14 Sewing Machines for Leather and Other Heavy Products

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14.1 INTRODUCTION

Sewing machines play an important role in the fashion industry. Their invention has been one of the most revolutionary in history. The most important function of the sewing machine is to join different types of textile fabrics or leather materials. The principle of a sewing machine relies on the stitches used to join or attach layers of textiles or leather patterns using a needle and thread. The basic sewing parameters include the seam, the thread and the sewing method. High quality must be ensured to contribute to the overall performance of the manufactured product. Poor seam quality will not provide a functional product. Depending on the type of product, seam requirements are different. They are linked to the type of leather, which plays an important role, threads and sewing parameters. Studies have found that the seam strength is higher with an increase in stitch density (1). A comparison between leather, denim and a PVC-coated fabric shows that leather has the highest sewing performance (2).

Sewing machines are used for a wide range of products, including clothing for fashion, protective clothing, automotive products such as seat cover, seatbelts and airbags and for domestic products such as upholstery and curtains. Depending on the type of product to be sewn, the sewing machine must fulfil various requirements such as durability.

14.2 AN OVERVIEW OF SEWING MACHINES FOR LEATHER PRODUCTS

For a long time, gathering or assembling two different pieces of fabrics was only possible using a needle and thread. The history of sewing machines in the manufacture of shoes is interesting and very important because their invention revolutionized the footwear production industry. It started in 1755 in London when a German immigrant, Charles Wiesenthal, took out a patent for a needle to be used for mechanical sewing. However, historical data depicts that, in 1790, the first real sewing machine was invented by Englishman Thomas Saint. Saint's invention remained a drawing as

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attempts were made to build the machine in 1880 including considerable modifications (3). In 1846, records show that Elias Howe Jr received the patent for his invention of the sewing machine, which was adapted to sew the upper part of a shoe in 1858 (4). Figure 14.1 depicts the sewing machine patent model of Elias Howe Jr at the National Museum of American History.

Creating leather products such as shoes, belts and clothing requires the assembly of each pattern. This is done by sewing or gluing depending on the type of product. Sewing machines used for leather products differ from those used for clothing. They are designed to sew leather, which is different from sewing textile fabric. Leather is different from the engineered structure of woven or knitted fabrics, and comes in various thicknesses and densities.

As a tough material, leather requires extra force to sew compared with textile fabrics.

Sewing machines play a significant role in the quality of leather products. Care should be taken to select the type of thread according to the type of leather product for use on a machine for leather as this improves the quality of the final leather product (6). Seam stability depends on correctly selecting the tensile features of sewing threads as these improve the sewability of leather products according to their purpose (7). The finer the needle size, the lower the needle penetration force. This enhances the sewability as in the case of artificial leather where the backing

FIGURE 14.1 Sewing machine patent model of Elias Howe Jr – 1846 (5).

of a fabric structure plays an important role (8). New technology developments can be implemented to study the sewing techniques for manufacturing fur and leather clothes (9). However, choosing the optimal machine equipment requires considering the qualification of the machine worker, the type of technological operation and the material's properties, including its thickness, coating and base (10).

14.3 MAIN PRODUCERS OF SEWING MACHINES FOR LEATHER

Both domestic and industrial machines can be used to sew leather. Most of the world's sewing machine manufacturers develop and produce a special machine for sewing leather.

One of the most popular historical manufacturers of sewing machines for leather, including those with a post-bed and cylinder platform, is the Singer company (11). The picture given in Figure 14.2 presents two sewing machines from the Singer company.

Most modern sewing machines for sewing leather have a roller presser and a post-bed or cylinder platform. These machines are often equipped with an additional cutting element. The picture in Figure 14.2 depicts the is a diagram of a sewing machine with a roller presser and a cutting element.

