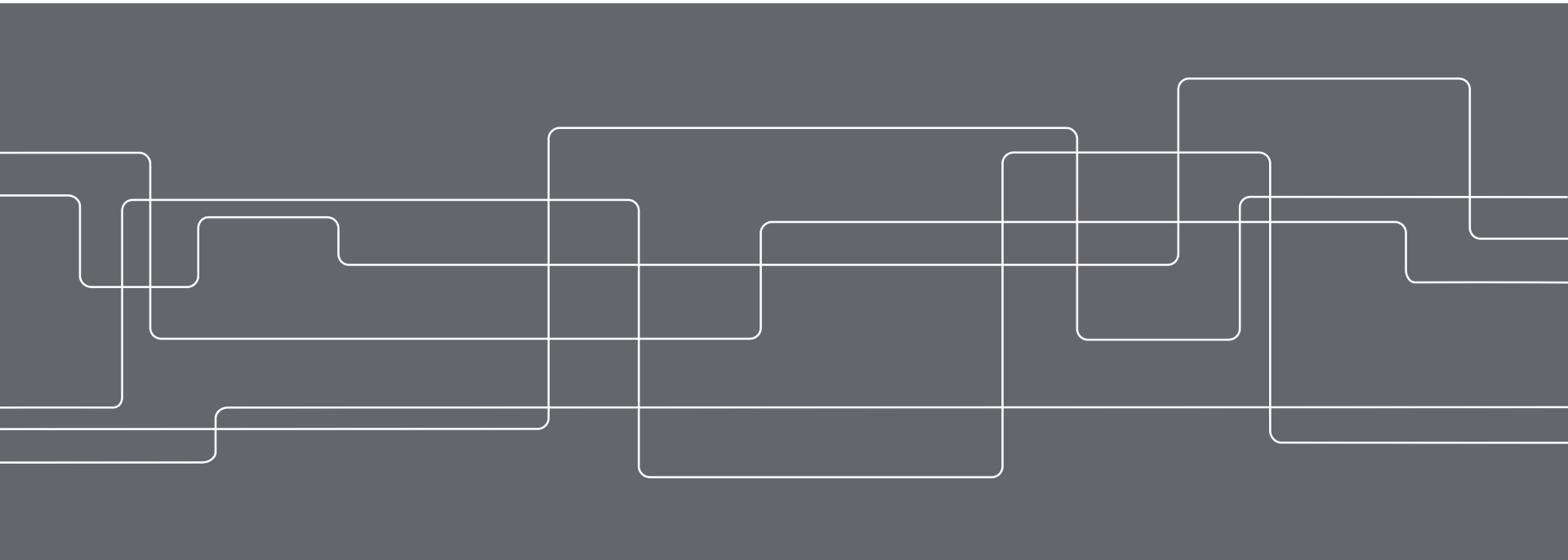
Assembly Technology

Lecture 8: Textile Industry



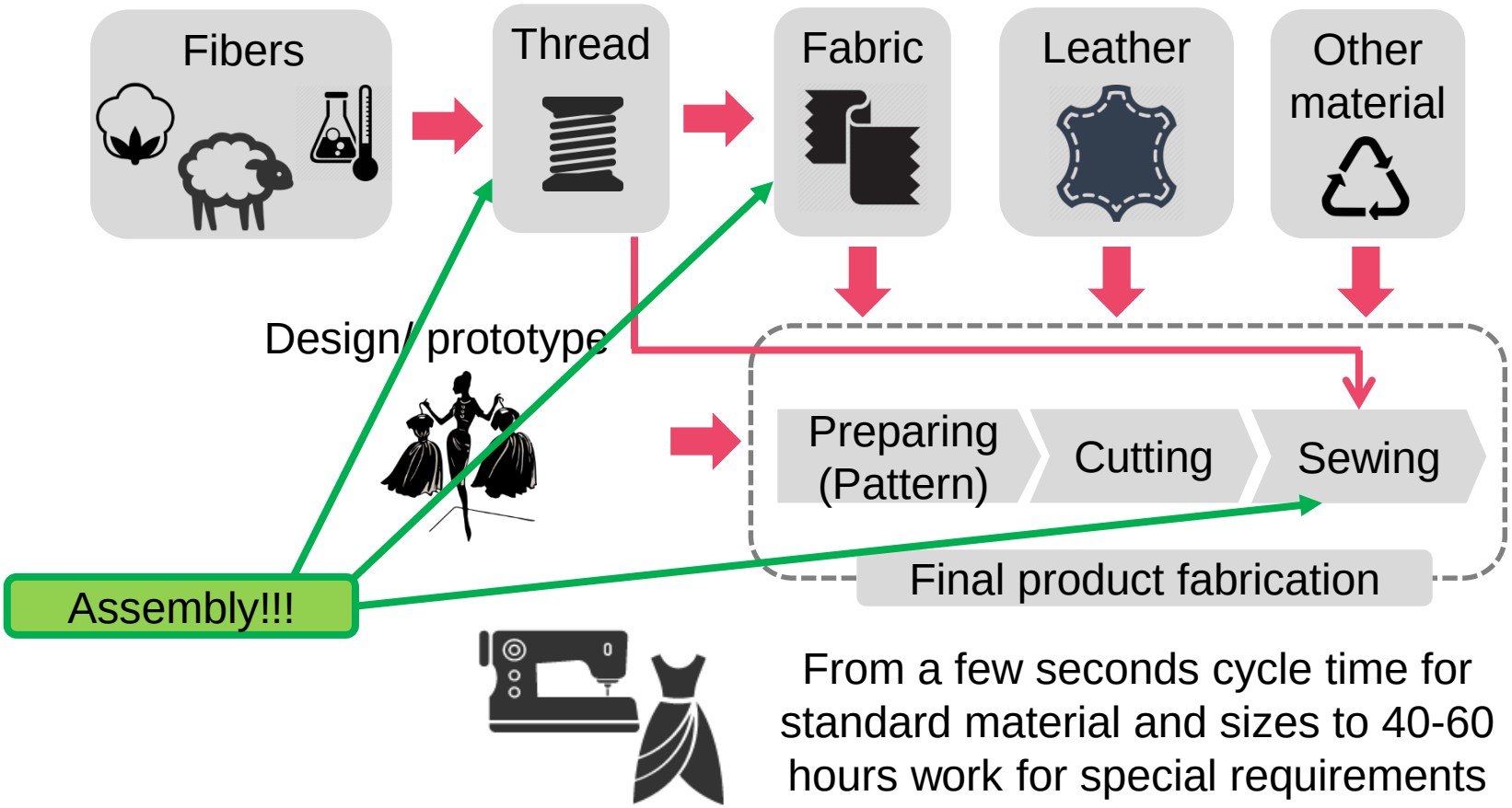
Outline

- The role of assembly in textile industry
- Thread
- Fabric
- Origin of sewing
- The sewing process in 4 elements
- Introduction to manual, machine and automatic sewing
- Assembly role in the typical textile process chain
- The sewing process: relevant constructs, parameters and related equipment

Intended Learning Outcome

- Position and describe all the embodiment of the assembly processes in the textile industry with particular enphasis on the aspect of mechanization and automation
- Describe the key processes and related parameters of the assembly process in textile industry and the equipment used to perform it.
- Calculate some basic parameters related with the sewing process.

Simplyfied process chain for textile and similar



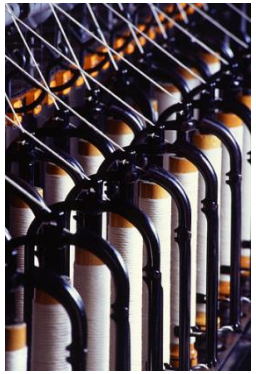
From a few seconds cycle time for standard material and sizes to 40-60 hours work for special requirements

Fibers, yarn and thread

Yarn is a long continuous length of interlocked fibres, suitable for use in the production of textiles, sewing, crocheting, knitting, weaving, embroidery, and ropemaking. Thread is a type of yarn intended for sewing by hand or machine. Modern manufactured sewing threads may be finished with wax or other lubricants to withstand the stresses involved in sewing.

Spools of thread

S- and Z- twist yarn



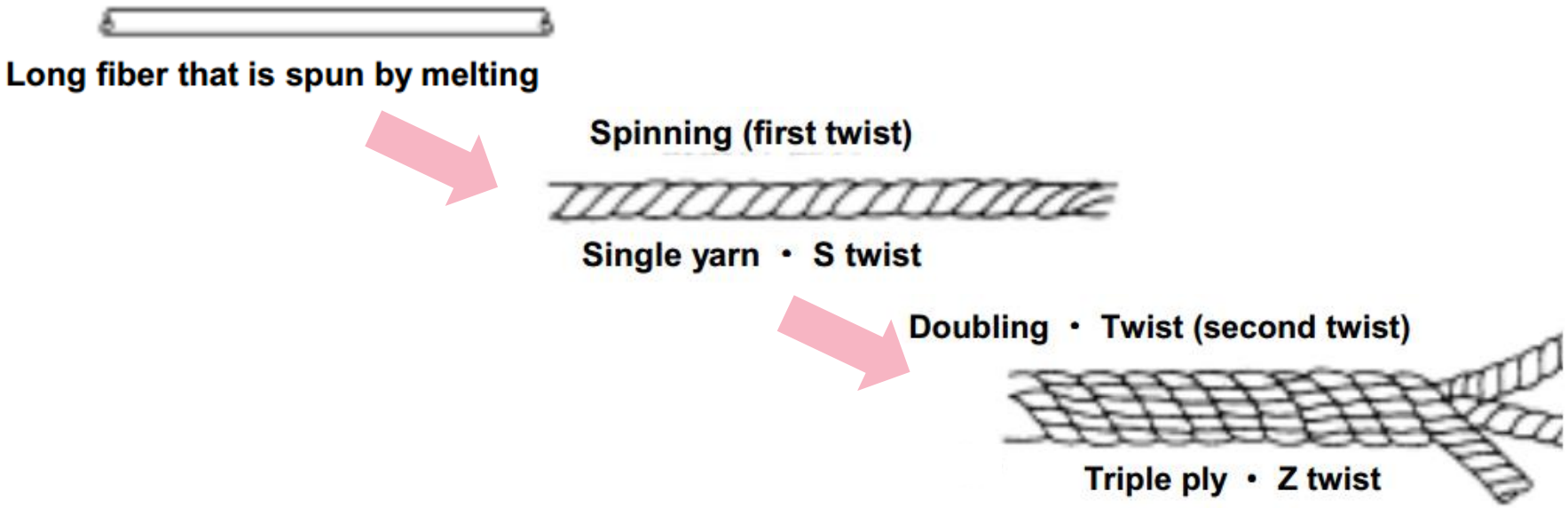
Cotton being spun

Construction and manufacturing processes of the sewing thread

- Natural textile products such as cotton thread, silk thread, etc. have been used as sewing thread before.
- Nowadays, however, chemical fiber products such as polyester thread, nylon thread, etc. are largely used.
- There are different kind of threads for different uses and with different manufacturing processes. In detail, the most important are:
  - Filament thread
  - Spun thread
  - Woolly thread
  - Mono-filament thread

Filament thread

Filament thread means that left twist (Z twist) is applied to the thread after right twist (S twist) is applied to the filament (long fiber) that is spun by melting and doubling of 2 to 3 filaments is performed:



Spun thread

Spun thread means that left twist (Z twist) (second twist) is applied to the staple (short fiber) after doubling

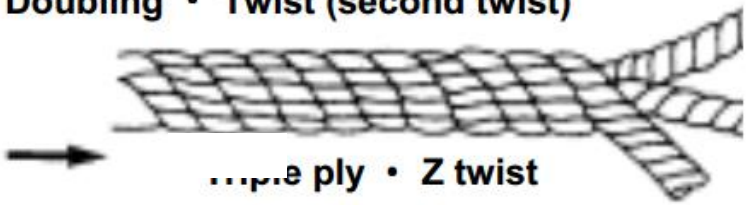
(first twist) of right twisted single yarn and doubling of 2 to 3 yarns is performed.

Short fiber such as cotton and synthetic fiber (Synthetic fiber means that the long fiber that is spun by melting is cut into the short fiber.)

Twist (first twist)

Single yarn • S twist

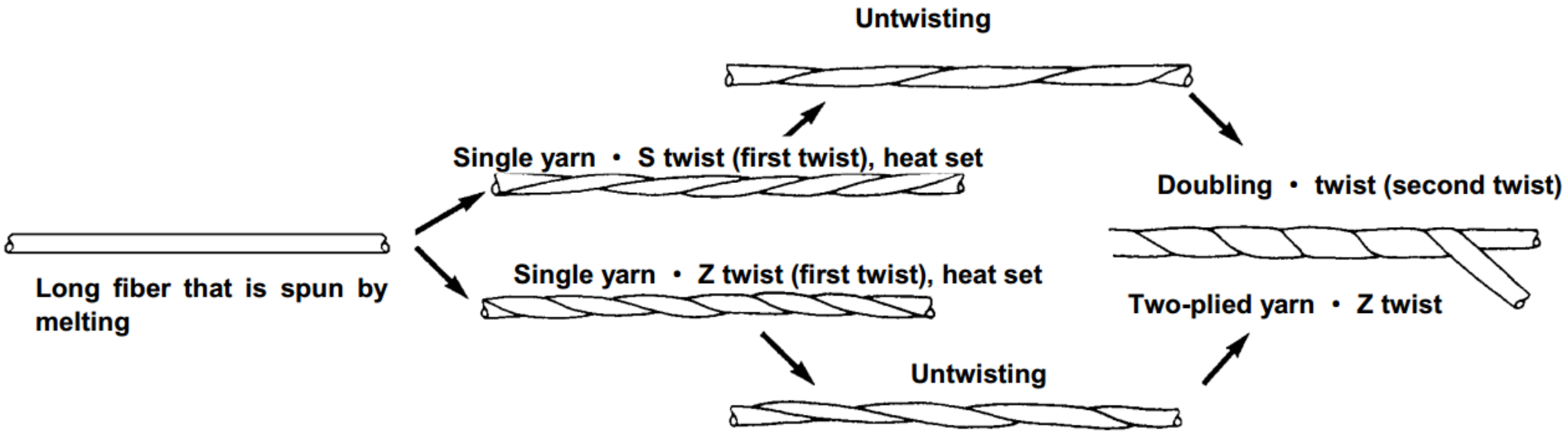
Doubling • Twist (second twist)



…ple ply • Z twist

Wooly thread

Filament yarn is performed the first twist and the twist is returned after superheating setting in the state that the yarn is strongly pulled. Wooly thread is a thread that doubling of these two yarns is performed and the twist is applied. This thread is called filament expansion processed thread.

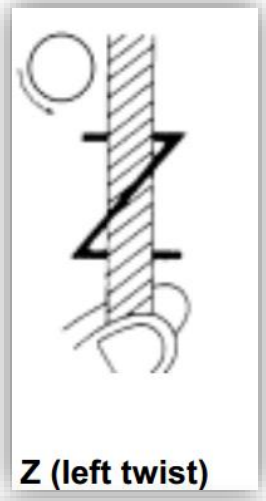


Mono-filament thread

This thread is just the same as long fiber that is spun by melting and a long yarn without twist. In addition to sewing thread, this thread is used for fishing thread or the like.

Long fiber that is spun by melting

Twist of the sewing thread



- Twist of the sewing thread is normally carried out by doubling 2 to 3 yarns and applying left twist (called second twist) to the yarns after applying right twist (called first twist) of single yarn.
- The reason is that return of the twist due to the rotation of the hook should be protected and that in case of normal stitching, the form becomes stable since friction between needle eyelet and thread is small and return of twist of thread is difficult to move. On the contrary, when the right twisted thread is used in normal stitching, friction between needle eyelet and thread is large, and the twist is easy to move. Then, the thread loop in the state of return of twist is formed, resulting in stitch skipping or thread breakage plying right twist (called first twist) of single yarn.

Numbering of thread thickness

- Thread thickness is calculated from the mutual relations between length and weight.
- The thickness is not represented by the diameter since the cross section of fiber is not a circle. Therefore, the thickness is represented from the relations of "length" and "weight".
- Two different systems for representation:
  - Length numbering system: based on the length
  - Weight numbering system: based on the weight

Lenght numbering system

Used for fibers. Two sub-system. Decitex (dtex) and Denier (D)

1. Decitex (**dtex**)
   - Decitex is called "1 dtex" when a piece of yarn, weighing 1 gram, is 10,000 meters long, and "2 dtex“ when weighing 2 grams.
   - The basic unit is called tex and it refers to 1,000 meters long thread
   - This numbering is the numbering system for the thickness of sewing thread for industrial sewing machine to be applied to all threads.
2. Denier (**den** or abbreviated **D**)
   - Denier is called "1 Denier" when a piece of yarn, weighing 1 gram, is 9,000 meters long, and "2 Denier“ when weighing 2 grams.
   - This numbering is used for silk thread, synthetic filament thread (polyester thread, nylon thread, etc.)

Lenght numbering system: dtex

- When measuring objects that consist of multiple fibers, the term "filament tex" is sometimes used, referring to the mass in grams per 1000 meters of a single filament.
- Tex is used for measuring fiber size in many products, including cigarette filters, optical cable, yarn and fabric.

Lenght numbering system: dtex

One can calculate the diameter of a filament yarn using tex with the following formula:

$$Diameter = \sqrt{\frac{dtex}{10000 * density * 0.7855}}$$

with density in grams per cubic centimeter and diameter in millimeters.

Lenght numbering system: Denier

- In practice, measuring 9000 meters is both time-consuming and unrealistic. Generally a sample of 900 meters is weighed, and the result is multiplied by ten to obtain the denier weight.
- A fiber is generally considered a microfiber if it is one denier or less. The term *microdenier* is used to describe filaments that weigh less than one gram per 9000 meters.
- A one-denier polyester fiber has a diameter of about ten micrometers.
- In tights and pantyhose, the linear density of yarn used in the manufacturing process determines the opacity of the article in the following categories of commerce: ultra sheer (below 10 denier), sheer (10 to 30 denier), semi-opaque (30 to 40 denier), opaque (40 to 70 denier) and thick opaque (70 denier or higher).

Lenght numbering system: Denier

- One can distinguish between *filament* and *total* measurements in deniers. Both are defined as above, but the first relates to a single filament of fiber — commonly known as denier per filament (**DPF**) — whereas the second relates to a yarn.
- The following relationship applies to straight, uniform filaments:
  - DPF = total denier / quantity of uniform filaments
- Broader terms such as 'fine' may be applied, either because the overall yarn is fine or because fibers within this yarn are thin. A 75-denier yarn would be considered fine even if it contains only a few fibers, such as thirty 2.5-denier fibers, but a heavier yarn, such as 150 denier, is only considered fine if its constituent fibers are individually as thin as one denier

Lenght numbering system: Denier

One can calculate the diameter of a filament yarn using denier with the following formula:

$$Diameter = \sqrt{\frac{Denier}{9000 * density * 0.7855}}$$

with density in grams per cubic centimeter and diameter in millimeters

More on thread classification

Thread sizes can be also classified according to the nominal count (thread count)

Filament thread and spinning thread are different in the total size although "nominal count" is the same.

