the picture) was available. The fabric to be produced had a pattern repeat of 89 threads, which fit four times on the frame, resulting in 356 threads. To reach the total number of 4800 threads, the warper had to warp 13 bands of 356 threads each and one remaining band with 172 threads.

The warper had to ensure that the number of threads per band was always an even number, as otherwise a double thread would have been created when crossing the threads, for example, if the last thread of the first band was at the bottom, and the first thread of the following band was also at the bottom in the reed. Since the number of threads per band should be divisible by two due to the reed and should also correspond to a full warping repeat, the warper chose a number of threads that was as close as possible to the total capacity of the spool creel.

He then calculated the width of the tape: the warp width was multiplied by the number of tape threads, divided by the total number of threads. This resulted in a width of 12.4 cm per belt for the 13 full belts. Each machine had two warping blades. The warp warping machine had one warping blade with 90 reed gaps (tubes) and a second with 100 tubes, each 30 cm long. The warper had to choose the blade that produced the least excess over the 12.4 cm strip width. In the case assumed here, the 90 reed would be used and 39 tubes would be covered with 9 threads each, the 40th tube with four threads. This would result in a width of approx. 13.3 cm per belt if the warping blade is parallel to the drum. This dimension is obtained by multiplying the length of the warping blade by the number of reed gaps used and dividing by the total number of reed gaps in the warping blade. To achieve the required width of 12.4 cm, the warper had to slant the warping blade with a screw so that the width measured behind the warping blade was 12.4 cm.

The warper used a folding rule or tape measure to check the width. For these calculations, the warper had to make notes.

WARPING AFTER 1990

In the newer case, the computer calculates how many ribbons are needed by entering the thread density and the weaving width. However, the task here is still to use the thread density and the number of threads, e.g. Nm 80/2 cotton as warp yarn and a thread count of 10560 threads on a width of 134cm, to calculate the required kilograms so that enough yarn is available for the warp warping.

Figure 25: Modern warping machine

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NEXT STEP “ABBÄUMEN“:

Once the skimmer had skived the required number of belts, he had to cut the chain. Then all the straps were knotted to the iron rod provided. When knotting, the warper counted the 16 ribbons again as a precaution. The warp discs then had to be adjusted exactly to the weaving width. The distance had to be the same on both sides of the warp beam. The discs had to be positioned and also centred by the warper. If the warp discs were set too narrowly, the threads would have reared up on the right, i.e. run up the right edge. If, on the other hand, the warper set the discs too far apart, the threads would fall down at the edge, resulting in the so-called ‘collapsed edge threads’. The warping drum also had to be positioned exactly in line with the beaming machine so that the upper layer of the warping drum chain ran exactly between the beam discs. The warper guided the chain over the moulding tubes and brake bars to the warp beam and fastened the iron rod to the canvas sitting on the warp beam with knots.

In order to set the beaming machine in motion, the gear had to be adjusted, because the beaming had to be done with the correct tension. This could be regulated by the skimmer using weights. This adjustment required experience and was purely a matter of feeling: ‘An experienced worker feels with his hand during the beaming process whether the warp is taut enough...’ The weaving chain had to be guided precisely between the tree discs during the entire reaming process. However, as the bottom warp layer was reamed sideways next to the top layer, the machine had to be shifted by the previously calculated width. The warper made certain machine settings so that the warping drum shifted by the required amount during the beaming process to ensure that the warp threads ran exactly between the beam discs.

The warp threads should also lie evenly on the warp beam. The warper constantly felt the unwinding warp to check its run and tension. He could correct small errors by hand. ‘If you'd been beaming and one of the belts wasn't running smoothly, you'd quickly put a little bit over it so that it was smooth afterwards.’

As soon as the last half turn of the warp appeared on the warping drum, the warper stopped the machine and continued to wind the threads onto the warp beam by hand only, although here too he had to maintain the required tension. Finally, he detached the tapes from the drum's suspension pins and tucked the thread ends under a few warp threads. This completed the beaming process and the warp beam could be transported to the weaving mill. Transporting the warp beam to the weaving mill was cumbersome and always required the help of several workers. The warp beam was unhooked and transported to the stairs on a warp beam trolley. Four colleagues carried the full warp beam down the steep stairs to the weaving mill using the warp beam carrying handle.