Today, different companies are engaged in the production of machines for leather as follows:

1. Machines with one needle, two threads, cylinder bed

Stitch type 103, 107

Singer 6ss, 7ss

PFAFF 3306 – 6/01 – 918/36b

BROTHER CM3-B933, CM3-B938

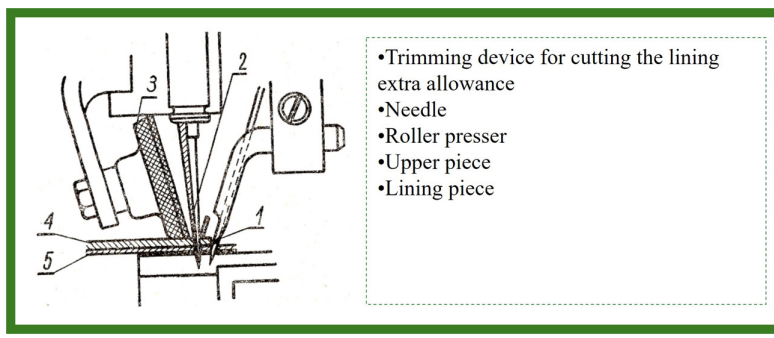

FIGURE 14.2 Diagram of a sewing machine (12).

2. Machines with one needle, two threads, flat bed

Stitch type 301

PFAFF 1243-3
PFAFF 441-R-755/03-900/61 -910/ 15-925/02 BL
PFAFF 483-0-944/07-900/99-910/04-911/35-926/01-925/02 BL
PFAFF 563-944/01-900/57 BL
PFAFF 1243-750/01 -4/01 900/56-910/04-925/02 C/DLMN8
JUKI DU - 141 H – 5 - 2B/MC - 210/AK - 44B
JUKI DNU-241H-5-2B/MC-210/AK-70B
MINERVA 72125- 105 QD
MINERVA 72128 – 101
ADLER 204
GRANUCCI 885

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3. Machines with two needles, two threads, flat bed

Stitch type 301

PFAFF 1244
PFAFF 244-750/01-4/01 -900/56-910/04-925/02A (1, 4)1
PFAFF 422-K-69/01 -913/52 B5
PFAFF 1244-720/02-944/01 -900/56-910/15-925/02 B/CLMN
MINERVA 72207 – 101 MINERVA 72207 – 105
JUKI LH 1152C-5-4B/MC-210/AK-11
JUKI LH 1172S-5-4B/MC-210/AK - 11
GRANUUCCI 974/979

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4. Machines with one needle, two threads, post-bed

Stitch type 301

PFAFF 1291
PFAFF 491-755/13-726/05-900/53-910/15-925/02 BL
PFAFF 491-755/13-900/53 BL
PFAFF 491-705/13-59/99-913 52-940/02 BL
PFAFF 1293-750/01-4/01-900/56-910/04-925/02 C/DLMN
PFAFF 1295-706/35-17/01-940/01-913/52 DLMM
PFAFF 1493-755/13-900/53-910/15-925/02 BLN5
PFAFF 1493-755/13-725/04-900/53-910/15-925/02 B/CLMN5
GRANUCCI 960
JUKI PLW – 1245-6/AK-69B

JUKI PLW – 1246-6/AK-69B
JUKI PLW – 1257-6
MINERVA 72405-101
MINERVA 72415-101
MINERVA 01192-P6

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5. Machines with two needles, two threads, post-bed

Stitch type 301
PFAFF 294-750/01-4/01 -900/56-910/04-911/35-925/02 BL
PFAFF 474-755/11-600/51 BLN 3.6
PFAFF 474-755/11 -725/04-900/51 BLN 3.6
PFAFF 1294-750/01-900/56-910/04-925/02 CDLMN
JUKI PLW 1264-6/AK-69B/
JUKI PLW 1266-6/AK-69B/
MINERVA 72402 – 101
MINERVA 72411 – 102 MINERVA 72411 – 105
MINERVA 72412 – 101
MINERVA 72414 – 101
MINERVA 01171 - P6
GRANUCCI 980

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6. Machines with one needle, two threads, cylinder bed