Thread made from two threads plied together, each consisting of three yarns

Weigth numbering system

For thread and yarn. Two sub-systems. Metric number and English number

1. Metric number
   - Metric number is called "Nm 1" when a piece of thread, weighing 1,000 grams, is 1,000 meters long, and "Nm 2" when the thread is 2,000 meters long.
   - This numbering is used for worsted and woolen yarn.
2. English number for cotton
   - English number for cotton is called "Ne 1" when a piece of thread, weighing 1 pound (453.6 g), is 840 (768.1 m) yards long, and "Ne 2" when the thread is 1,680 yards long.
   - The thickness of cotton single yarn is represented by English numbering. This numbering is used for cotton thread, silk spinning and staple fiber.

Melting point and softening point of sewing thread

Both points are the indication of thermal resistance:

- Melting point means the temperature that sewing thread melts by heat.
- Softening point means the temperature that the thread starts softening by heat.

Especially, in case of synthetic thread, stitch skipping or thread breakage occurs according to the circumstances. Accordingly, the thermal resistance is one of the important points. In addition, the thermal resistance affects the temperature setting of iron and press in the rear process. It is necessary to select a proper sewing thread after considering these factors.

Melting point and softening point of sewing thread

	Polyester	Nylon 6	Nylon 66	Vinilon	Cotton
Melting point	255 to 260° C	215 to 220° C	250 to 260° C	Unknown	Decomposed at 150° C
Softening point	238 to 240° C	180° C	230 to 235° C	220 to 230° C	None

Strength and ductility of the sewing thread

The force that is required to cut sewing thread by applying a load to the sewing thread in a certain direction is called "strength". Percentage of elongation at this time is called "ductility".

Both the strength and the ductility are essential basic quality of sewing thread. For example:

- Strength, when sewing heavy-weight materials, it is necessary to sew with sewing thread having high strength since thread breakage is apt to occur. It is the same in case of preventing thread breakage or puncture when wearing the clothes.
- Ductility, if it is excessive, it will be the cause of seam puckering or stitch skipping, and if it is too low, it may be the cause of thread breakage. In addition, when wearing clothes, thread breakage may occur unless there is the proper ductility

Normally, when the strength and the ductility are simply used, they mean "pull strength and pull ductility". For other items, there are "hook strength and hook ductility" and "knotting strength and knotting ductility"

Manufacturing of Tread/Yarn

Textile Spinning and direct extrusion in filament. The latter one can be considered as “process-like” assembly of fibers.

Video:

- How is made cotton yarn (textile spinning) (4:49)
- Plastic Yarn extrusion (3:11)

Manufacturing of Fabric and textile

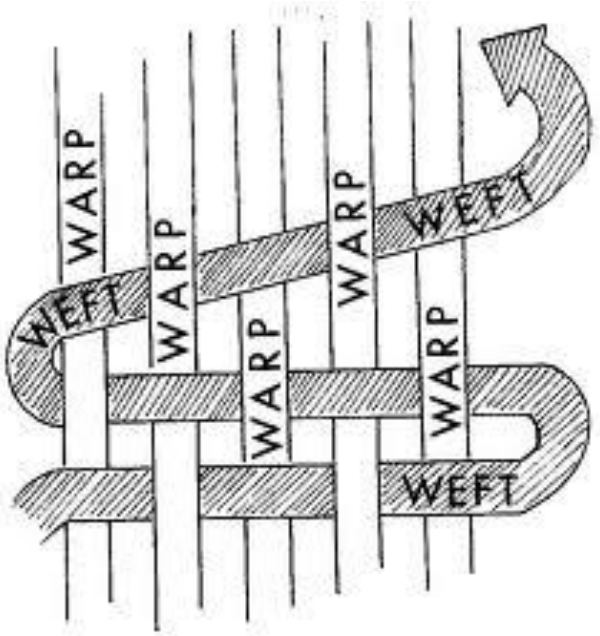
Several different processes available. Three main families:

- Using thread
- Leather
- Synthetic (extrusion)

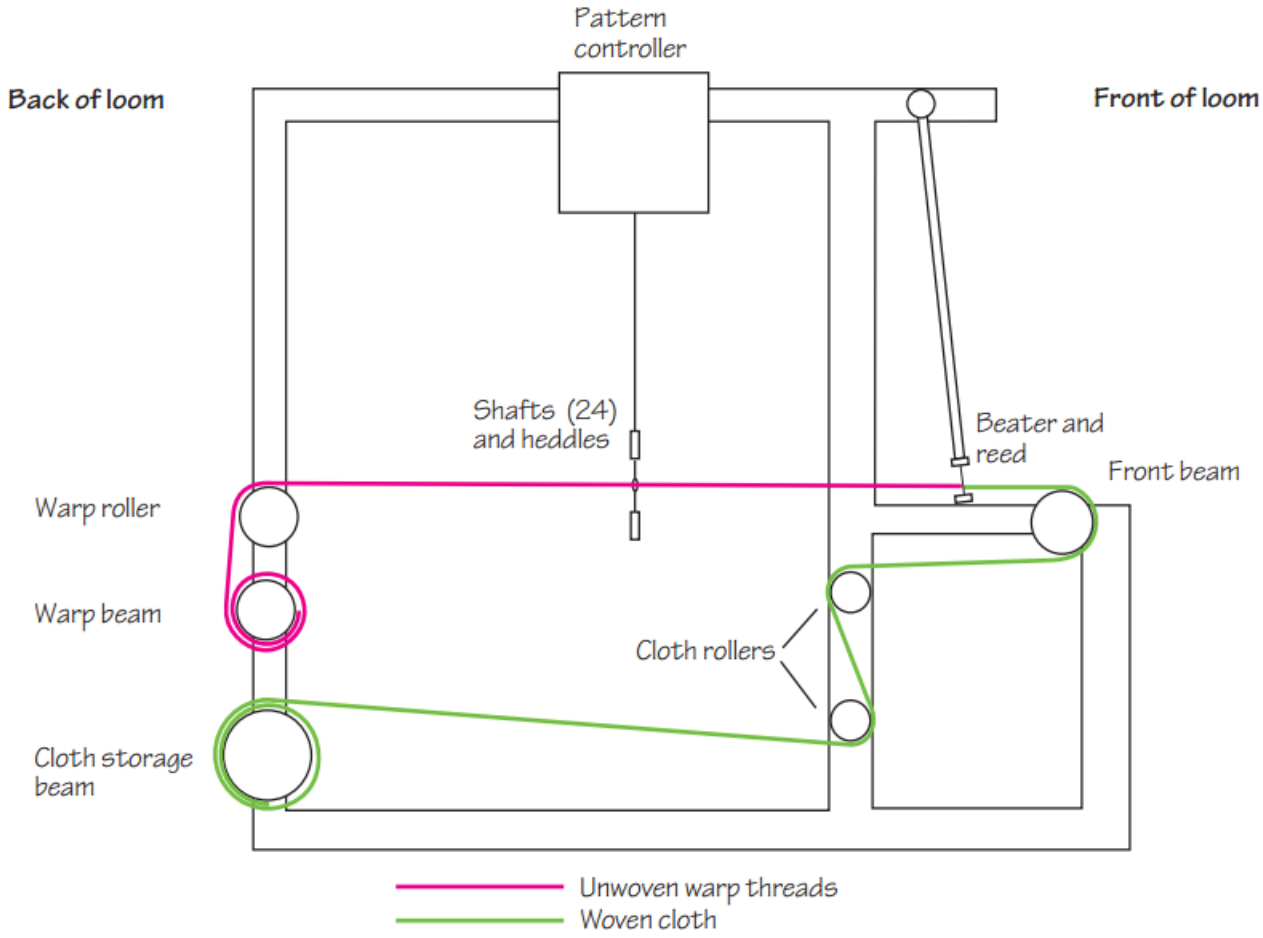
Not in the assembly domain

Manufacturing of Fabric and textile: threadd based

- The weaving process uses a loom. The lengthway threads are known as the warp, and the cross way threads are known as the weft. The warp which must be strong needs to be presented to loom on a warp beam.
- The weft passes across the loom in a shuttle, that carries the yarn on a pirn. These pirns are automatically changed by the loom. Thus, the yarn needs to be wrapped onto a beam, and onto pirns before weaving can commence

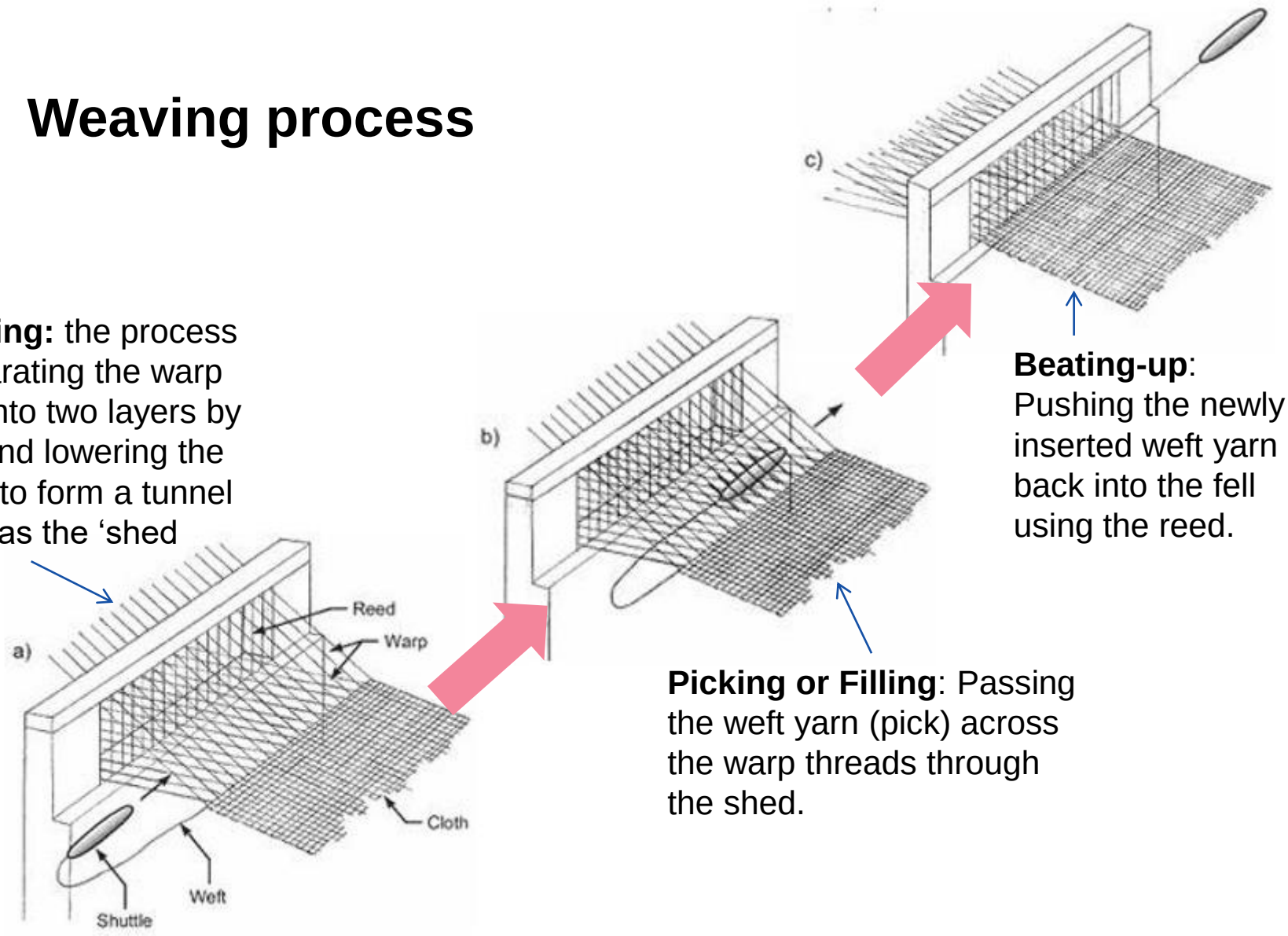


Simplified loom



Weaving process

Shedding: the process of separating the warp yarns into two layers by lifting and lowering the shafts, to form a tunnel known as the ‘shed



Picking or Filling: Passing the weft yarn (pick) across the warp threads through the shed.

Beating-up: Pushing the newly inserted weft yarn back into the fell using the reed.

Shedding

Weaving machines control the warp yarns to create a shed. This can be accomplished with the following systems:

- Crank shedding
- Cam shedding or tappet shedding
- Dobby shedding
- Jacquard shedding

Crank, cam and dobby mechanisms control the harnesses which lift the shafts. Jacquard machines control the individual warp yarns.

Crank shedding

Crank shedding mechanisms are simple and relatively cheap to use. However it can only be used for plain weave fabric constructions. In this system the harnesses are controlled by the crank shaft of the weaving machine. For each crank shaft revolution a wheel is rotated half a turn, which changes the harness position. This system is only used in air-jet and water-jet machines where high speed is achieved.

Cam shedding or tappet shedding

Cam shedding is also simple and inexpensive. A cam is a disk which has grooved or conjugated edges which corresponds to the lifting plan. The lifting plan controls which harnesses are lifted. The disadvantage of cam shedding is that when the woven design has to be changed the cams have to be rearranged to suit the new design. Pattern design is also limited due to the amount of harnesses the cams can control.

Dobby shedding

Dobby shedding is more complex than crank and cam systems. The main advantage of dobby looms is that more intricate designs can be produced. Older dobby looms were operated by wooden lags with pegs, which rotated around a roller above the loom. The pegs in the lags correspond to the lifting plan, which controls which harnesses are lifted. Punched paper or plastic pattern cards can also be used. Recently modern dobby looms are controlled via an electronic system. The disadvantage of dobby systems is that faults are more likely to occur due to there complexity

Jacquard shedding

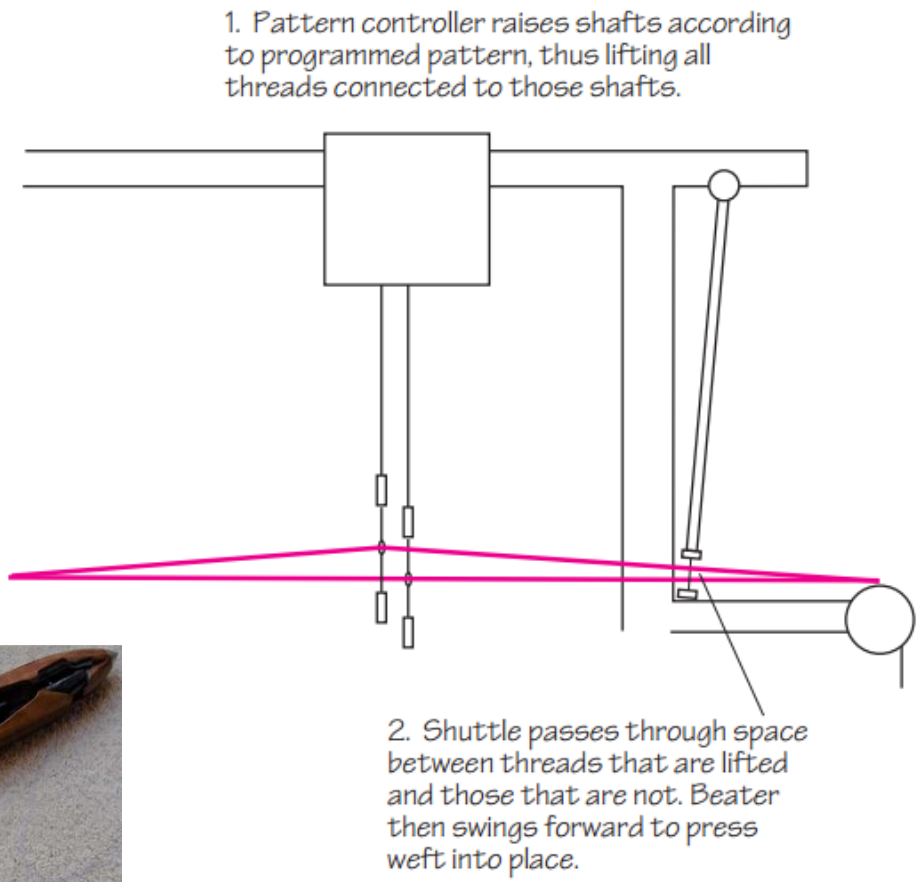
In jacquard weaving a device called a ‘jacquard’ selects and lifts the warp yarns individually. This type of machine is used for larger more detailed patterns, where all or most of the yarns in a repeat, move independently. There are single or double lift machines which use either mechanical or electronic systems, using CAD to control the harness lifting and lowering. Modern jacquards are capable of handling over 1200 harness cords which control the lifting and lowering of the warp yarns.

Weft insertion

Shuttles are not required in modern looms

Video:

- Type of weft insertion in weaving loom (5:57)



Fabric manufacturing

It can be considered as an assembly operation. Some notable examples include Persian carpets and Artistic tapestries.

Video:

- Making a persian carpets (2:43)
- How it is made fabric (4:29)

Origin of sewing

Sewing is one of the oldest of the textile arts, arising in the Paleolithic era. Before the invention of spinning yarn or weaving fabric, archaeologists believe Stone Age people across Europe and Asia sewed fur and skin clothing using bone, antler or ivory needles and "thread" made of various animal body parts including sinew, catgut, and veins.

First evidence date back to 60.000 years ago making it one of the first assembly process!

The sewing process in 4 elements

Sewing is the craft of fastening or attaching objects using stitches made with a needle and a thread:

- Typical *objects* include: fabric, leather, rubber and polymer.
- *Stiches* can be of different type depnding by use and realization process (manual/automatic)
- A sewing *needle* is a long slender tool with a pointed tip and an *eye* in one of the ends that allows such tool to drive a cord or thread through the fabric after the pointed end pierces it. Needle can have different sizes and shapes according with the intended use
- *Thread* can be made of natural or syntetic *fibers*

The sewing process: objects

Fabric

Rubber

Polymers

Leather

The sewing process: stitches

All stiches made with a sewing needle with an «eye» are variation of seven basic stiches:

- *Running Stitch*
- *Backstitch*
- *Overcast stitch*
- *Cross stitch*
- *Buttonhole or blanket stitch*
- *Chain stitch*
- *Knot stitch*

IMPORTANT

Stitches are not only used to join objects but also to decorate them: this process is known as **embroidery**

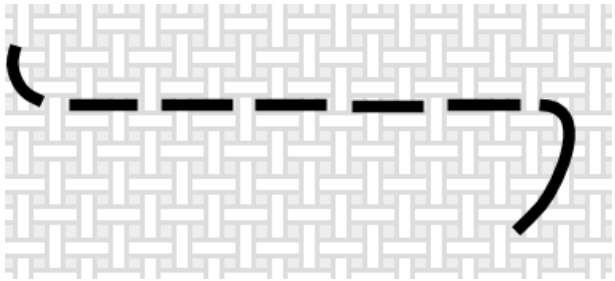
Embroidery

Even though such a practice is not a direct form assembly, it is still relevant in this domain as one can see it as a very elaborated process of manufacturing and assembling the decoration on a textile product starting from a basic thread.