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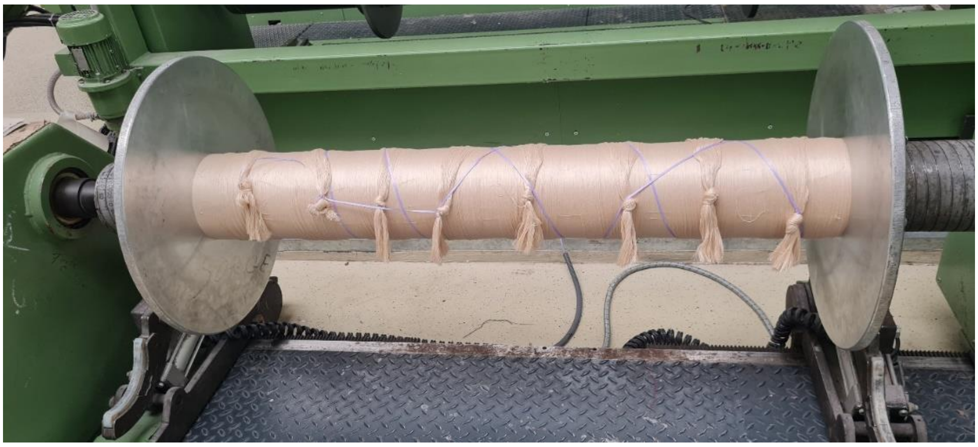

Figure 26: Warp beam

A historical speciality, today the yarn is treated with an avivage during the finishing process if necessary: Gluing

Gluing was used as an aid to make the warp threads more resistant to the subsequent rigours of weaving. Gluing or 'sizing (levelling, smoothing) is the original name of this work, which consists of smoothing fibres and rough areas by means of a sticky substance and preparing them in such a way that they do not roughen again through friction, that the sized threads do not lose their elasticity but gain hold; that finally a large number of threads lying next to each other dry quickly, do not stick together and do not become hard or brittle'. [16]

It should be noted that in a cloth factory, for example, it did not play a major role because wool, unlike cotton, already had a certain fat content and thus the necessary smoothness.

The warp threads produced first ran through a sizing trough in which the warp was soaked with glue. It then passed through two squeezing rollers, through which excess sizing agent was removed. The warp threads then passed over a roller and the superstructure into a drying box, where they were exposed to warm air. The warp finally travelled over a take-off beam to a beaming machine, where it was wound up. This prepared the warp for the rigours of weaving. The warper mainly stayed between the two beams. This allowed him to watch the warp enter the glue trough, run over the superstructure, run out of the drying chamber and be wound onto the yarn beam. The release rod was also within reach on the machine superstructure.

The glue 'A good preparation' of the sizing or gluing agent is of great importance. In any case, the mass must always be fresh and as odourless as possible.' [17]

Sizing agents used in the production of woollen cloth, for example, should be water-soluble so that they can be easily removed later during textile finishing.

The chain was treated with a solution of animal glue, which was a product of the decomposition of various animal body parts by water and heat. The glutin (identical to gelatine) produced from bones and skin had a high adhesive capacity. Unlike in the cotton and linen processing industry,

[16] H. Voigt, Die Kunstweberei auf Handstühlen; Die Weberei, vol. 1, Weimar 1863, p. 22, quoted from: Westfälisches Industriemuseum, p.77
[17] Gröbner/Grote 1951, p. 401

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where a large number of different substances were added to the sizing agents, glue was processed in the wool industry with little or no additives. Occasionally tallow was added, potato starch or Icelandic moss was used.

The purpose of the glue was to give the yarn greater strength, but the thread was still supposed to remain rough. That is why it was not brushed afterwards. This would have made the beading process more difficult during finishing.

Activities and requirements: The warper had to unhook the full warp beam from the warping machine and feed it to the gluing machine. The so-called front beam was stored on trestles that were mobile so that beams of different widths could be used. The help of colleagues was also needed to transport the warp beams from the warping machine to the gluing machine. From the front beam, the entire width of the warp was fed over various rollers into the sizing trough. This was a so-called double trough. A copper glue trough was suspended in a water trough, the contents of which were heated by a steam pipe.

This allowed the glue to be kept evenly warm. It also prevented it from sticking to the steam pipes and rollers, which could easily have been the case with direct heating. In the sizing trough, the warp threads were passed between two rollers. One of the two, the so-called pressure roller, could be loaded more or less by weights so that the worker could leave more or less glue in the warp as required. Excess glue was removed by the other roller. Once the chain had passed the glue trough, it was guided over a roller and the superstructure of the machine and then entered the drying machine. The drying chamber was a box that was closed on all sides with windows so that the worker could watch the chain run. Warm air was fed into the drying chamber, which was sucked in by two wind vanes through channels on the side and forced through the chain. The chain had little contact surface during this process, which prevented it from sticking. The wind blades pushed the moist air through a large opening in the ceiling of the box. From there, it was channelled through a wide pipe through the west wall of the room to the outside. To make the work of running in the threads easier, a traveller was stretched in front of the warp threads, which pulled them into the machine. They were attached to it - as on the warp beam - with an iron rod.

This procedure not only had the advantage of making work easier. If the chain had run directly through the drying box, it would have had to be preheated for a long time so that the first piece of chain was not reeled up undried. So the traveller passed through first. During this time, the drying box was warmed up and the chain was exposed to the correct temperature. The traveller was therefore a kind of pre-run cloth. A trigger bar behind the drying box regulated the chain tension, which meant that any desired tension could be applied to the wet chain in the drying box. Only when the chain was completely dry was it wound up with high tension. Once again, the worker had to ensure that the warp always ran exactly between the discs of the yarn beam. He could move the beaming machine during the run.