Stitch type 301
PFAFF 335-H3-17/01-900/52 BL
PFAFF 3336-22/01-966/13 BL
PFAFF 3337-308/01-964/02-966/11 B
JUKI DSC 245 – 5 2B/MC -210/AK -70B
JUKI TSH-411 TSU-471 TSN-421 TSC-441
JUKI T5C-461
JUKI MINERVA 72317 – 101
Granucci 840

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7. Machines with two needles, two threads, cylinder bed

Stitch type 301
PFAFF 646-706/47-656/01-59/01 -910/04-913/52-925/02 CLMN
MINERVA 72314-101
MINERVA 72316-107

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8. Machines with one needle, two threads, flat bed

Stitch type 304
PFAFF 418-47/12-944/01-900/51-908/02-910/04-917/15-925/02CL x 8.0
PFAFF 418-49/01-900/51-908/02-909/04-910/04-911/15-925/02 BL
JUKI LZH – 1290-6/AK – 68B/
MINERVA72527 – 101, MINERVA72527 – 105
MINERVA72528 – 101, MINERVA72528 – 105
Granucci 780

9. Machines with one needle, two threads, flat bed

Stitch type 308
PFAFF 938-716/06
SINGER 457A

10. Machines with one needle, two threads, flat bed

Stitch type 401
PFAFF 3806-2/02
PFAFF 3806-2/03
PFAFF 3821-1/13

11. Machines with two needles, four threads, flat bed

Stitch type 401
PFAFF 5696-H-840/02-706/07-63/01-910/04-913/52

12. Machines with two needles, three threads, flat bed

Stitch type 402
PFAFF 5483-H814/02-711/01-69/01 BSx3.2

13. Machines with one to two needles, two to five threads, post-cylinder bed

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Stitch type 503, 505, 512

PFAFF-SINGER 1831u, 1832u, 1842u

14.4 FOOTWEAR PRODUCTION: THE ROLE OF SEWING OPERATIONS IN SHOE MAKING

Shoes are a complex product of the fashion industry, composed of an upper part and bottom elements joined together. The technological process of shoe production can include a large number of operations, many of which are sewing operations. In general, the shoe production process can be divided into different stages as follows:

1. Cutting the upper parts.
2. Skiving the edges of the parts.
3. Overlapping the interlining.
4. Folding or binding the edges of the upper parts.
5. Assembling the footwear parts – sewing.
6. Lasting process on the shoe last.
7. Preparation of the bottom surface of the lasted upper parts for attaching the sole.
8. Attaching the sole.
9. Finishing, removing the last from the footwear.

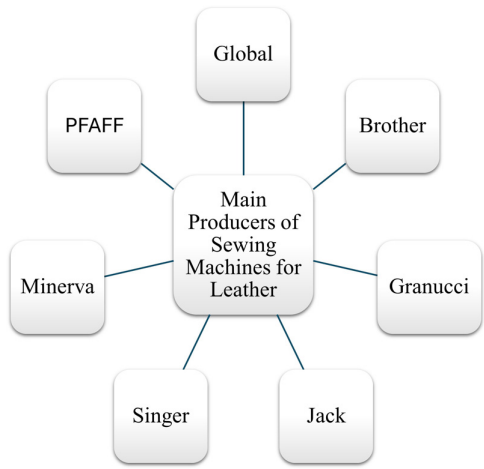

FIGURE 14.3 Main producers of sewing machines for leather products.

Figure 14.4 is a graphical presentation of the above stages for footwear production.

Since the middle of the 19th century, the sewing of shoe parts has traditionally been done with a sewing machine. With the development of technologies, materials and equipment, the fashion industry has actively used chemical methods for joining parts, especially for attaching the bottom. However, given the prevailing sustainable trend in world fashion today, mechanical methods for joining parts are becoming increasingly popular, and sewing machines for shoe manufacturing are expanding their scope of application and the range of constructions.