Similar techniques deliver real pieces of work of arts like fine carpets and tapestry

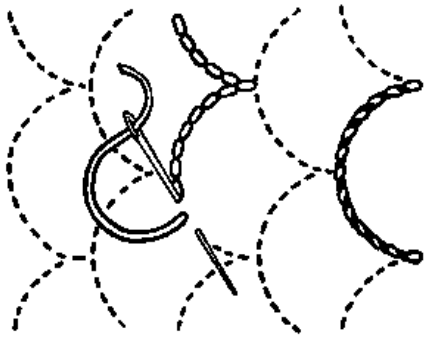
Running stitch

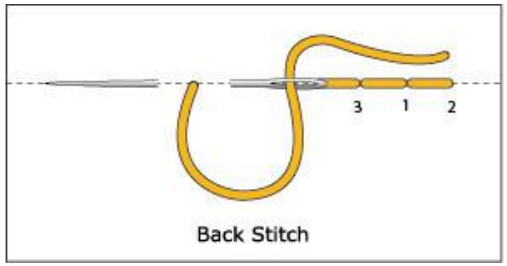
The running stitch or straight stitch is the basic stitch in hand-sewing and embroidery, on which all other forms of sewing are based on. The stitch is worked by passing the needle in and out of the fabric. Running stitches may be of varying length, but typically more thread is visible on the top of the sewing than on the underside. So, a running stitch runs through the fabric



Backstitch

Backstitch or back stitch and its variants *stem stitch*, *outline stitch* and *split stitch* are a class of embroidery and sewing stitches in which individual stitches are made backward to the general direction of sewing. In embroidery, these stitches form lines and are most often used to outline shapes and to add fine detail to an embroidered picture. It is also used as a hand-sewing sewing utility stitch to attach definitively and strongly two pieces of fabric together

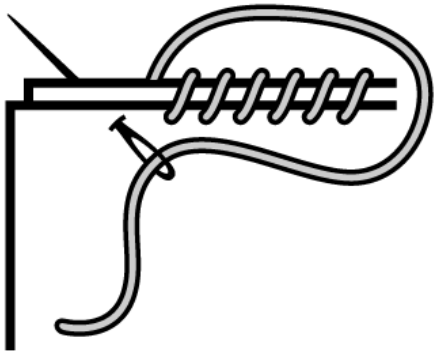




Overcast stitch

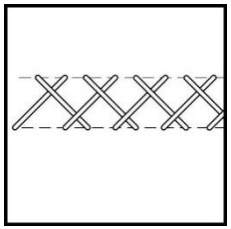
Overcast stitch is one of several types of sewing stitches, this type being used on a raw, or unfinished, seam or edge. The purpose is to prevent unraveling of the fabric.

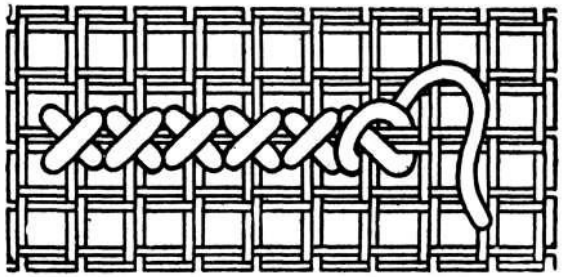
Overcast stitches may be reversible, as when they are used to join together crochet or knitted block pieces



Cross stitches

Mostly used in embroidery and other form or decorative needle work. In its many variants is probably the most widely used stitch of all.

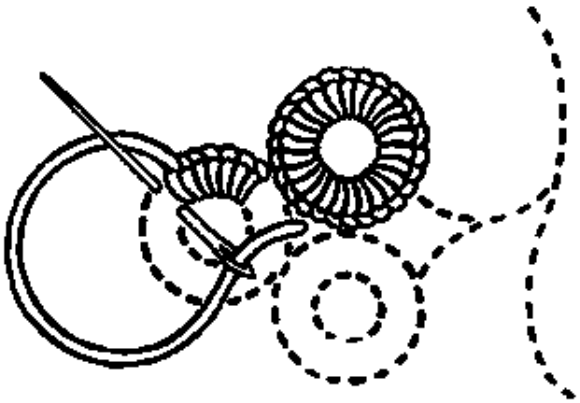


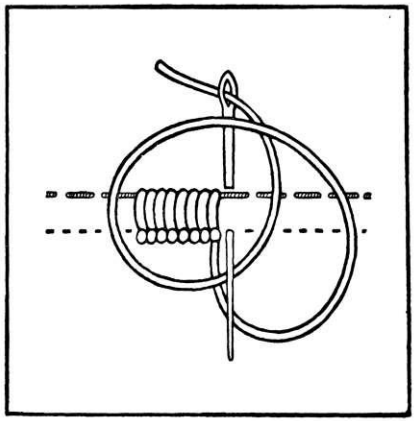


Butthole stitches

Buttonhole stitch and the related blanket stitch are hand-sewing stitches used in tailoring, embroidery, and needle lace-making.

Buttonhole stitches catch a loop of the thread on the surface of the fabric and needle is returned to the back of the fabric at a right angle to the original start of the thread. The finished stitch in some ways resembles a letter "L" depending on the spacing of the stitches.

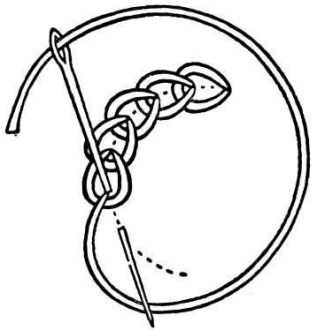




Chain stitches

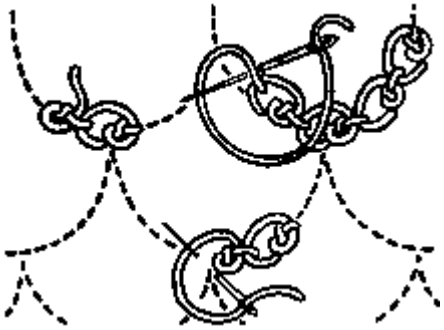
Chain stitch is a sewing and embroidery technique in which a series of looped stitches form a chain-like pattern.

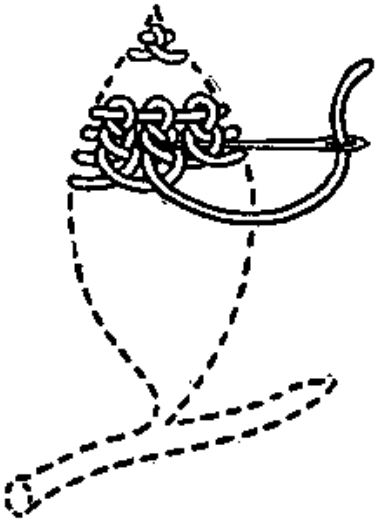
Handmade chain stitch embroidery does not require that the needle pass through more than one layer of fabric. For this reason the stitch is an effective surface embellishment near seams on finished fabric. Because chain stitches can form flowing, curved lines, they are used in many surface embroidery styles that mimic "drawing" in thread

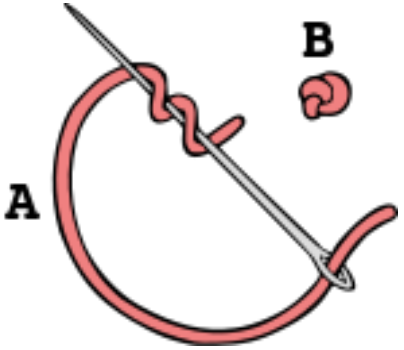


Knotted stitches

A knotted stitch is any embroidery technique in which the yarn or thread is knotted around itself.

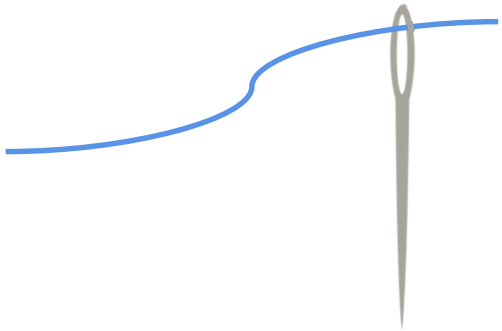




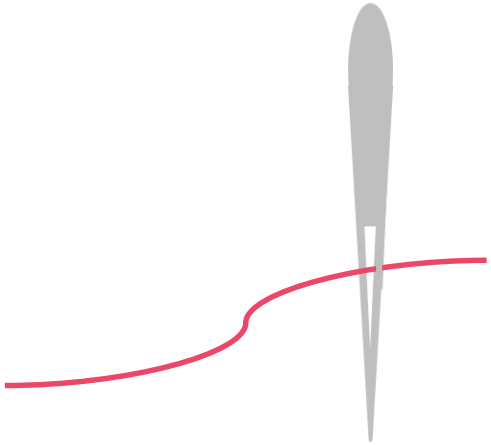


The sewing process: needle

- While the first needles were probably made of animals' bones, today we use steel, titanium alloy and also precious metals such as gold and platinum agains coorsion
- Eye:



Hand-sewing, hole in the blunt end: the needle pierce and goes through the fabric



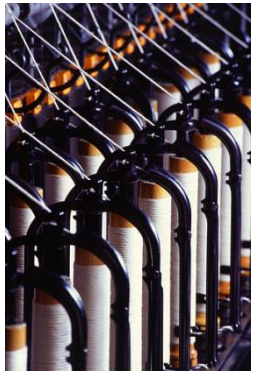
Machine-sewing, hole in the pointy end: the needle pierce but does not go through the fabric

The sewing process: thread or yarn

Yarn is a long continuous length of interlocked fibres, suitable for use in the production of textiles, sewing, crocheting, knitting, weaving, embroidery, and ropemaking. Thread is a type of yarn intended for sewing by hand or machine. Modern manufactured sewing threads may be finished with wax or other lubricants to withstand the stresses involved in sewing.

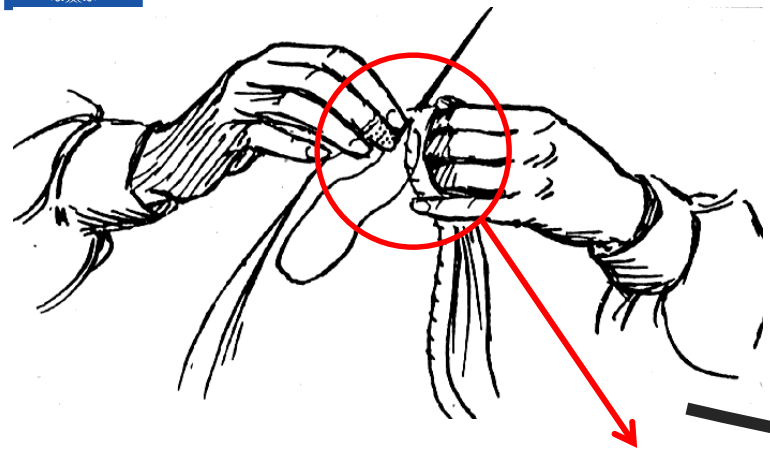
Spools of thread

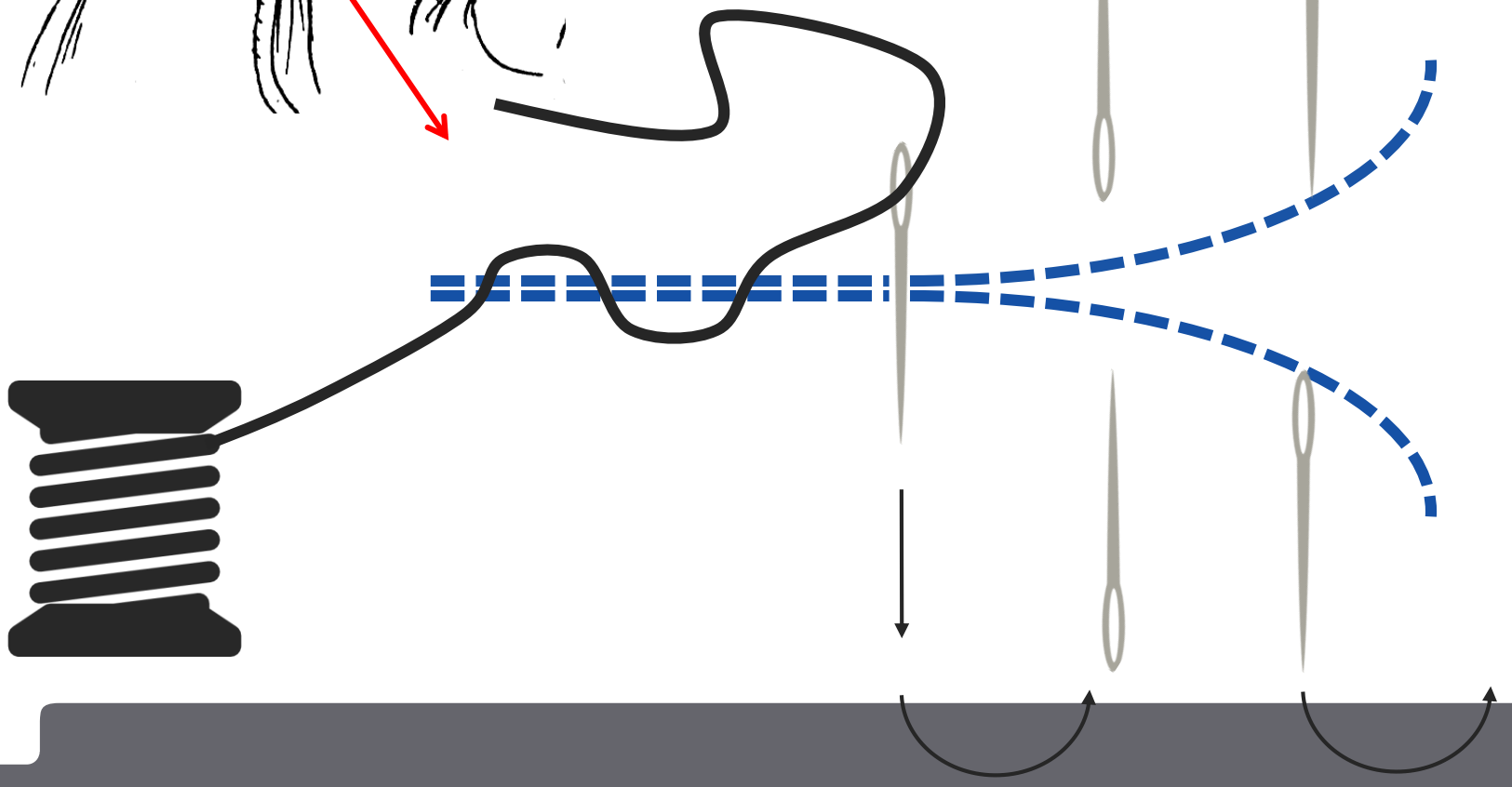
S- and Z- twist yarn



Cotton being spun

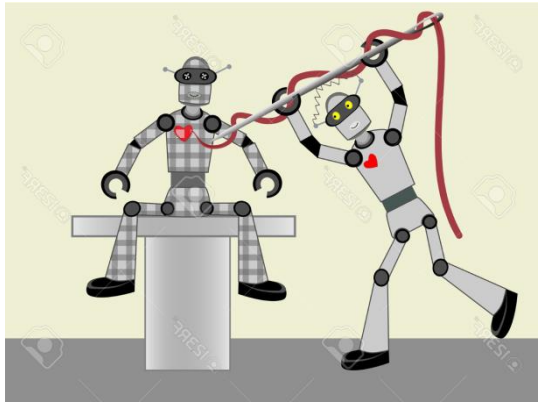
Manual sewing





From manual to machine

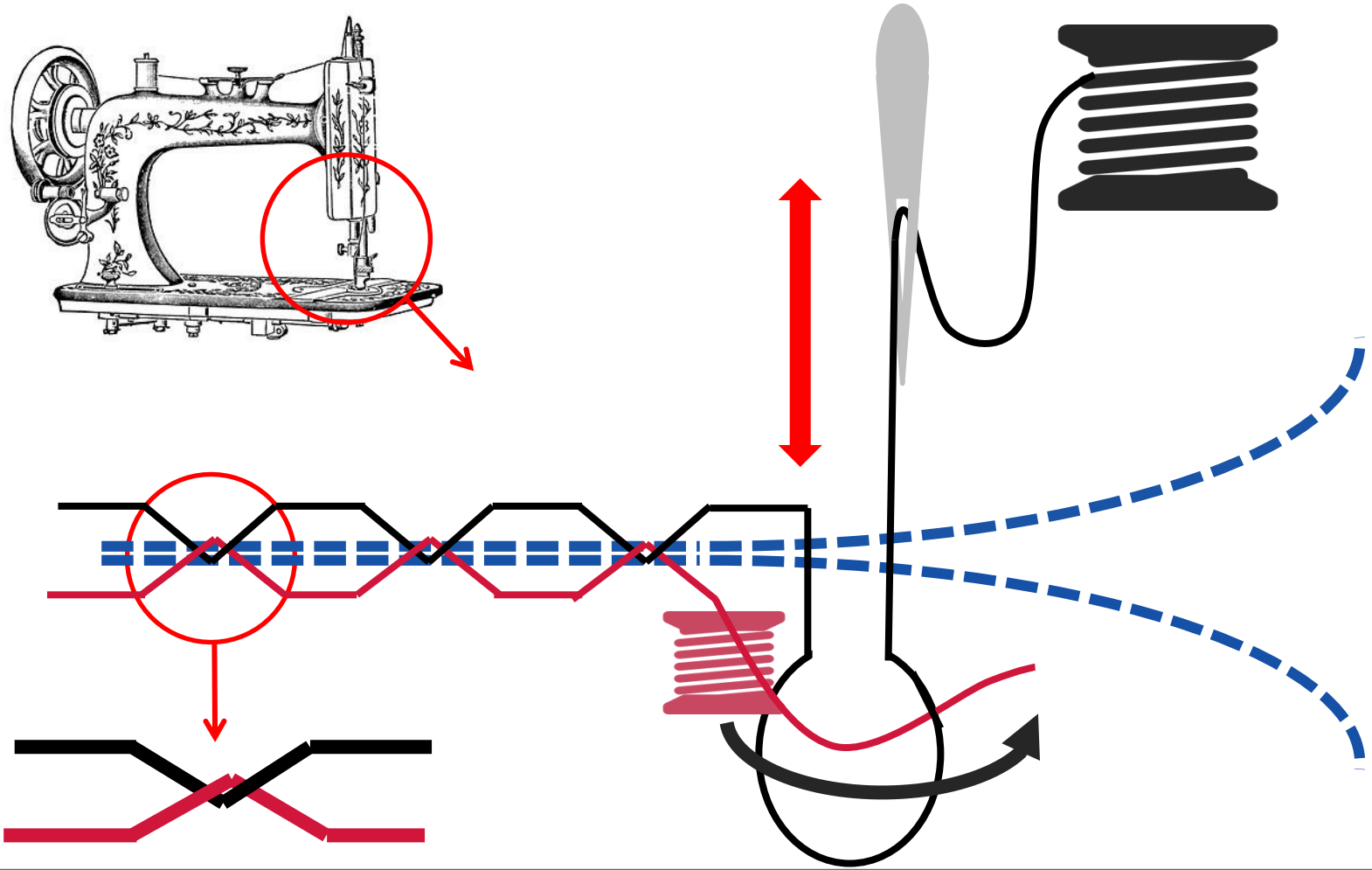
Manual sewing is a labor intensive process that is hard to automate as it is.



The 1800´ has seen many inventors approaching this problem with completely innovative approaches which had nothing to do with human sewing!

Sewing machine were born!