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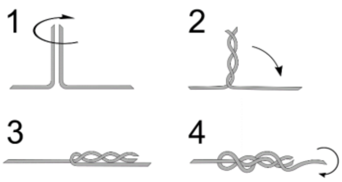
TAMING THE WARP

In weaving, the purpose of warping is to avoid the time-consuming process of drawing in a new warp. It establishes the connection between an expiring (woven) warp with the new one (technical jargon: a warp is turned on).

The connection is so tight that the thread ends of the old warp are used to pull the new threads through the thread eyes of the healds (shaft) or jacquard healds through the reed.[18]

Figure 27: Warping process

Manual tightening process



1. The two thread ends are bent (usually with thumb and forefinger) at right angles (approx. 2-3 cm)
2. The bent thread ends are twisted together (twisted)
3. The twisted ends are bent at right angles to the warp thread of the new warp
4. The twisted end is twisted with the new warp thread

A paste containing glue and some chalk was often used for attaching the chains.

[18] https://sachsen.museum-digital.de/object/49893

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Until the late 1950s and early 1960s, the chains were still attached manually and took four to eight hours, depending on the chain and the experience of the worker! In large companies, there were even set-up crews just for this work. These specialists managed a remarkable 800 to 900 knots per hour by hand.

Hand knotting was increasingly replaced by machine knotting.

Figure 28: A warp-tying machine

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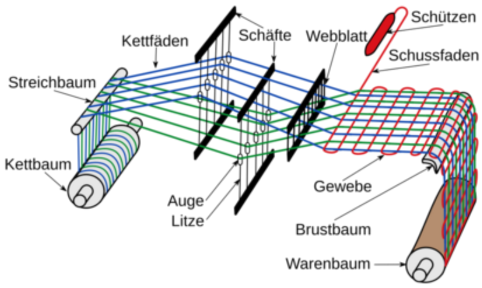
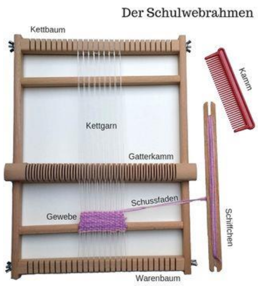
Figure 29: Cammann Gobelin Manufaktur / Braunsdorf / Sachsen[19]





The Jacquard control technique brought a particular perfection to weaving. Joseph-Marie Jacquard invented the machine named after him around 1800. This made it possible to weave even the most complicated patterns by scanning perforated strips. Unlike the dobby machine, which could raise and lower two or more shafts in their up and down movements and therefore only entire groups of threads, the Jacquard machine made it possible to control each individual warp thread.

This is done by means of needles that scan a perforated plate. The punched cards, which have holes in many but not all places, run over this plate. At the points where the scanning needles do not find any holes in the card or in the perforated plate, the resistance triggers unhooking of the warp threads concerned. These warp threads are not lifted to form the shed, but are carried along on the underside of the fabric ‘invisibly’ for the pattern.

The so-called lifting box change is also important for the weaving mill.

[19] https://de.wikipedia.org/wiki/Webmaschine

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Figure 30: Shuttle with weft thread

Figure 31: Manual Shuttle box

A movable shuttle box with usually four slots is attached to the left and right of the drawer, allowing weaving with a maximum of seven shuttles. The shuttle change can be used to change colours within the motif, for example for adjacent stripes in different colours.[20]

Figure 32: Depiction of a shuttle moving between lifted warp threads

[20] http://gepete.de/weben/Huebschmann_Kap_B1_np.pdf

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Summary

Here are the basic steps of weaving.

- **Preparation of the warp:** The warp threads are wound onto a warp beam. These threads run in the longitudinal direction of the fabric.
- **Setting up the loom:** The warp threads are threaded through the heddles and the reed of the loom. The heddles raise and lower the warp threads to create the shed.
- **Inserting the weft:** The weft thread is passed through the shed with a shuttle or another insertion tool. This is done alternately over and under the warp threads.
- **Closing the shed:** After the weft thread is inserted, the shed is closed, and the weft thread is beaten firmly against the already woven fabric with the reed.
- **Repeating:** This process is repeated until the desired fabric is completed.[21]

[21]https://industriemuseum.lvr.de/media/imus/museum/mediencenter/eus_3/forschungsprojekt_tuchfabrik/09_Webvorbereitung_Martina_Wirtz.pdf

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Useful links

- https://industriemuseum.lvr.de/media/imus/museum/mediencenter/eus_3/forschungsprojekt_tuchfabrik/09_Webvorbereitung_Martina_Wirtz.pdf
- https://de.wikipedia.org/wiki/Webmaschine
- https://sachsen.museum-digital.de/object/49893
- www.sciencephoto.com
- https://www.fashionmakery.com/makery/fabrics/textilbindungen/
- https://www.handweb-museum.de/zur-geschichte-des-webens/
- https://www.kymo.de/de/blog/weben-uraltes-und-smartes-kunsthandwerk
  https://palundu.de/handarbeit/weben

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