The upper part of a shoe can be a flat, half-spatial or three-spatial blank, made by connecting individual parts to each other. Thread seams are mostly used to connect parts, which have different parameters and performance features. Several factors affect the choice of equipment for stitching footwear parts and the technological parameters of the operation:

- Assignment of details.
- Materials of connecting parts.
- Type and construction of shoes.
- Type of seam.
- Location of seam.
- Requirements for shoes and connecting seams.
- Technical conditions of the enterprise.

Seams play an important role in footwear products, including for functional and aesthetic purposes. Moreover, the seam can define the shoe's style. According to the type of shoe, a seam is used for the following reasons:

- Joining the upper parts together.
- Attaching the insole to the upper part when conducting Strobel lasting.
- Decorating shoe parts.
- Attaching the sole and stitching the side of the mould sole.

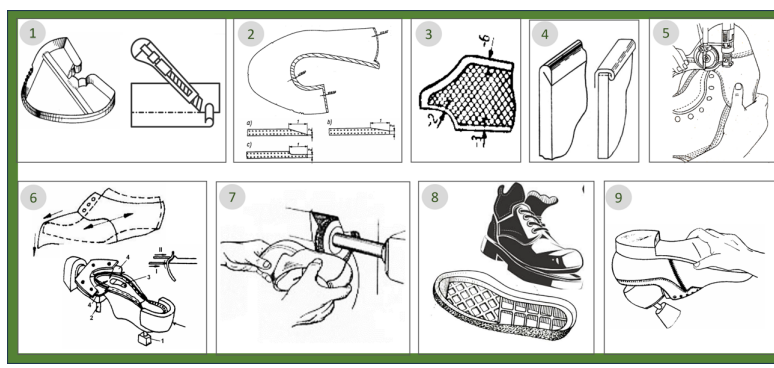

FIGURE 14.4 Main stages of footwear manufacturing (11,12).

The method of joining parts using seams is one of the most reliable and is widely used in footwear production, both for assembling the upper parts and for attaching the lower part or sole. Therefore, specialized enterprises are developing a huge number of machine designs that can perform certain types of seams for footwear production. The type of seam and the type of sewing thread greatly influence the aesthetic properties of the shoe. A good-quality sewing thread is essential to ensure the durability and the strength of the footwear products. A specific characteristic of the sewing thread used in footwear products to ensure their durability is the thread's resistance to environmental conditions to which footwear products are exposed. Footwear products are used during daily life, which means that they are exposed to sunlight. As a result, resistance to UV rays that might cause colour fading and especially thread degradation is necessary. Other requirements related to environmental conditions are linked to moisture resistance. Threads are in contact with water from rain and other sources that can cause the development of mould and their subsequent degradation. For this reason, moisture resistance is important to ensure thread strength and good shoe hygiene that might impact foot health.

The above-mentioned requirements are related to the use of footwear products. However, even during their production, due to the various processes they must undergo, sewing threads are exposed to chemical agents and heat processes depending on the shoe model. Withstanding these heat and chemical processes without affecting thread resistance is essential during the production process.

The selection of sewing threads for footwear products includes the requirements linked to their performance and durability during the sewing process. Additionally, they are related to the type of shoe model and the type of sewing machine thread used regarding materials and weight, or colour matching with the upper part of the shoe.

14.5 CLASSIFICATION OF SEWING MACHINES

In the footwear industry, sewing equipment is represented by a wide range of sewing machines and has a wide multi-level classification. Figure 14.5 presents various types of classifications.

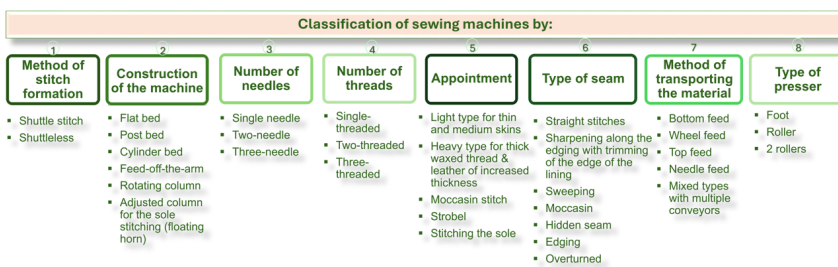

FIGURE 14.5 Classification of sewing machines for leather products.