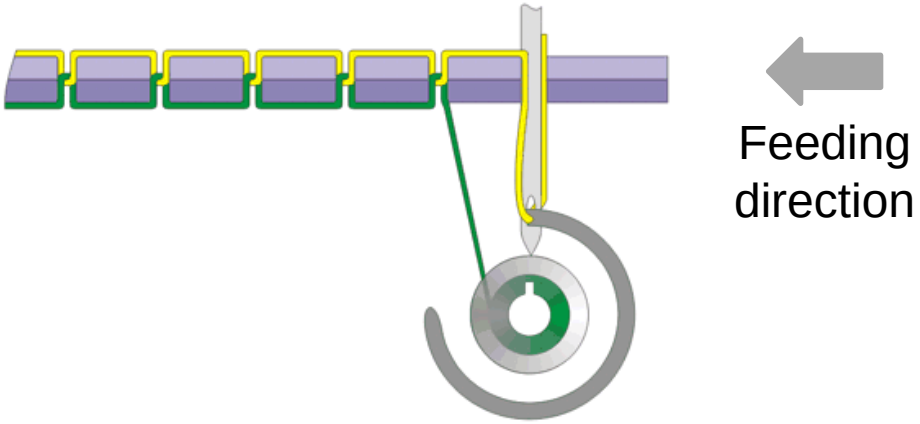
Machine sewing



From manual to machine

Chain stitch was the stitch used by early sewing machines; however, as it is easily unraveled from fabric, this was soon replaced with the more secure lockstitch.

Formation of the double locking chain stitch



Lockstitch rotational mechanism

Summary: manual vs machine sewing

Characteristic	Manual	Machine
Number of ”hands”	Two	One
Number of threads	One	Two
Grasp of needle	Repeated grasp and ungrasp	Never ungrasp
Location of eye	Rear of needle	Tip of needle
Needle movement	• Passes through cloth • Flips 180°	• Point penetrate cloth but needle does not pass through • Needle does not flip
Joining method	One thread passes through cloth repeatedly	Two thread interlock but do not pass through cloth

Machine to automatic

Even with a sewing machine the human is a key element of the process. In order to sew properly the operator must perform a lot of activities:

- Loading the fabric
- Aligning the fabric,
- Starting the mecanism,
- Controlling the feeding movement,
- Unloading the fabic
- Checking the quality
- ...

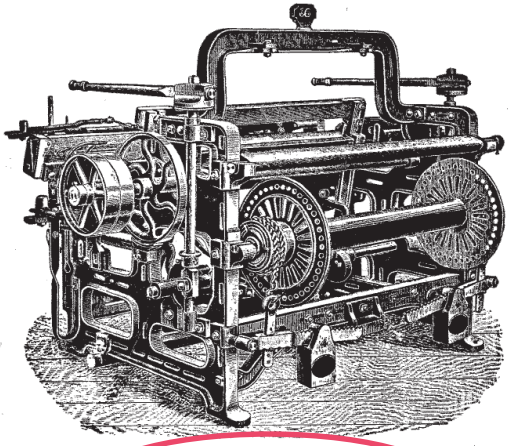
Fully automatic sewing

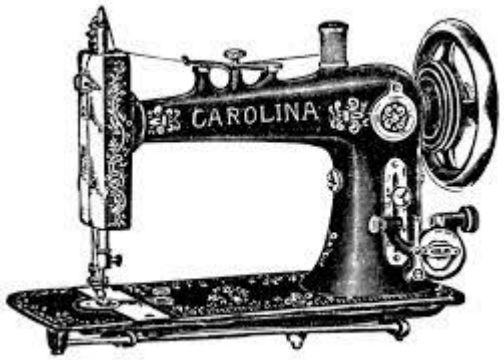
Video:

- Fully automatic sewing machine (0:34)
- Robot sewing (1:40)

From manual to machine

If the power loom has boosted fabric manufacturing, it was the sewing machine that brought together all the produced cloth! They where both fundamental for the industrial revolution!



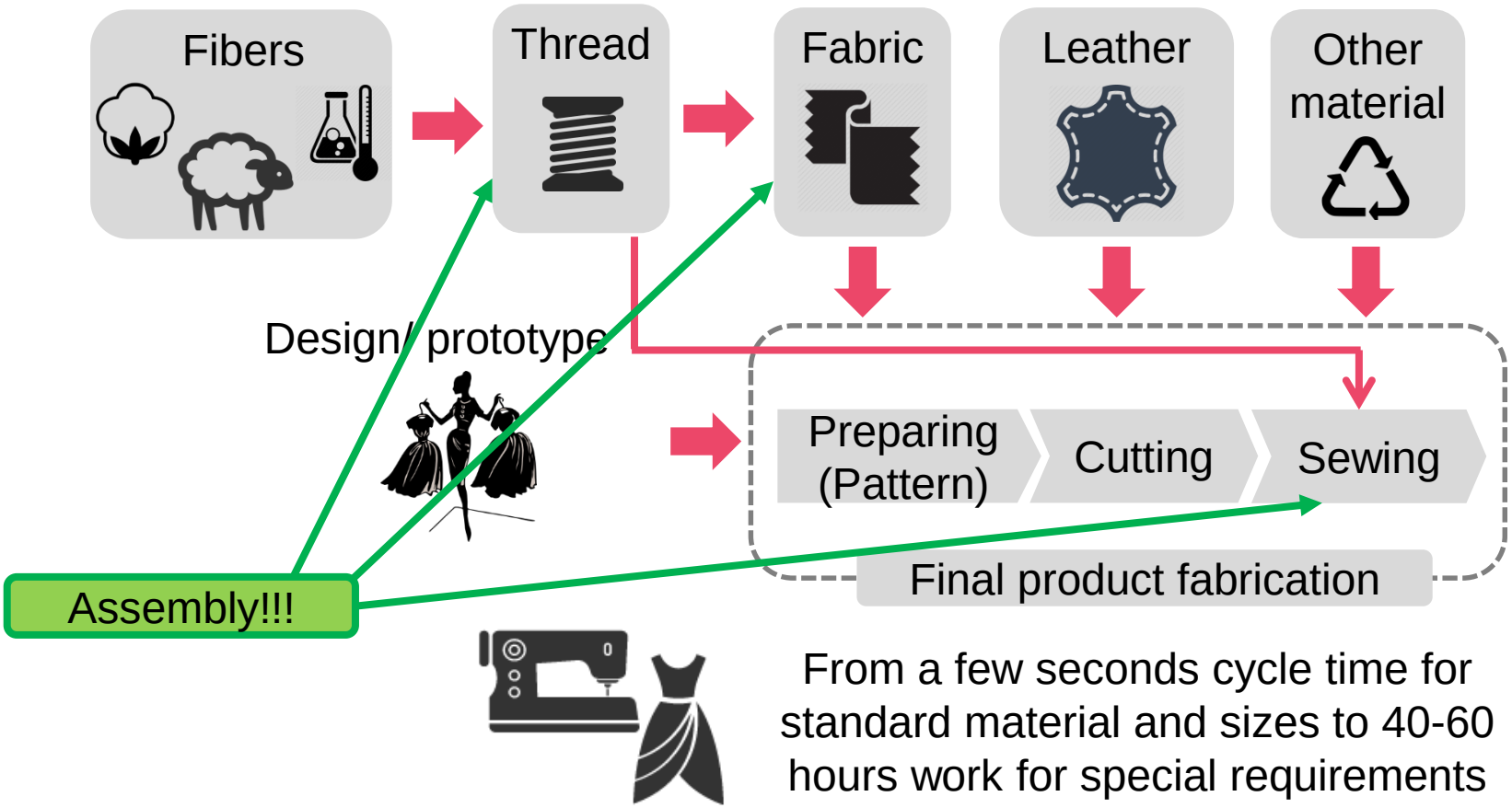


Manufacturing

Assembly

Assembly

Simplyfied process chain for textile and similar



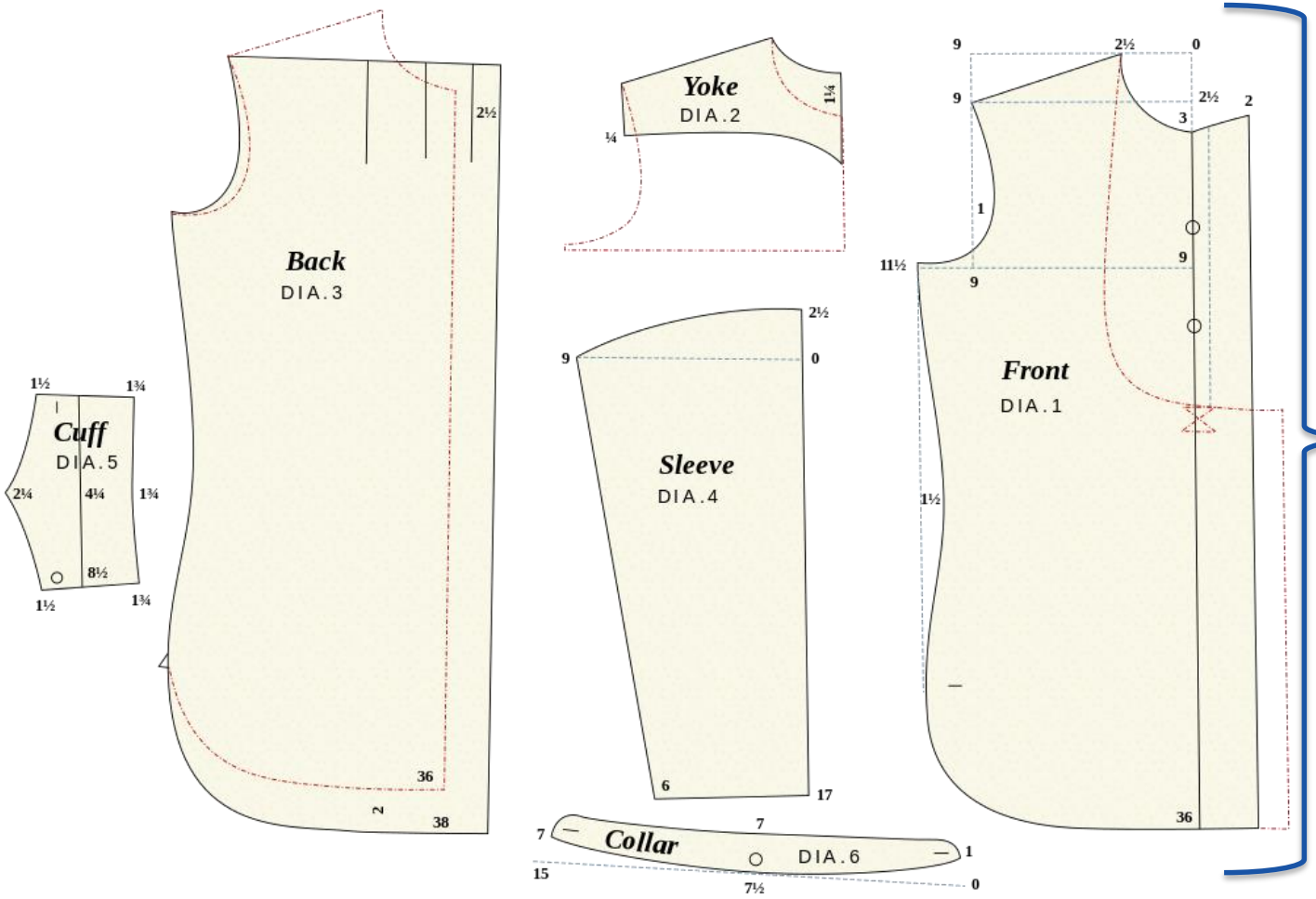
From a few seconds cycle time for standard material and sizes to 40-60 hours work for special requirements

Final product fabrication: pattern

In sewing and fashion design, a pattern is the template from which the parts of a garment are traced onto fabric before being cut out and assembled. Patterns are usually made of paper, and are sometimes made of sturdier materials like paperboard or cardboard if they need to be more robust to withstand repeated use.

Patterns can be standard or unique. Standard patterns are adapted to different sizes through a grading process of shrinking or enlarging.

Final product fabrication: pattern



Final product fabrication: cutting

Cutting is the process which cut out the pattern pieces from specified fabric for making garments. Using the markers made from graded patterns and in accordance with the issue plan, fabrics are cut to prepare garment assembly.

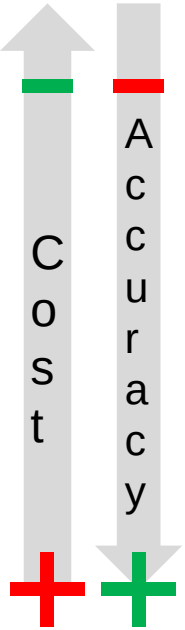
The cutting process may also involve transferring marks and notches from the garment parts to assist operators in subsequent processes

Final product fabrication: cutting

Cutting techniques:

- *Manual*: with scissor. Very rare: only for small batches

- *Machine assisted*: cutters guide electric cutting machines around the perimeter of pattern pieces, cutting through the fabric stack. An electric drill may be used to make pattern notches.
- *Computerized* cutting systems are achieving more widespread use as technology costs decrease and labor costs rise. These computer-driven automated cutters utilize vacuum technology to hold stacks of fabric in place while cutting. Cutting blades are sharpened automatically based upon the type of fabric being cut.



Final product fabrication: cutting

Video:

- Laser cutting machine for fabric & leather (2:13)
- Computerized fabric knife cutting table (0:50)
- Automatic cut of fabric (1:09)

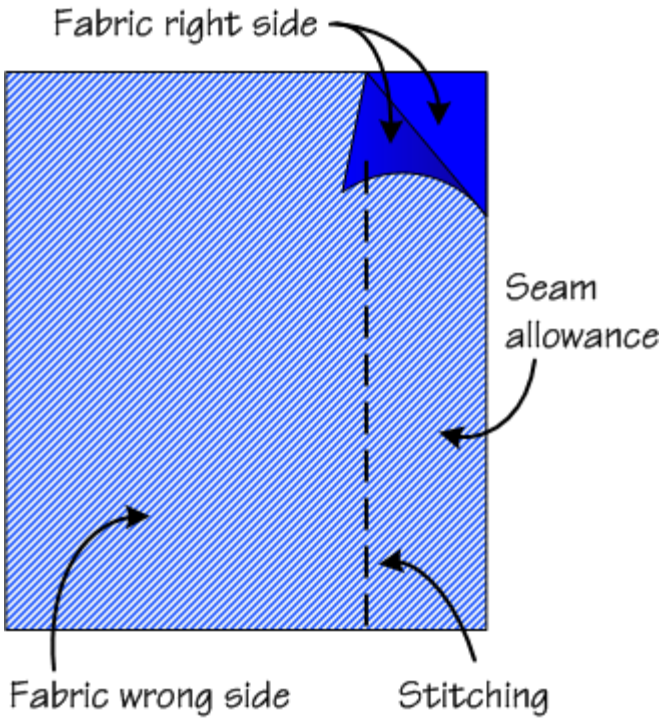
Sewn joint

The result of a sewing joining operation is called seam. Seams can be classified for pattern and type. All basics seams used in clothing construction are variants on four basic types of seams:

- Plain seams
- French seams
- Flat or abutted seams
- Lapped seam

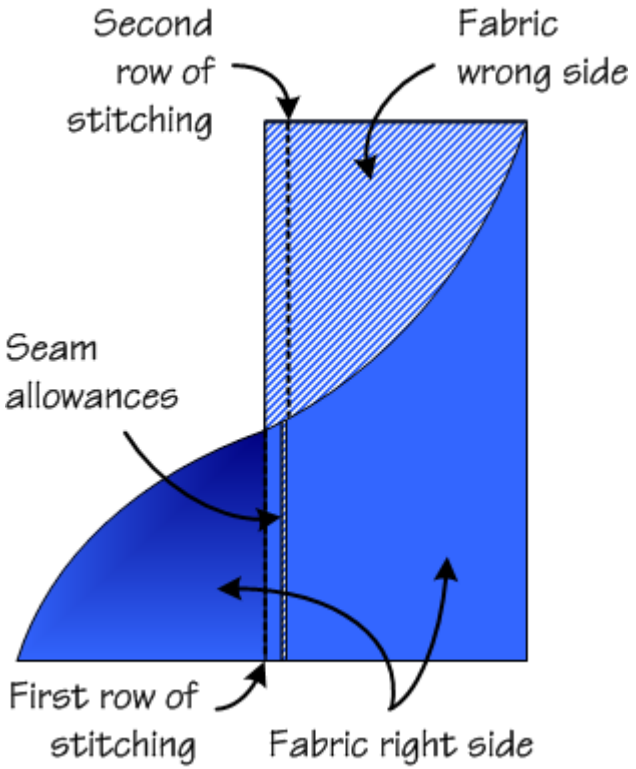
Sewn joint: plain seams

A plain seam is the most common type of machine-sewn seam. It joins two pieces of fabric together face-to-face by sewing through both pieces, leaving a seam allowance with raw edges inside the work. The seam allowance usually requires some sort of seam finish to prevent raveling:



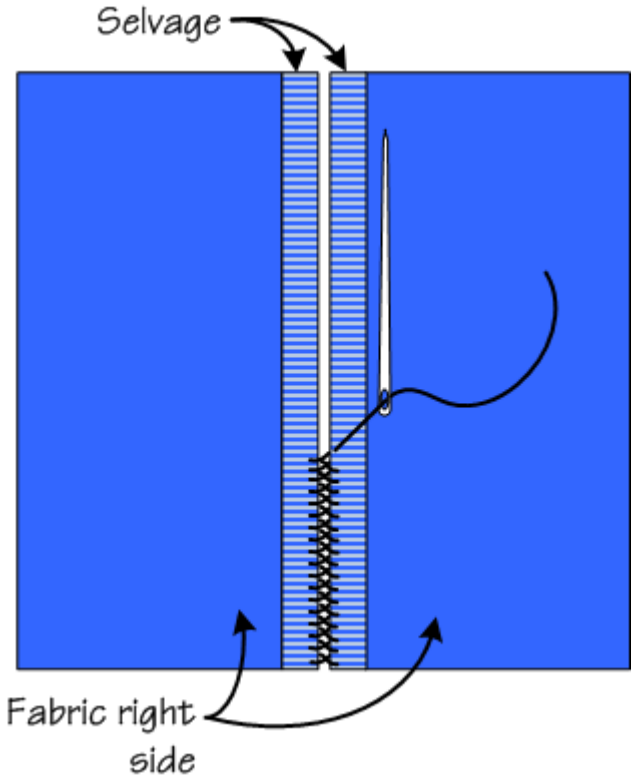
Sewn joint: French seam

In a French seam, the raw edges of the fabric are fully enclosed for a neat finish. The seam is first sewn with wrong sides together, then the seam allowances are trimmed and pressed. A second seam is sewn with right sides together, enclosing the raw edges of the original seam.