The upper parts are joined with thread seams, which are linear or zig-zag. Linear stitches are used when parts are placed on top of each other. Zig-zag stitches are used when parts are joined at the back line (e.g. quarters) and for the lining.

Today, despite the wide variety of shoe types, constructions and designs, the following seams are most often used:

A lapped seam is used to join the toe part to the vamp, the vamp to the quarter and counters, and the front to the leg in boots. The quarters, the leg parts of boots, are sewn together using plain closed or zig-zag stitches. The zig-zag stitch is less durable than the stitch seam, so it is reinforced with a back strap. Using a turned seam, the outer parts of the top are sewn together with the lining along the top-line. The moccasin seam is used to connect the main part and apron in moccasins.

Each of the listed seams has its own technological features and necessary accompanying operations that precede or follow stitching.

Plain closed seams. These seams are produced by facing two sections together and stitching approximately 1.5–2 mm from the edge.

After opening outwards, a ridge is left prominently exposed on the inside; a ridge that would cause much discomfort during wear unless flattened, an operation usually termed rubbing down.

This type of seam requires neat stitching with small, even stitches made with thin or medium thickness threads. Of great importance for the quality of the seam is high-quality skiving the edges of the parts before stitching. To strengthen the seam, tape is used, which is glued after smoothing (rubbing down) the seam. For everyday shoes, the back seam is often reinforced with a strap. For additional strengthening of the seam when using thick skins, a pipe or welt is used.

Turned top-line seam. This is a type of closed seam that is used on the top-line of the upper part of boots, half-boots and shoes. The parts of the workpiece are placed face-to-face with the front sides and joined with a closed seam. They are then unfolded relative to each other so that they are folded. After turning inside out, the sewn parts are stitched along the edge of the turned seam.

Plain lapped seam. This seam is the most used in the assembling of the upper shoe. It is the strongest of seams and it is possible to use more stitches to the centimetre than in any other type of seam. The top section has usually undergone some previous treatment to the edge, while the under section has been skived to a feather to prevent an unsightly appearance and discomfort during wear. The seam can be single row, double row or multi-row. The stitching allowance varies according to the materials used and the number of rows of stitching. For lightweight leather stitched with one row or two close rows, the allowance can be as little as 6 mm. The number of rows in the seam depends on the tension in this area during the use of the shoes. Adding a second row to a single-row stitch leads to an increase in the bonding strength by 60–85%, depending on the properties and conditions of the stitch. A further increase in the number of rows (up to three to four or more), slightly increases the binding strength. Therefore, single-row and double-row seams are the most common. A multi-row seam can be performed with or without perforation.

Before sewing the seam, and after the edges of the parts have been roughened, markers are applied to the lower part, and a thin layer of glue is applied to the joints

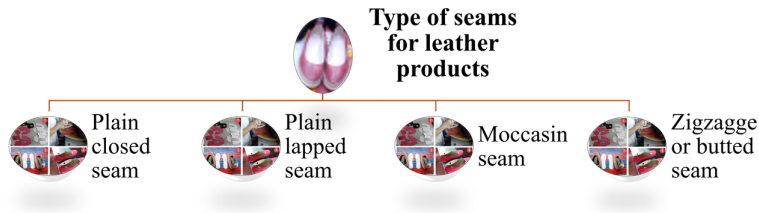

FIGURE 14.6 Types of seams on footwear products.

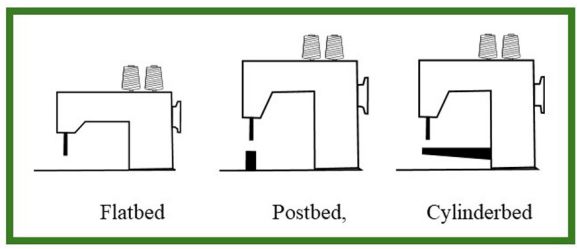

FIGURE 14.7 Types of sewing machines according to bed construction.

of the edges of the parts, after which the upper part is superimposed on the lower part according to the markers.