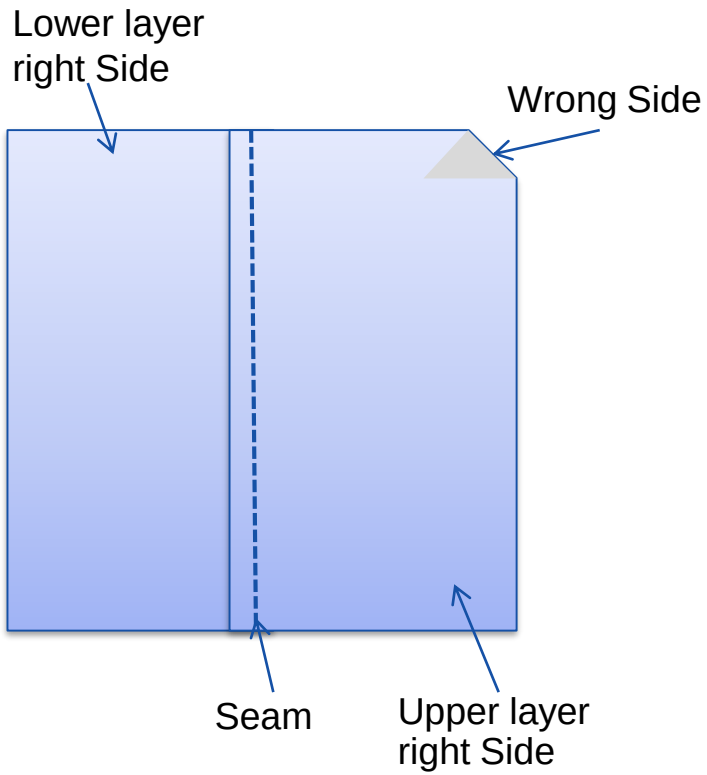
Sewn joint: flat or abutted seams

In a flat or abutted seam, two pieces of fabric are joined edge-to edge with no overlap and sewn with hand or machine stitching that encloses the raw edges.

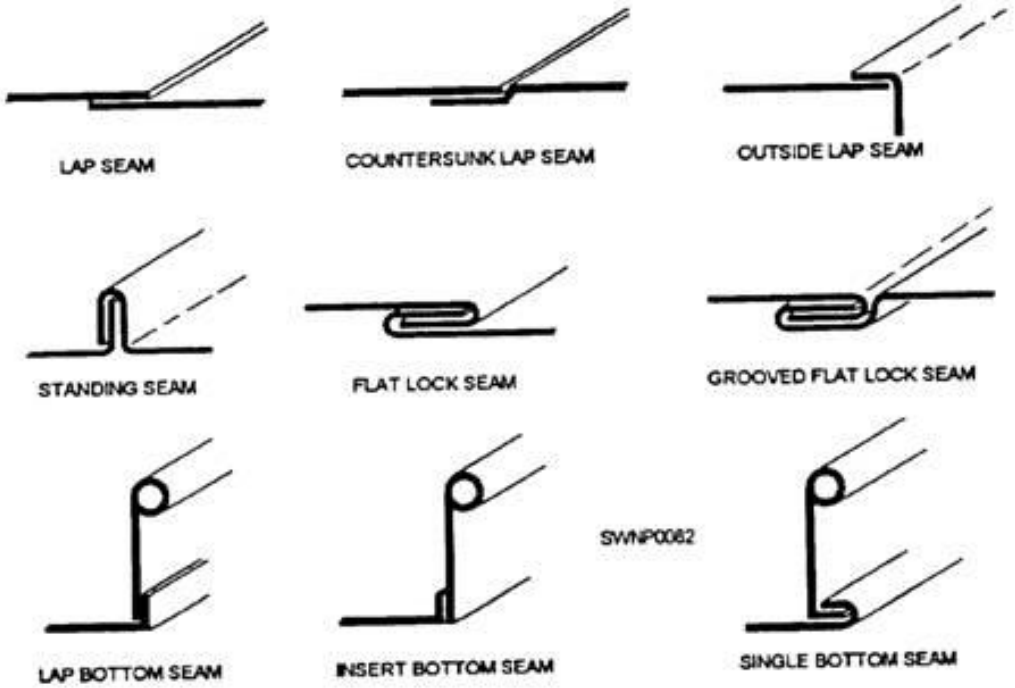


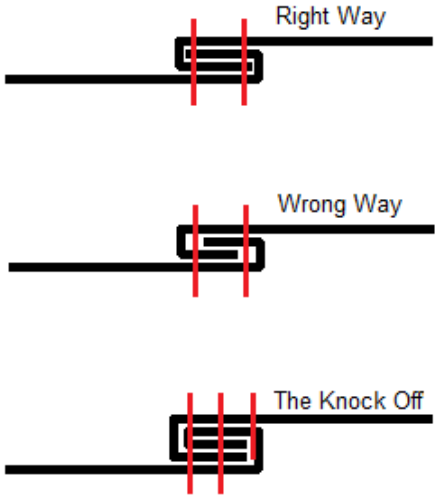
Sewn joint: lapped seam

In a lapped seam, the two layers overlap with the wrong side of the top layer laid against the right side of the lower layer. Lapped seams are typically used for bulky materials that do not ravel, such as leather and felt.

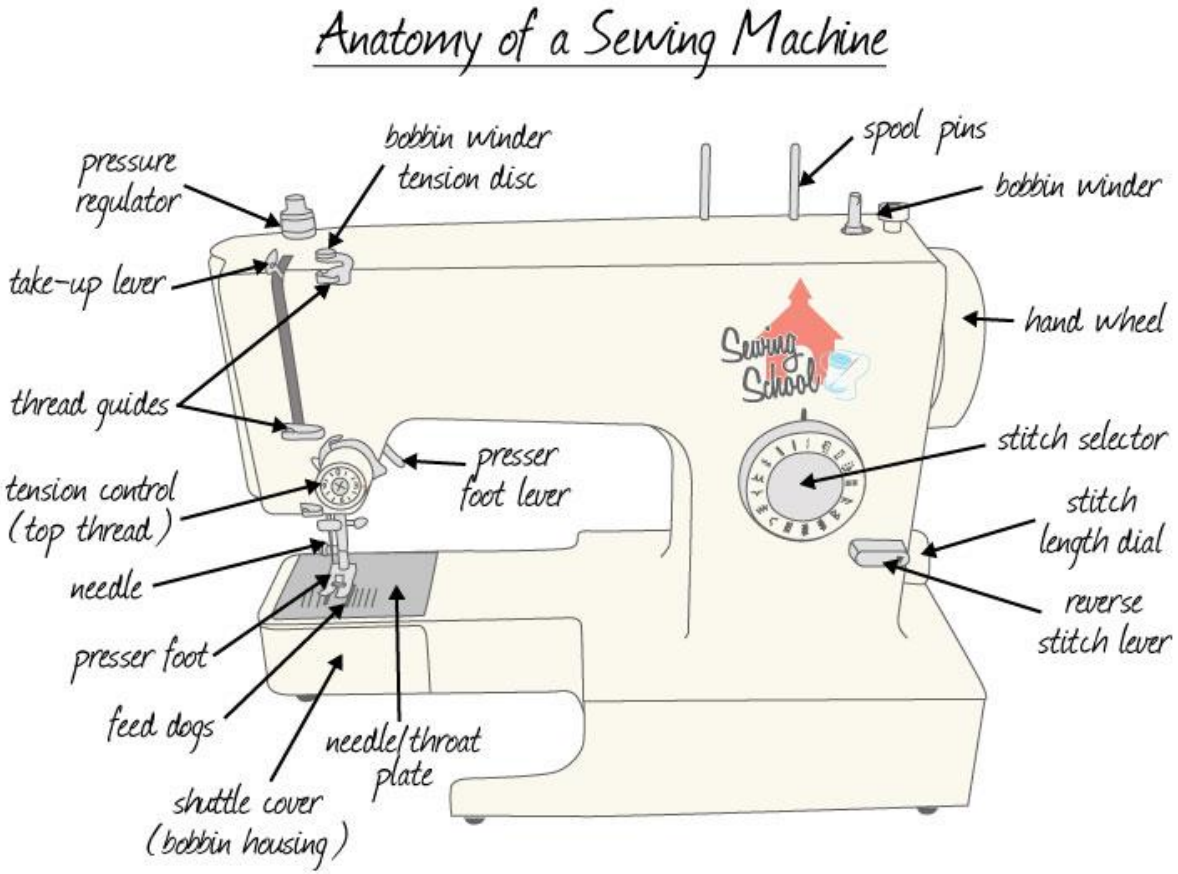


Different seams

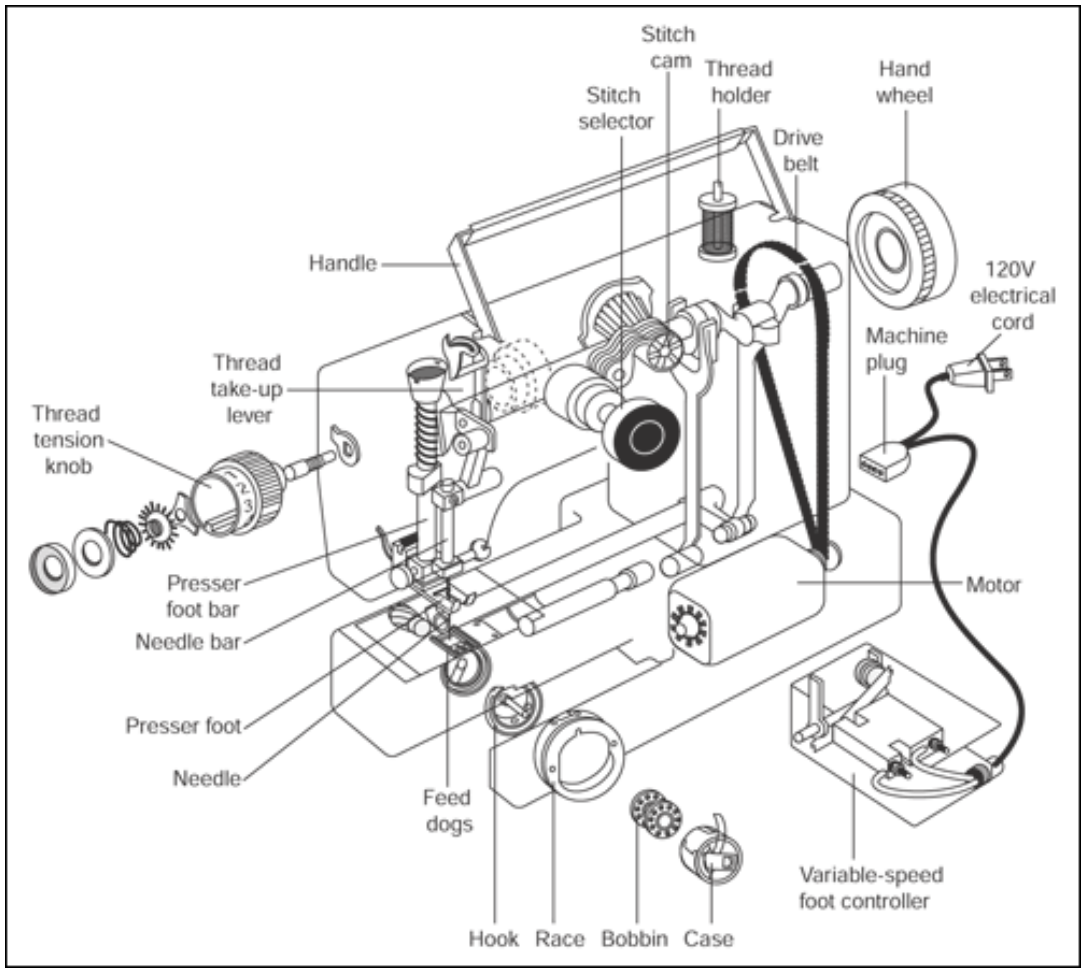




The sewing machine



The sewing machine



Parts and function of a sewing machine 1

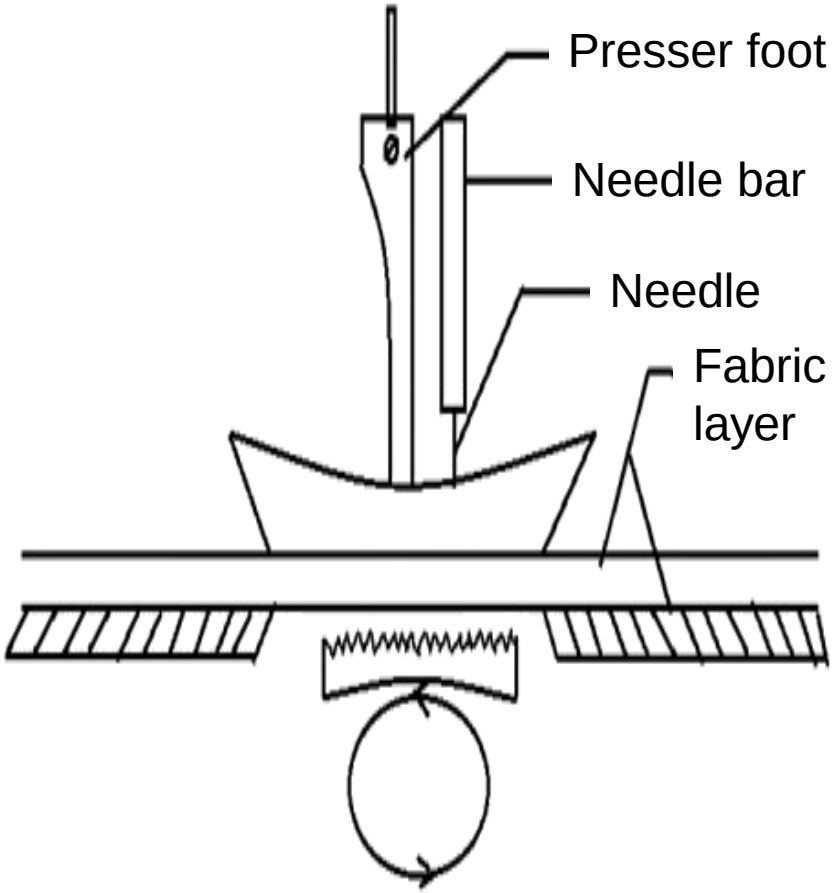
- **Spool holder or spool pins:**The spool holder has multiple functions. It holds the spool of thread, but also controls the direction of the thread as it goes through the machine. Spool holders can be horizontal and vertical.
- **Bobbin**: a small spindle that is wound with thread. It supplies the bottom thread of the stitches. The bobbin fits into the bobbin case. You wind the bobbin with thread using the **bobbin winder**.
- **Bobbin case**: the case the bobbin sits in. This can be found under the needle plate and usually has a piece of plastic that flips up to cover the bobbin case when you're not sewing.

Parts and function of a sewing machine 2

- **Adjustment for stitch:**
  - **Length:** sets the length of every individual stitch. The type of fabric and thread you use will determine what stitch length you should use.
  - **Tension:** Sewing involves pulling thread through the two sides of the fabric, and to do this without having thread bunch up or tangle the correct amount of tension in the thread is necessary. The same amount of thread needs to be pulled from the spool and the bobbin at the same time, and to ensure this you need to use the tension adjustment. The tension discs squeeze the thread as it passes between them and the tension regulator controls the amount of pressure on the discs
  - **Pattern:** chose which kind of stitches to use

Parts and function of a sewing machine 3

- **Presser foot:** The presser foot puts pressure on the fabric to keep it going smoothly along and prevent any wrinkles that could mess up the stitch. There are different kinds of presser feet, such as the one-sided presser foot used for doing zippers. Presser feet snap on and off using the presser foot lever on the back of the presser foot.
- **Needle and needle bar:** The needle fits into the needle bar, which holds it in place with a small screw



Parts and function of a sewing machine 3

- **Take up lever: t**he take up lever is used in threading the sewing machine and to keep the thread tension at the proper level. If the take up lever is threaded improperly, the thread will knot up and jam in the machine.
- **Needle plate and feed dogs:** The needle plate is the metal plate that is under the needle and on top of the bobbin case. Your sewing machine may have the seam guides that the sewing machine pictured has, which are helpful when making patterns that call for specific seam measurements. The needle plate covers the feed dogs, which are the rough pieces of metal that are used to push the fabric along as you sew. There are two feed dogs.

Parts and function of a sewing machine 4

- **Power switch:** It has to be said: sewing machines run on electricity (well, most do).
- **Hand wheel:** the hand wheel is used for when you want to manually move the needle up and down. This is used when sewing an extremely thick piece of fabric, pulling the thread of the bobbin up through the needle plate or just when you need to sew very carefully. The hand wheel can be pulled out when you want to disengage the needle (run the spool of thread without the needle going up and down).
- **Back-sew button:** this button on the front of the machine is used to sew backwards, which you will do at the end of every seam to tie it off. Sewing backwards is the same in every aspect of sewing the usual way except for the direction**.**
- **Foot pedal:** the foot pedal operates in the exact same way a car pedal does; the more pressure you apply to the pedal, the faster you sew.

Sewing machine feed mechanism

Feed mechanisms is the basic motion of needles, loopers and bobbins, the material being sewn must move so that each cycle of needle motion involves a different part of the material.

Function:

- To advance the fabric in the feeding zone of the sewing machine.
- To decide the length of individual stitch (spm)

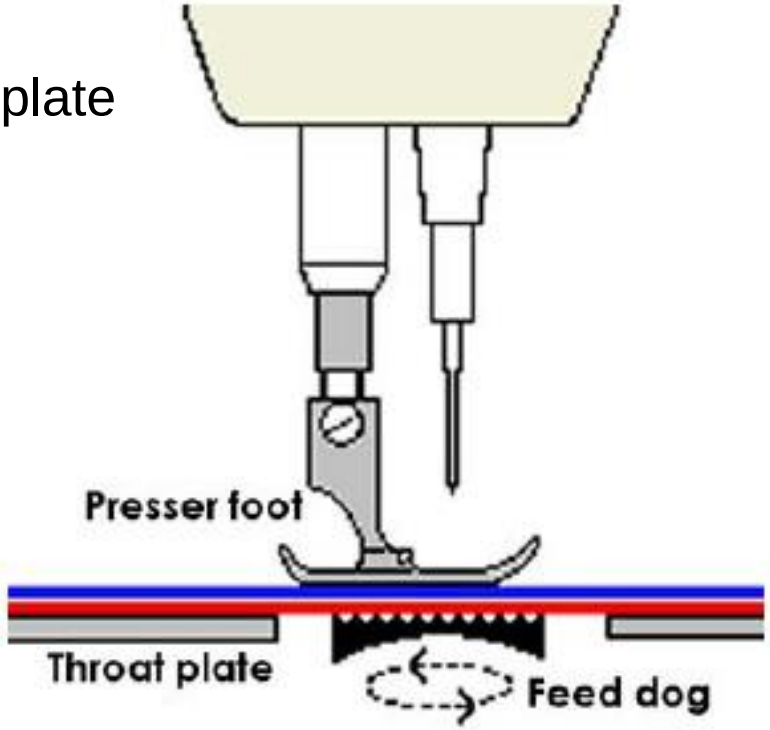
Sewing machine feed mechanism

Types:

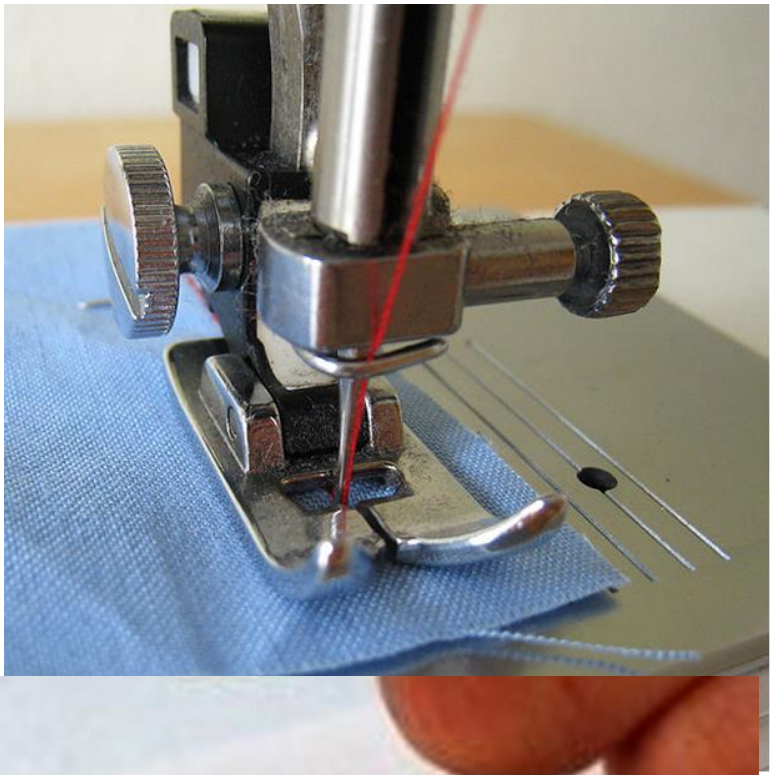
- Drop feed mechanism.
- Differential bottom feed mechanism.
- Adjustable top feed mechanism.
- Needle feed mechanism.
- Unisom feed mechanism.
- Puller feed mechanism.