Zig-zagged or butted seam. This is a temporary seam in which the cut edges of two sections are butted together using a special machine stitch needle that alternates from one section to the other, forming a zig-zag stitch. The seam has little strength, but its advantage is that it is completely flat and is ideal for backs of quarters, for instance, when a back-strip is to be put on later. It uses a comparatively elastic method of stitching, another advantage for taking the strain when lasting.

GENERAL RULES FOR ASSEMBLING THE UPPER PART USING STITCHING:

1. The edges of the adjustable parts must coincide with the notches and markers.
2. Seam allowances depend on the number of rows, the presence of punches (perforations) and the distance between rows.
3. The stitches should be parallel to the edge of the part.
4. Threads must be well pulled, without overhanging loops and pulled edges.
5. The length of the stitch step depends on the thickness of the material and the thickness of the thread.
6. The size of the needle depends on the thickness of the thread and the thickness of the material.

14.5.1 Bed Construction

The choice of bed construction is regulated by the type of upper shoe.

A flat bed is used for sewing shoes that can be assembled flat (front and back part of derby boots, sandals, and constructions that are closed along the back seam).

The post-bed is used for more complex designs, when the stitching is made on a semi-flat upper part (Oxford boots, Chelsea boots, boots). Stitching on bags mostly requires the use of a post-bed machine. At the same time, the height of the post can be different. A high post enables stitching on the most complex workpieces (e.g. boots-stockings with a high leg).

The cylinder bed machine is mainly used for inserting zippers in boots, for repairing shoes and for sewing bags.

TABLE 14.1
Main Parameters of the Lapped and Closed Seams in Footwear

Type of seam	Material	Distance from first row to edge of piece	Distance between next rows of seam	Number of rows	Punches	Seam allowance
Lapped seam	Lining leather	1.0 ± 0.2	–	1	–	6–7
Closed seam	Lining leather	1.4 ± 0.2	–	1	–	1.5–2
Lapped seam	Delicate leather (kid leather, suede leather, etc.)	1.0 ± 0.2	–	1	–	6–7
Lapped seam	Delicate leather (kid leather, suede leather, etc.)	1.0 ± 0.2	1–1.5	2	–	8
Lapped seam	Delicate leather (kid leather, suede leather, etc.)	1.0 ± 0.2	6	2	Ø 3	10–11
Closed seam	Delicate leather (kid leather, suede leather, etc.)	1.0 ± 0.2	–	1	–	1.5–2
Closed seam	Nubuck, leather of standard thickness	1.7 ± 0.2	–	1	–	2 ± 0.2
Lapped seam	Nubuck, leather of standard thickness	1.3 ± 0.2	–	1	–	7
Lapped seam	Nubuck, leather of standard thickness	1.3 ± 0.2	1.5–2	2	–	8–9
Lapped seam	Nubuck, leather of standard thickness	1.3 ± 0.2	7–8	2	Ø 4	12 – 13
Lapped seam on the top-line	Delicate leather (kid leather, suede leather etc.)	1.0 ± 0.2	–	1	–	–
Lapped seam on the top-line	Nubuck, leather of standard thickness	1.3±0.2	–	1	–	–

14.5.2 Number of Needles

For sewing leather, the needle used must be specifically designed for leather. Needles used for sewing leather have a sharp point and a chisel-shaped blade to penetrate through the tough material without causing any damage. The needle size for leather can range from 14 to 18, depending on the thickness of the material (13).

Sewing needles used for leather have a special knife-shaped point to cut through leather material, avoid bursting stitch holes and enhance the appearance and strength of the stitching. These needles come in more than eight different point styles: diamond point, triangle (TRI) point, narrow wedge point, twist points or SD1 round tri-tip point (14).