Drop Feed mechanism

- Also know as the regular feed
- The three machine parts that constitute the drop feed or regular feed are:
  - The presser foot
  - The Throat (or needle) plate
  - The feed dog

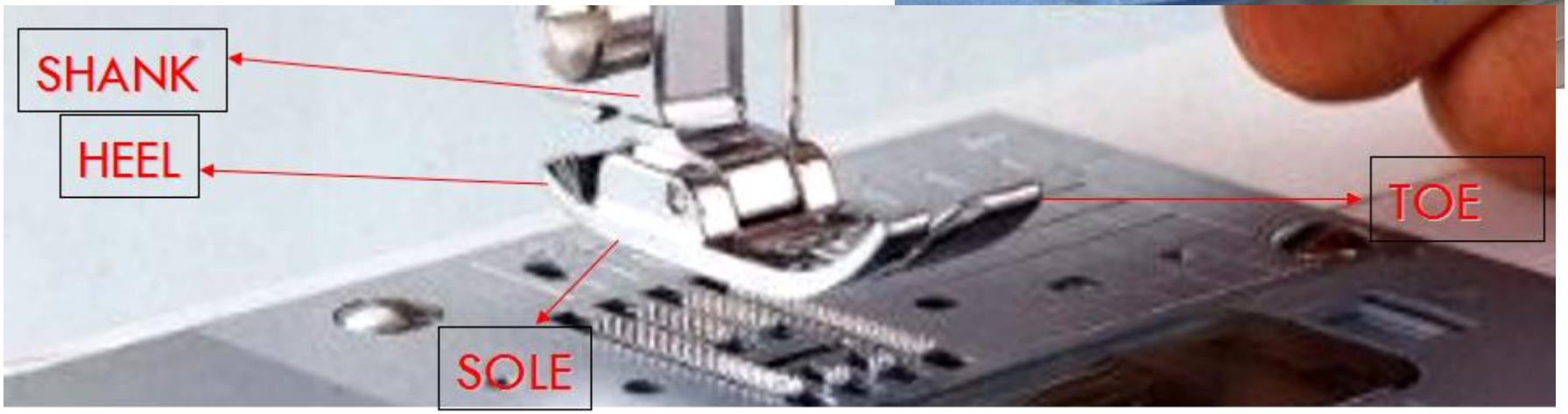


Drop Feed mechanism



The presser foot:

- Hold the fabric and keep it flat
- Typically spring-hinged to provide some flexibility as the work piece moves beneath it.



Drop Feed mechanism

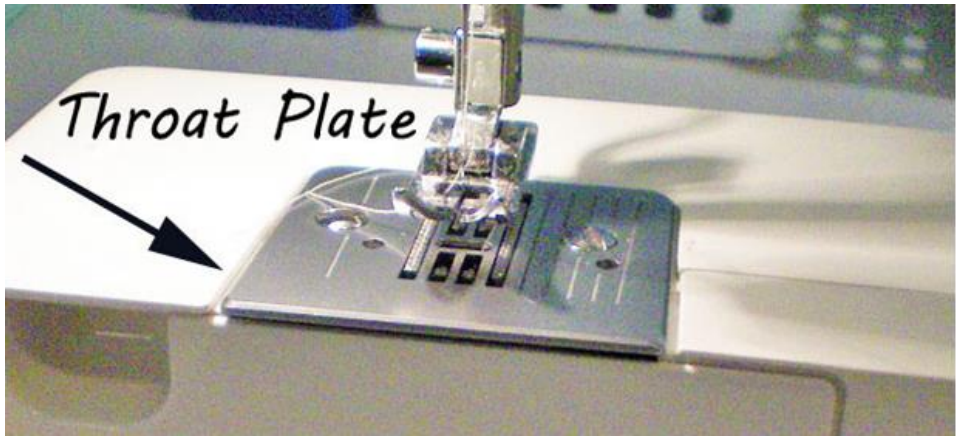
The presser foot:

- Upper part of the feeding combination that holds the fabric in place for the feeding action and stitch formation
- Attached to presser bar
- Controls the amount of pressure placed on the fabric when it is fed through the machine
- Assists in operation of feed dog
- Higher speeds may require more pressure
- Most common is the flat presser foot

Drop Feed mechanism

The Throat or Needle plate:

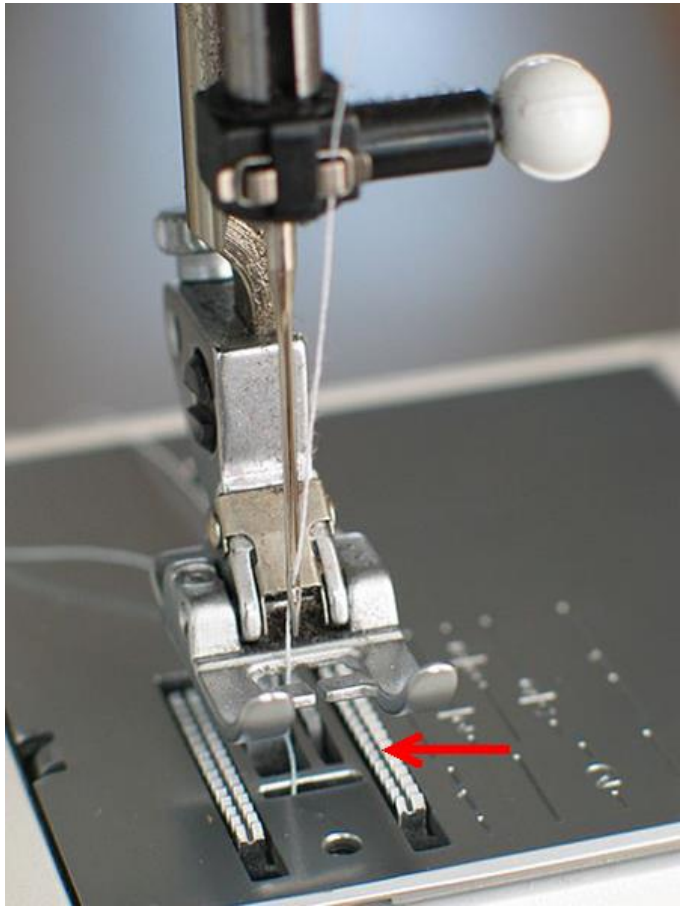
- A throat plat is the metal plate beneath a sewing machine's needle and presser foot.
- The throat plate has an opening for the needle to pass through as it stitches and opening for the feed dogs to emerge from below and help move the fabric forward during sewing.
- A sewing machine throat plate is usually marked with closely spaced, grooved lines to the right (and/or left) of the presser foot. Grooves serve as guidelines for seam allowances of varying width



Drop Feed mechanism

Feed dog:

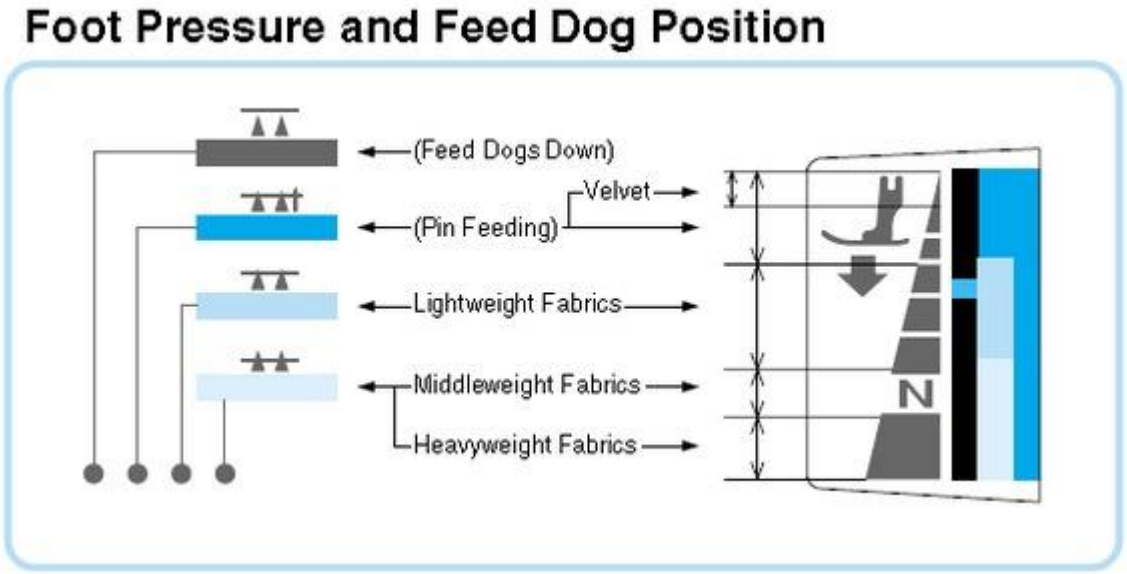
- Mechanical bit, usually in the bed of the machine with teeth or friction surface that transports or assist in the transport of material.
- Has a directional movement in which material is fed.
- May lift upwards to capture material between itself and a presser.
- May not lift upwards but a presser may hold material down against the feed dog



Drop Feed mechanism

Problem of Drop Feed:

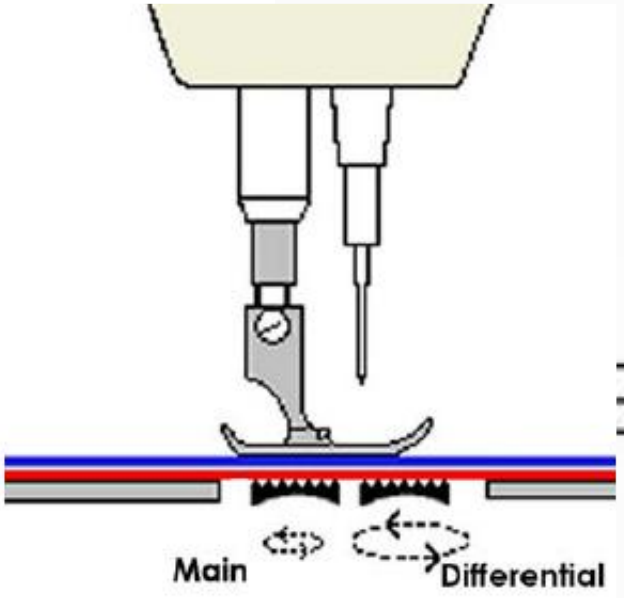
- Differential feeding of upper and lower layer of fabric: needs to have the right pressure (and consequently stitch length)

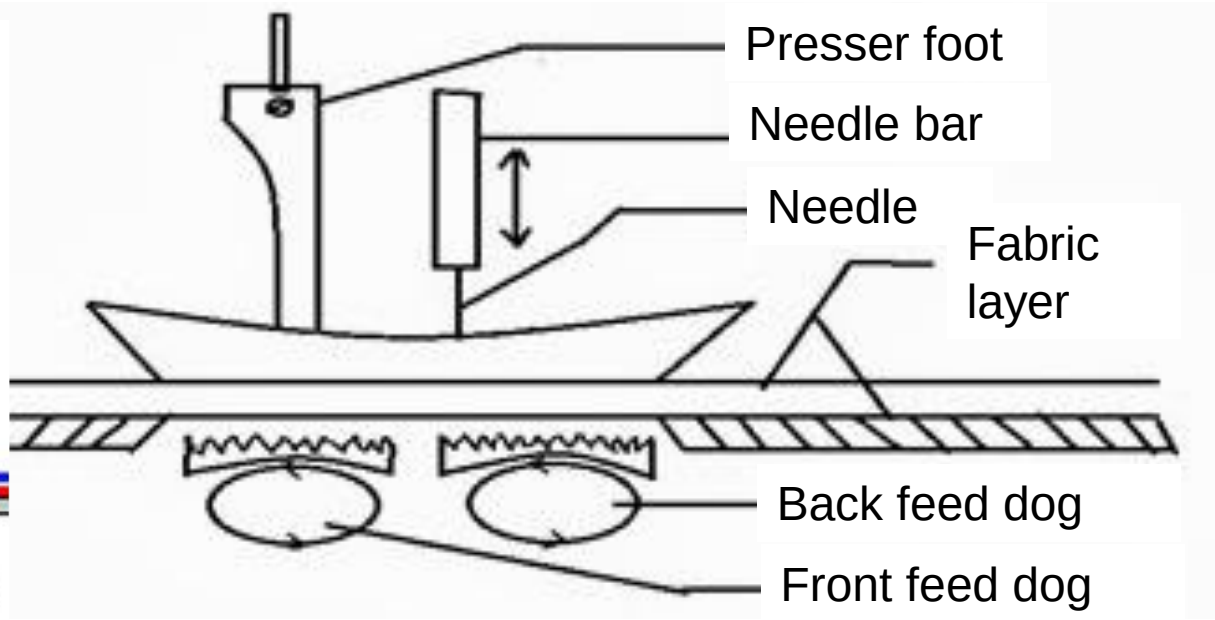


Some suggested regulation on a sewing machine

Differential bottom feed mechanism

Modification of drop feed system. In the feed mechanism the feed dog consists of 2 sections: one at back & one at front of the needle. Mechanism of each section of feed dog is like the drop feed system. But the speed of each part can be adjusted separately. Extensively used for stretchy materials





Differential bottom feed mechanism

- When the speed of the front feed dog is higher than the back feed dog. “ The bottom ply is pulled by the back feed dog but this will over come by the greater speed of the front feed dog. So less possibility of shifting”.
- When the speed of the front feed dog is less “ we get lacy effect because the feeding speed in grater than the delivery speed”.
- Stretching & gathering of fabric can be done by this system

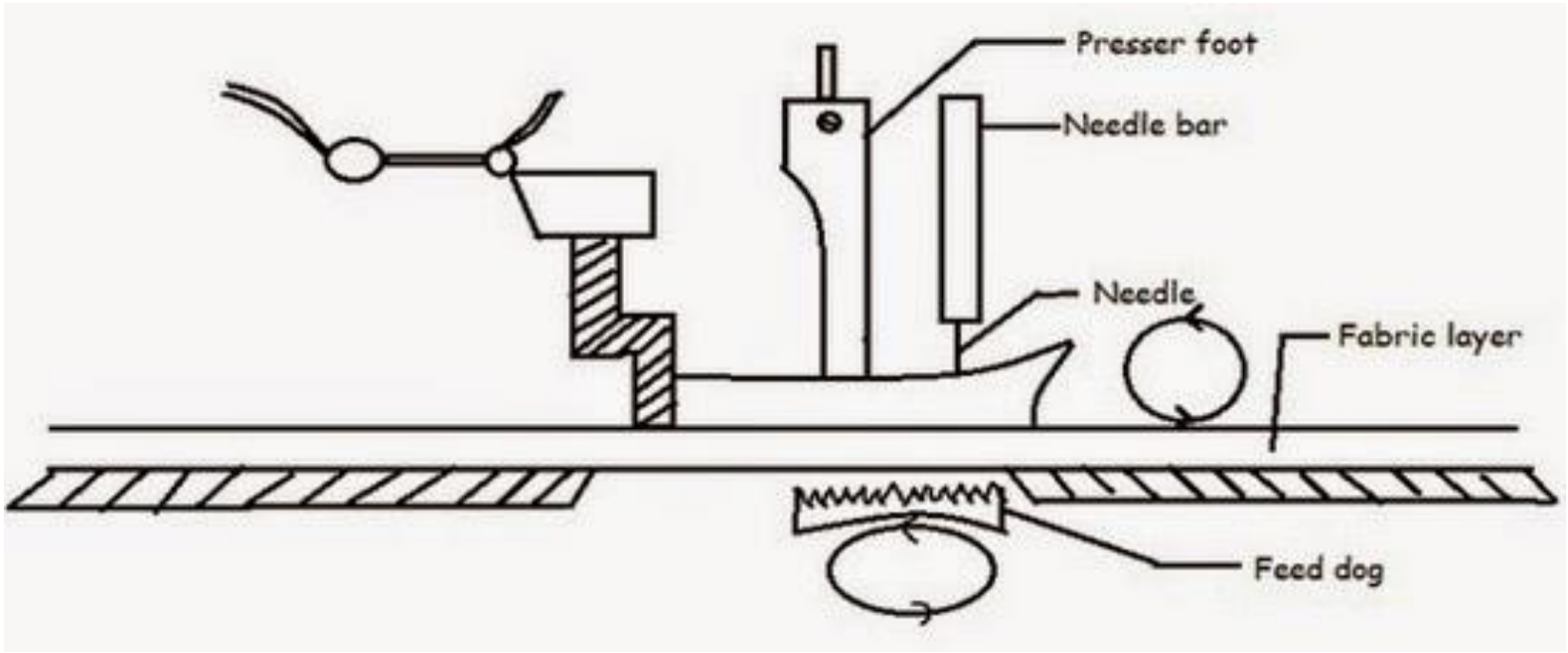
Adjustable top feed mechanism

Presser foot is in two section:

- One holding the fabric in position while the needle form the stitch
- the other having length on the lower side & moving or waking in such a way that the top ply is taken along, positively while needle is out of the materials.

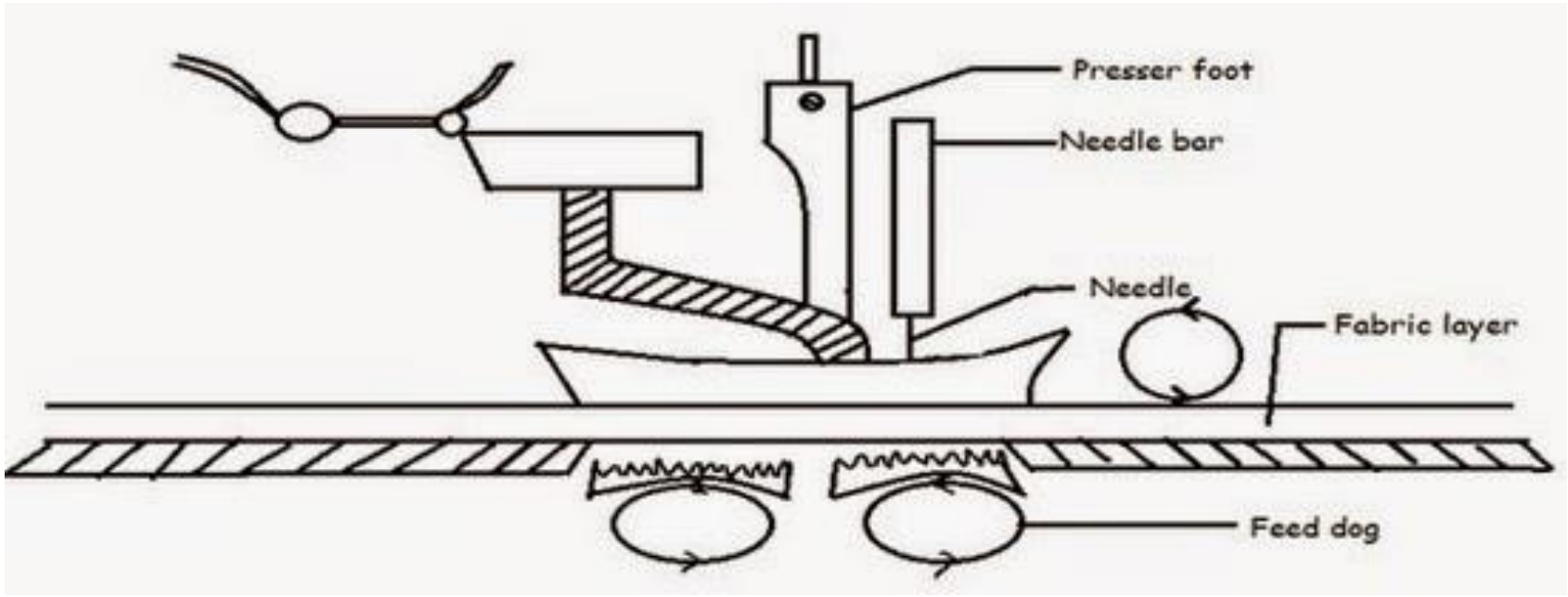
In sewing machine, the feed mechanism can be used with both drop feed & differential bottom feed. Combination of adjustable feed & differential bottom feed can make top ply gathering or the gathering of bottom ply.

Adjustable top feed mechanism



With drop system

Adjustable top feed mechanism

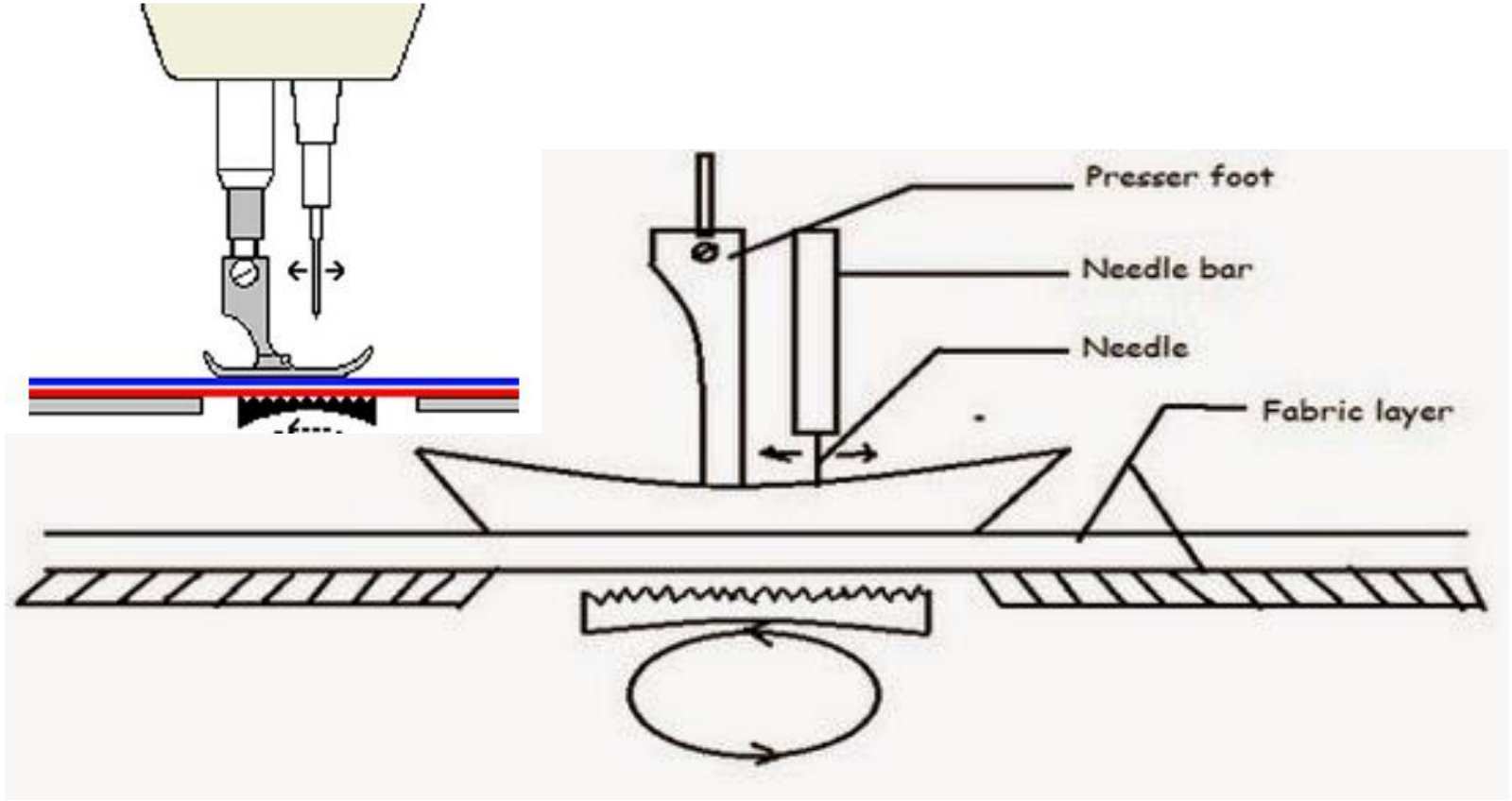


With differential bottom feed

Needle Feed System Mechanism:

Another name of needle feed mechanism is “Compound feed”. Needle itself moves forwards & backward: it penetrates the fabric enters into the note of the feed dog & for the advance movement of 1 stitch length of fabric feed dog & needle pass the fame distance at the same time. Then needle rise up & moves to form the next stitch with one step advance. Practically useful in bulky sewing situation such as when quilting through the fabric. wadding & for slapping fabrics. For the change of stitch length the setting of both needle & feed dog should be changed.

Needle Feed System Mechanism:



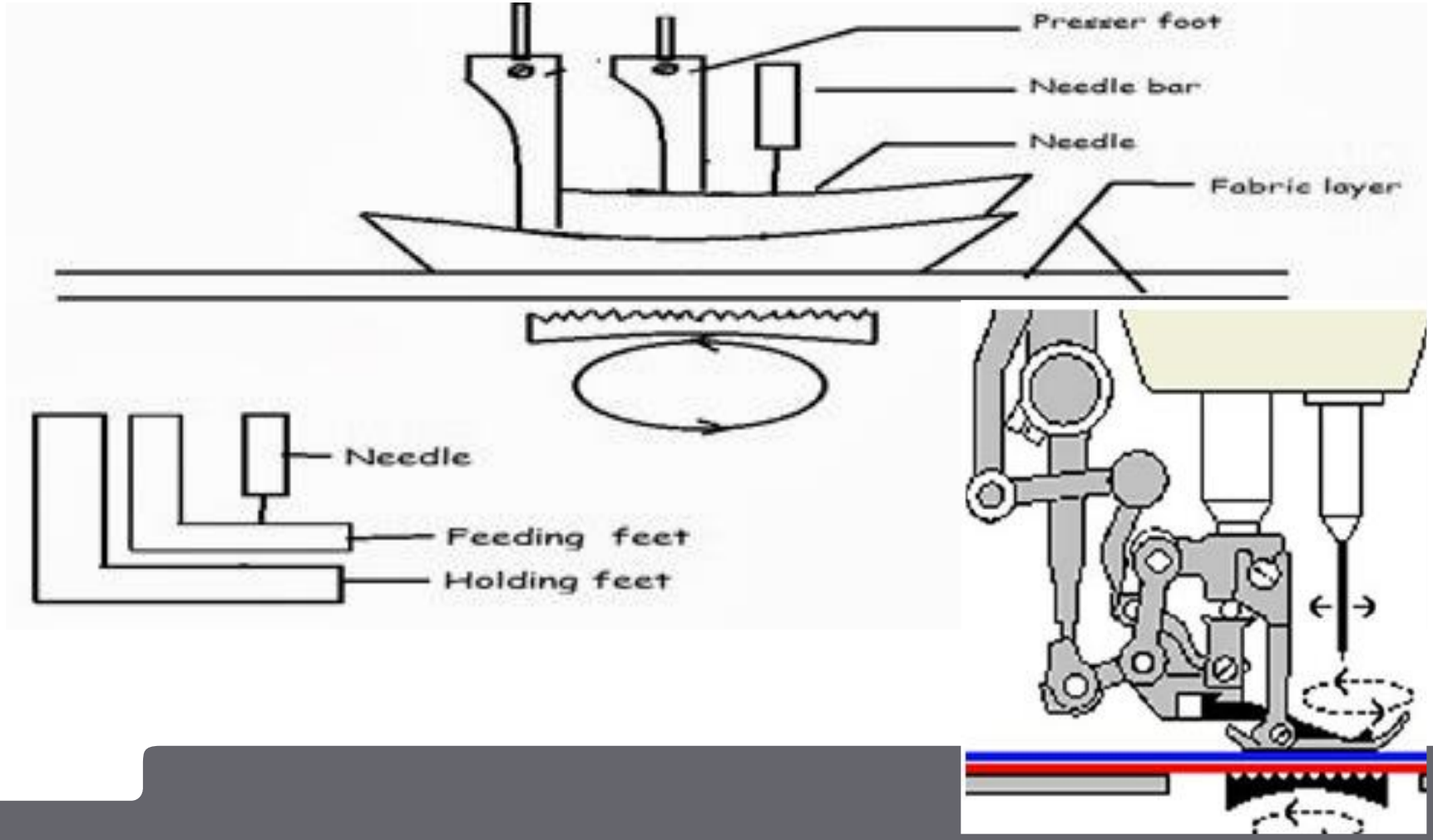
Unison Feed System Mechanism

AKA “walking foot system because the presser foot has two independently driven section: the holding and the holding & the feeding feet which allows combination of needle feed & positive top and bottom feed.

In this system one presser foot is inside the other presser foot & gives movement at different times. The inside presser foot & needle are driven at the same time toward the same direction → No possibility of ply shifting.

Suitable for sewing stitch fabric & for bulk seam in heavy weight materials… normally not so used unless special case.

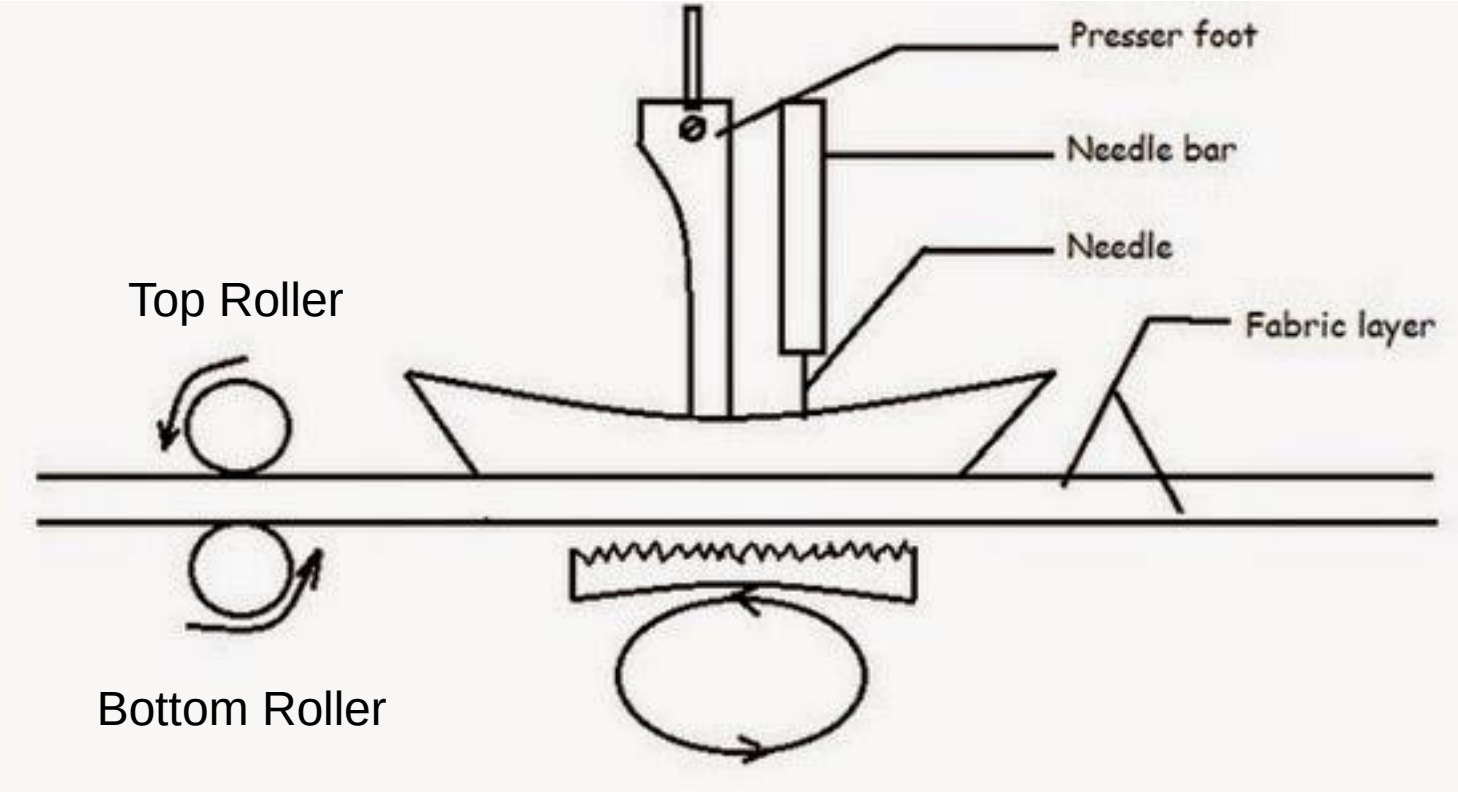
Unison Feed System Mechanism



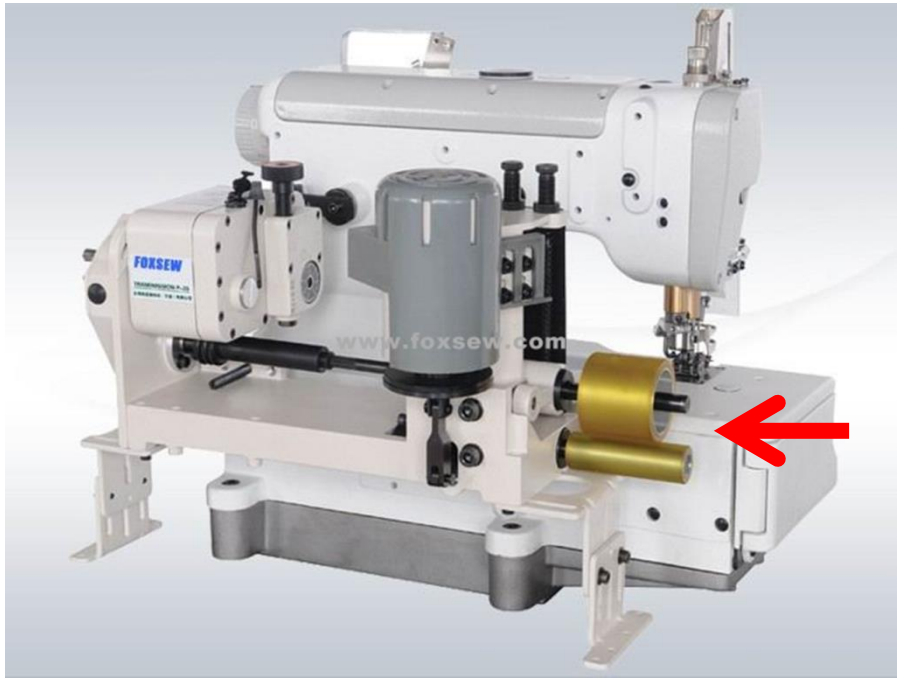
Puller Feed Mechanism

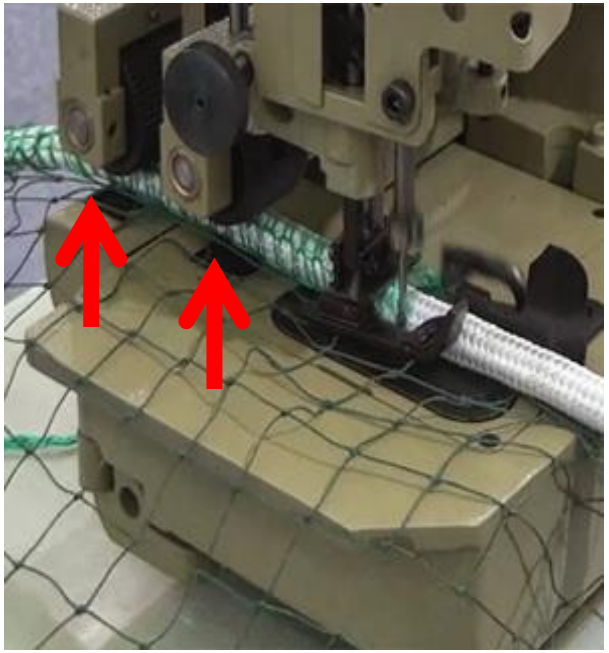
Modification of drop feed system where a pair of roller used to give a pulling motion on the fabric behind the presser foot. Top roller is generally driven by machine whitest the lower one moves due to control & presser of the top roller. The surface speed of puller roller is slightly higher then the feed dog speed to presser ply shifting roping. Useful in multi needle machine.

Puller Feed Mechanism



Puller Feed Mechanism





Main types of industrial sewing machines

Type of Industrial Sewing Machine	Main Characteristics	Suitable For
Flatbed	a common type of industrial sewing machine; quite similar to a traditional sewing machine; the arm and needle extend to the base	sewing flat pieces of fabric together
Post-bed	features feed dogs, bobbins, or loopers; features a vertical column raising above the base	boot making, attaching emblems, and glove making
Cylinder-bed	features a horizontal column opposed to the base	sewing cylindrical pieces and bulky items
Off-the-arm	less common type of industrial sewing machine; the material needs to be fed along the axis of a horizontal column	a limited range of designs; ideal for sleeve and shoulder seams

Programmable sewing machine

Video:

- Automatic sewing machine (1:24)

Practicalities and exercises

- Number of stitches per inches
- Thread consumption

Stitches Per Inch (SPI)

When writing garment specifications, you should not neglect specifying the proper number of stitches per inch that should be used in your sewn products. The number of stitches per inch can have a direct influence on the following:

1. the seam strength
2. the stitch appearance
3. the seam elasticity on stretch fabrics.

If you are more confident with SI measures you can convert al the reasoning below by using stitches per centimeters: remember an inch is 2.54 cm!