The number of needles in a machine is selected according to the type of shoe, its purpose and the location of the stitch. Two-needle machines are used to adjust the quarter to the vamp, the toe part to the vamp, the counter to the quarter, etc. Single-needle machines are used for assembling women's fashion shoes, for top-line stitching, for closed seams, etc. Figure 14.8 presents a view of one needle and twin needles for sewing machines.

14.5.3 Types of Needles

For sewing leather and laminated leather, cutting points and round points are used, depending on the number of layers and the consistency of the leather. To ensure a good-quality seam, it is important to select the correct size of needle and thread (11).

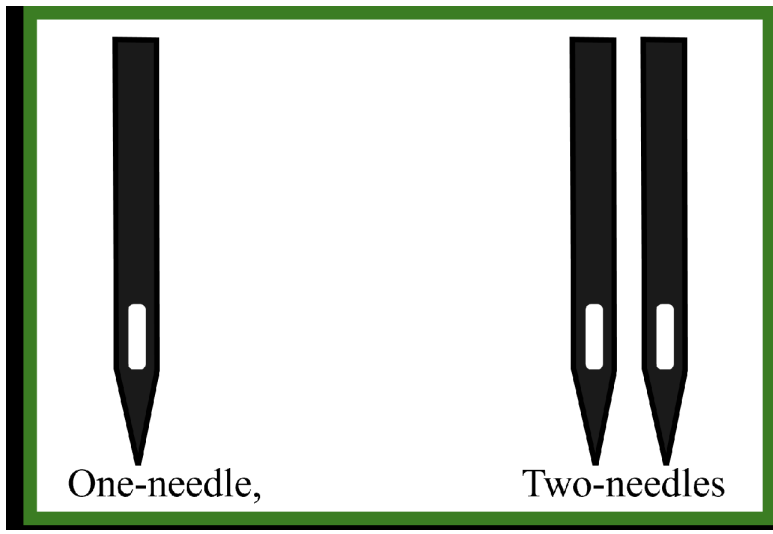

FIGURE 14.8 One needle and two needles for sewing machines.

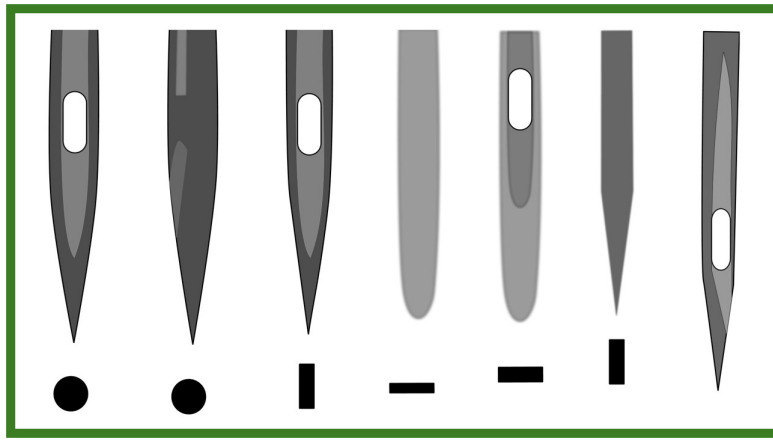

FIGURE 14.9 Types of needles with different needle points.

14.5.3.1 Feed of Material and Type of Presser

The classification of sewing machines according to the feed of the material and the type of presser is provided in Figure 14.10.

The feed type is chosen taking into account the materials of the shoes, their thickness and structure. For shoes and bags that use thick materials and multi-layer connections, a combination of several feed types is required. A roller presser is used for leather materials and a foot presser is used for textiles.

14.5.3.2 Additional Mechanism for Special Operations

Operations that use tape can use a tape trimmer. A vertical knife that cuts the material perpendicular to the seam is used for edge stitching, when it is necessary to cut off excess lining.