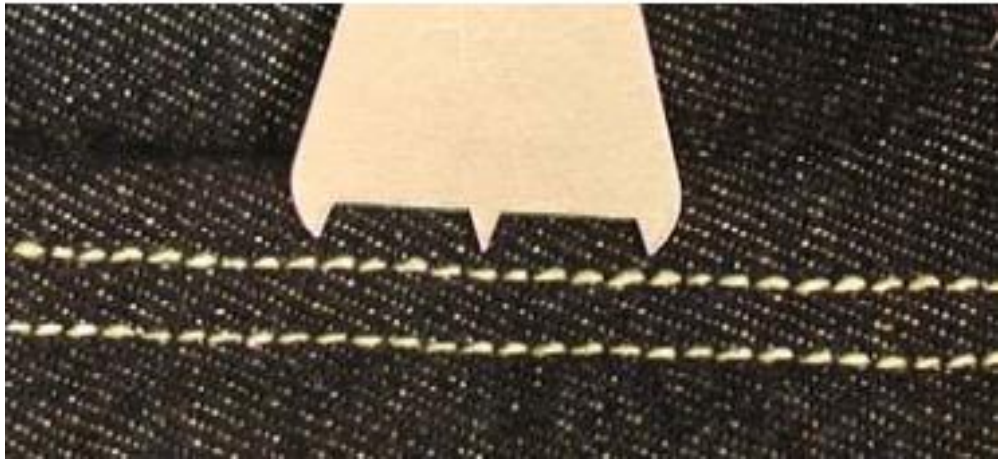
A note...

Obviously, the seam strength is dependent also on anumber of other factors factors including:

- Type & Weight of the Fabric
- Stitch & Seam Construction
- Stitches Per Inch
- Thread Type and Size
- Stitch Balance (Thread Tensioning)

Measuring SPI

The stitch length is measured by measuring the number of lengths of thread found within one inch.



As you can see here, there are approximately 9 SPI sewn in this seam.

Choosing the ideal SPI

Recommendations comes from practice rather than from very well grounded theoretical models. There are a number of table available that suggest good solution for different parameters. One example below…

KNIT GARMENTS

Garments	SPI	Comments	Garments	SPI	Comments
Jersey T-Shirts, Tops, Polos	**10 - 12**	Using more SPI increases the chance of needle cutting.	**Swimwear**	**12 - 16**	The more elastic the seam, the more SPI that should be used to minimize stitch cracking.
Underwear	**12 – 14**	The more elastic the seam, the more SPI that should be used to minimize stitch cracking.	**Dresses, Skirts**	**10 - 12**	The more elastic the seam, the more SPI that should be used to minimize stitch cracking.
Infantwear	**10 - 12**	The more elastic the seam, the more SPI that should be used to minimize stitch cracking.	**Intimates**	**12 – 16**	The more elastic the seam, the more SPI that should be used to minimize stitch cracking.
		More stitches per inch	**Stretch Knits**		More stitches per inch

Stitches Per Inch (SPI) relevant formulas

Estimating Seam Strength on Woven Fabrics 301:

- Estimated Seam Strength = SPI X Thread Strength (lbs.) X 1.5*
- Example (10SPI and thread strength 4lbs)= 10 SPI X 4.0 lbs. X 1.5 = 60 lb. strength

Estimating Seam Strength on Woven Fabrics 401:

- Estimated Seam Strength = SPI X Thread Strength (lbs.) X 1.7**
- Example (10SPI and thread strength 4lbs)= 10 SPI X 4.0 lbs. X 1.7 = 68 lb. strength

* 1.5 is a factor based on the average loop strength ratio of most sewing threads.

**This factor is higher than a lockstitch because almost twice as much thread is consumed per inch of seam using a chainstitch (301)

Stitches Per Inch (SPI) Example

Given:

- 301 Lockstitch Superimposed Seam
- Thread Used Top & Bottom = T-24 Perma Core – Strength: 2.6 lbs.

Calculate the strength for 6, 8, 10 and 12 SPI

SPI	6	8	10	12
Estimated seam strenght	23.4	?	?	?

Try yourself

- Estimated Seam Strength = SPI X Thread Strength (lbs.) X 1.5*
- 6 SPI X 2.6 lbs. X 1.5 = 23.4 lb. strength

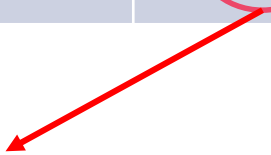
Stitches Per Inch (SPI) Example

Given:

- 301 Lockstitch Superimposed Seam
- Thread Used Top & Bottom = T-24 Perma Core – Strength: 2.6 lbs.

Calculate the strength for 6, 8, 10 and 12 SPI

SPI	6	8	10	12
Estimated seam strenght	23.4	31.2	39	46.8



- Estimated Seam Strength = SPI X Thread Strength (lbs.) X 1.5*
- 6 SPI X 2.6 lbs. X 1.5 = 23.4 lb. strength

Thread consumption

- In today's competitive marketplace, there is a need for tight cost control. A realistic estimation of potential thread requirements for particular garment styles or contracts will not only end up saving you money, but also enable you to use a superior thread for the same cost, thereby not compromising on garment quality.
- Several factors determine the extent of thread consumption in any sewn product, such as:
  - stitch type
  - seam type
  - material thickness
  - number of layers
  - construction and SPI (stitches per inch).
- However, these factors are not constant with the different style preferences. Hence, thread consumption is never standard for sewn product categories such as shirts, trousers and footwear.

Thread consumption methods

There are two methods generally used to calculate the amount of thread in a seam and hence the thread consumption in the sewn product:

- By measuring the actual amount of thread consumed
- By calculation using thread consumption ratios

Thread consumption methods: measuring the actual amount

A specified length of a given seam is measured and then the thread is pulled out of this length. We can use the amount pulled out of this specified length to calculate the ratio of thread consumed in the entire seam. By dividing the amount of thread by the seam length, we get the ratio of thread consumed. If we multiply this factor times the total length of seam, we can determine the total thread consumed for that seam.

Generally, 10% to 15% wastage of thread is added to the consumption derived. This wastage occurs due to shop-floor conditions like machine running, thread breakage, repairs, etc.

Thread consumption methods: calculation using consumption ratios

The easier method is to use the generally applicable Thread Consumption Ratios for the various stitch types that are listed in the table below. By relating these ratios to the length of seams using each stitch type, total thread consumption can be calculated.

Stitch Class	Description	Total Thread Usage (cm per cm of seam) / Thread Ratio	No. of Needles	Needle Thread %	Looper / Under (incl. Cover) Threads %
301	Lockstitch	2.5	1	50	50
101	Chainstitch	4.0	1	100	0
401	Two Thread Chain Stitch	5.5	1	25	75
304	Zigzag Lockstitch	7.0	1	50	50
503	Two Thread Overedge Stitch	12.0	1	55	45
504/td>	Three Thread Overedge Stitch	14.0	1	20	80
512	Four Thread Mock Safety Stitch	18.0	2	25	75

Note:

- The above ratios are arrived at with a stitch density of 7 stitches per cm (18 stitches per inch).
- These ratios are the prescribed minimum in regular conditions and marginally vary with the factors affecting thread consumption.
- A certain percentage of wastage is to be added to the above ratios as per shop floor conditions. It may vary from 10% to 15%.

Clarification on the table

- **Stitch class** and **description** refer to the particular kind of stitch (to be chosen according to use)
- **Total thread usage (cm per cm of seam)/ Thread ratio**: gives the ratio between the cm of thread used for each cm of seam
- **Needle thread %**: percentage of the thread used by the upper part of the seal; the ones delivered by the needle
- **Looper/Under thread %**: percentage of the thread used by the Looper for the lower part of the seal.

Thread consumption calculation example

Calculate the thread consumption for a seam of 100 cm for a stitch class 401 (two thread chain stitch).

Stitch Class	Description	Total Thread Usage (cm per cm of seam) / Thread Ratio	No. of Needles	Needle Thread %	Looper / Under (incl. Cover) Threads %
301	Lockstitch	2.5	1	50	50
101	Chainstitch	4.0	1	100	0
401	Two Thread Chain Stitch	5.5	1	25	75
304	Zigzag Lockstitch	7.0	1	50	50

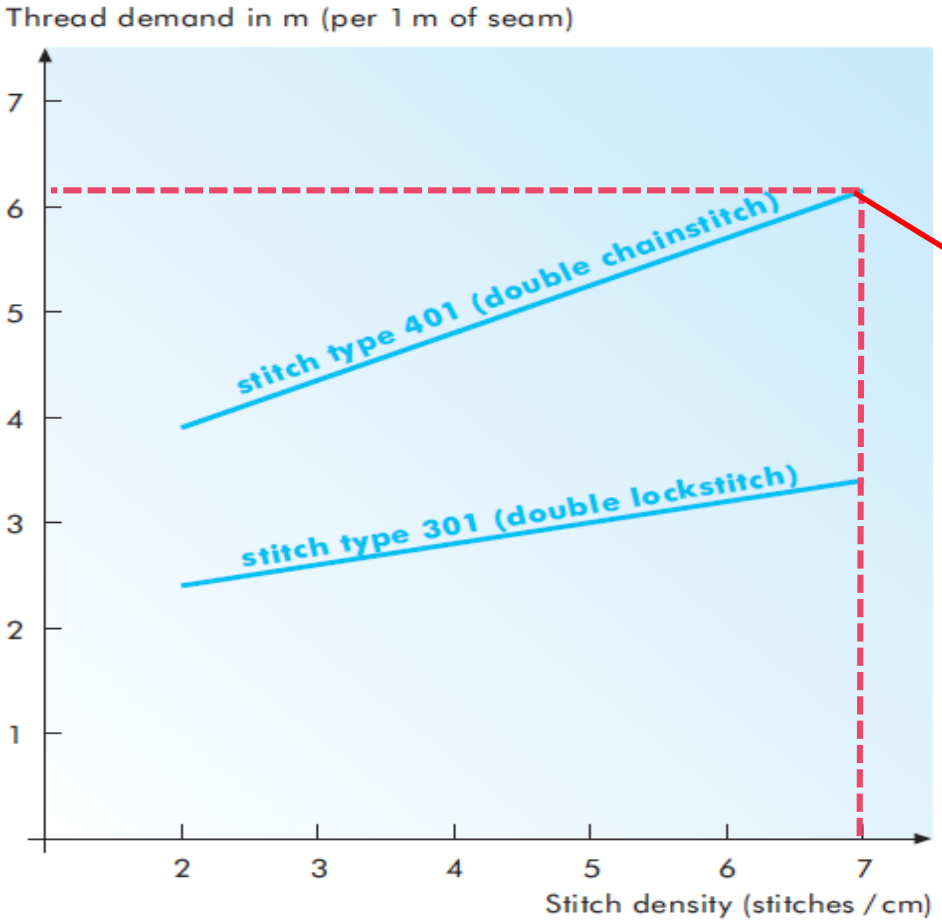
Thread consumption calculation example

Stitch Class	Description	Total Thread Usage (cm per cm of seam) / Thread Ratio	No. of Needles	Needle Thread %	Looper / Under (incl. Cover) Threads %
401	Two Thread Chain Stitch	5.5	1	25	75

- Total thread usage per cm of seam = 5.5 cm
- Total thread consumption = 100 cm x 5.5 = 550 cm
- Estimated Needle thread = 550 x 0.25 = 138 cm
- Estimated Looper thread = 550 x 0.75 = 412 cm
- Add 15% wastage = 550 cm x 1.15 = 633 cm of thread per seam

Influence of stitch density on thread demand

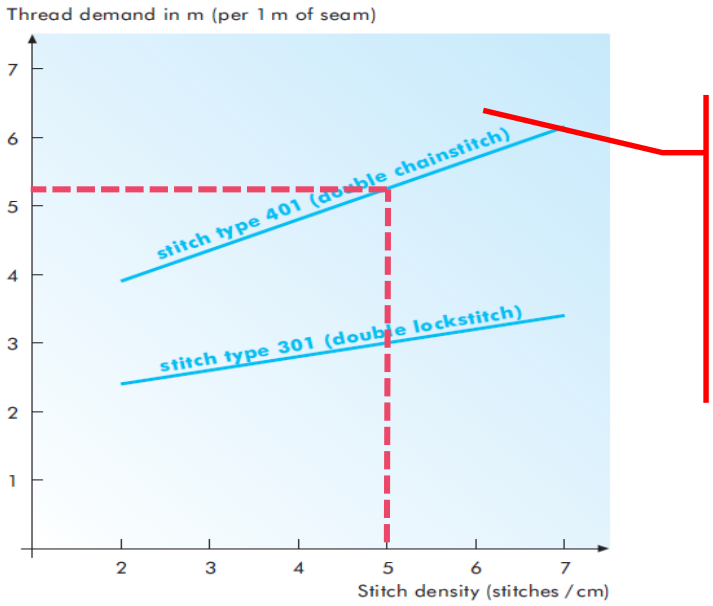
The table we have seen are valid for 7 stitches per cm...how do we work with different density?



From the table we have 5.5 plus 10% wastage we have ≈ 6.1

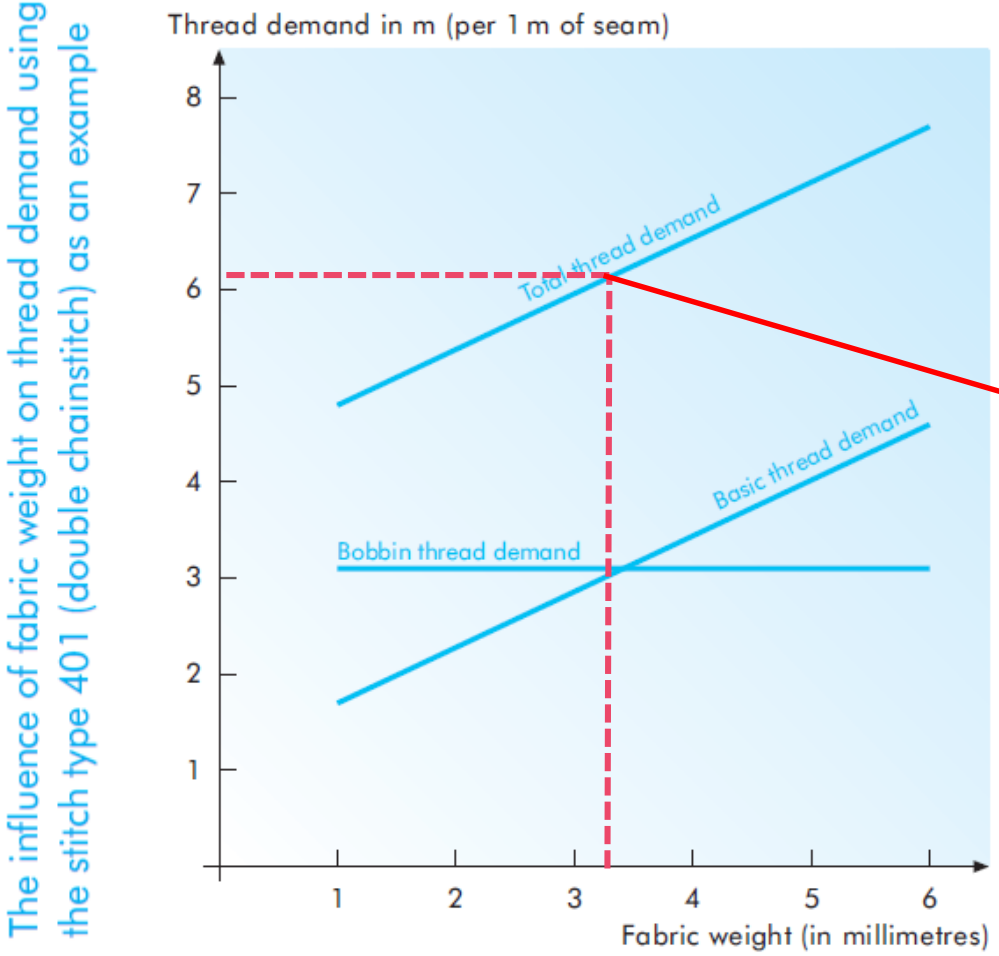
Thread consumption calculation with other value of stitches per cm

Calculate the thread consumption for a seam of 100 cm for a stitch class 401 (two thread chain stitch) in case we work with 5 stitch per cm.



≈ 5.1
We need to remove 10% wastage so the ratio is roughly
4.5

Influence of fabric weight on thread demand



Following the table we deduce that the fabric weight in the previous example ≈ 3.2

Thread consumption calculation with other value of stitches per cm

Stitch Class	Description	Total Thread Usage (cm per cm of seam) / Thread Ratio	No. of Needles	Needle Thread %	Looper / Under (incl. Cover) Threads %
401	Two Thread Chain Stitch	4.5	1	25	75

New

- Total thread usage per cm of seam = 4.5 cm
- Total thread consumption = 100 cm x 4.5 = 450 cm
- Estimated Needle thread = 450 x 0.25 = 112.5 cm
- Estimated Looper thread = 450 x 0.75 = 337.5 cm
- Add 15% wastage = 450 cm x 1.15 = 517.5 cm of thread per seam

Tutorial: calculation of the thread consumption for an average-sized knitted t-shirt

Refer to the PDF for table and problem description.

For an average T-Shirt you need:

- 4m seam 301 (lockstitch)
- 3m seam 504 (three thread overedge stitch)
- 0,75m seam 401 (two threaded chain stitch)
- 0.95m seam 503 (two threaded overedge stitch)
- 0.1 m seam 101 (one thread chain stitch)

Considering wastage of 15% and use of regular thread (table provided) what is: the total thread consumption, needle thread and looper thread?

Tutorial: calculation of the thread consumption for an average-sized knitted t-shirt

Solution:

Stitch	Type	Seam Length (m)	Thread Ratio	Total Thread Consumption (m)	NT	LT
301	Lockstitch	4.0	2.5	10.0	5.0	5.0
504	Three Thread Overedge Stitch	3.0	14.0	42.0	8.5	33.6
401	Two Thread Chain Stitch	0.75	5.5	4.0	1.0	3.0
503	Two Thread Overedge Stitch	0.95	12.0	11.4	6.3	5.1
101	One Thread Chain Stitch	0.10	4.0	0.4	0.4	0.0
Total thread consumed				**67.8**	**21.1**	**46.7**
Wastage (15%)				**10.0**	**3.0**	**7.0**
Total after considering wastage				**77.8**	**24.1**	**53.7**

Excercise: calculation of the thread consumption for an average-sized knitted t-shirt

Refer to the PDF for table and problem description.

Given that for an average pair of jeans you need:

- 8m seam 504 (three thread overedge stitch)
- 14m seam 301 (lockstitch)
- 4m seam 401 (two threaded chain stitch)
- 1m seam 503 (two threaded overedge stitch)
- 0,4m seam 101 (one thread chain stitch)

Considering wastage of 15% and use of regular thread (table provided) what is: the total thread consumption, needle thread and looper thread?

Question for formative assessment

1. Describe graphically a simplified process chain for textile industry highlighting the phases where assembly-like process are involved.
2. List and describe the most important kind of thread used in textile.
3. What does 1 dtex yarn stands for?
4. List and describe the common system to perform the shedding operation in fabric manufacturing.
5. List and describe the four elements involved in the sewing process.
6. What is a chain stitch and which are the other main types of stitches?
7. Summarize in a table the main differences between automatic and machine sewing.
8. List the main parts of a sewing machine and the different feeding mechanisms.