14.5.3.3 Type of Stitch

Various types of stitches are used to join single parts of leather. The most-used types are stitch type 301 (double lockstitch) and stitch type 304 (zig-zag stitch) as well as stitch type 401 (double chain stitch). Because they form stitches in different ways (interlacing in the case of the double lockstitch, zig-zag stitch in the middle of the material and interlooping in the case of the double chain stitch at the bottom side of the material), the double lockstitch is used where the seam is visible at the bottom side of the material. The appearance of the top and bottom seam is identical.

14.5.3.4 Type of Thread

The appropriate selection of thread in the production of shoes is essential as many different material combinations are used. The correct sewing thread is of crucial importance for a quality end product. The most important criteria are seam strength and an undamaged, straight seam appearance. Seam strength is additionally influenced by the choice of stitch type, stitch density and thread tension.

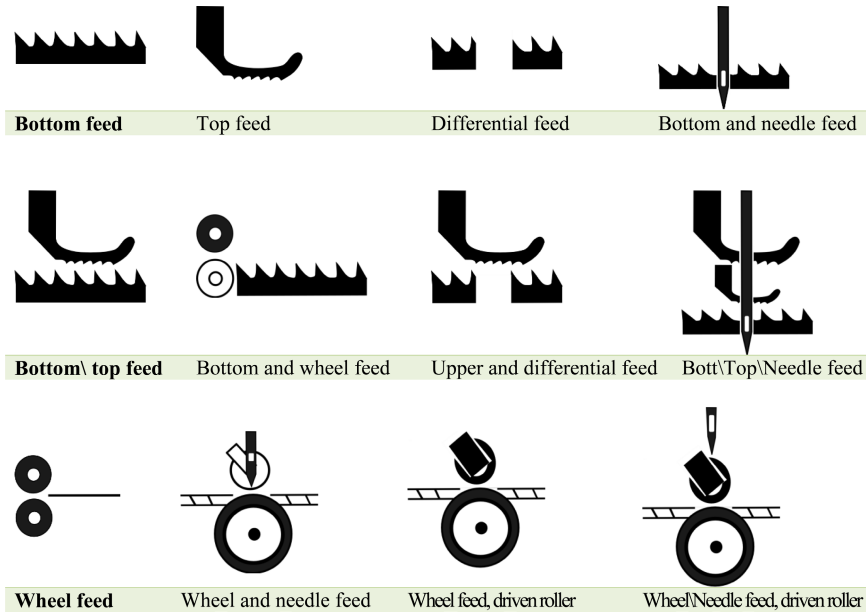

FIGURE 14.10 Classification of sewing machines according to the feed of material and the type of presser.

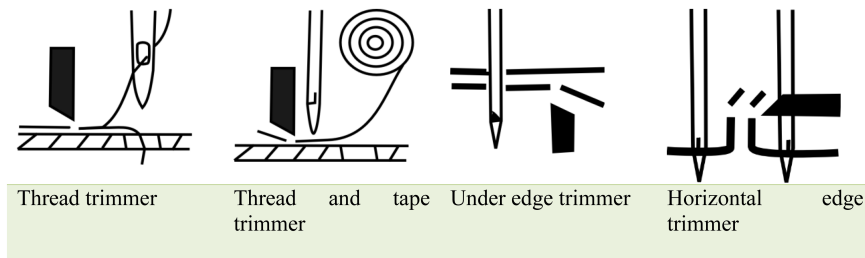

FIGURE 14.11 Additional mechanism for a special operation.

The composition and quality of the sewing thread significantly contribute to seam quality. In the production of shoes, e.g. when sewing back seams and stay seams, continuous multi-filament sewing threads made from 100% polyester or 100% polyamide are used almost exclusively.

14.5.4 Shoe Production Steps in a Footwear Company

Figures 14.13–14.18 present the different steps of shoe production in the footwear company PRODYN operating in Tirana, Albania (15). The first step includes leather inspection to further analyse any defects that may be found on it. This is an important process in order to guarantee high-quality products not only regarding the aesthetic part but also other characteristics related to footwear products.

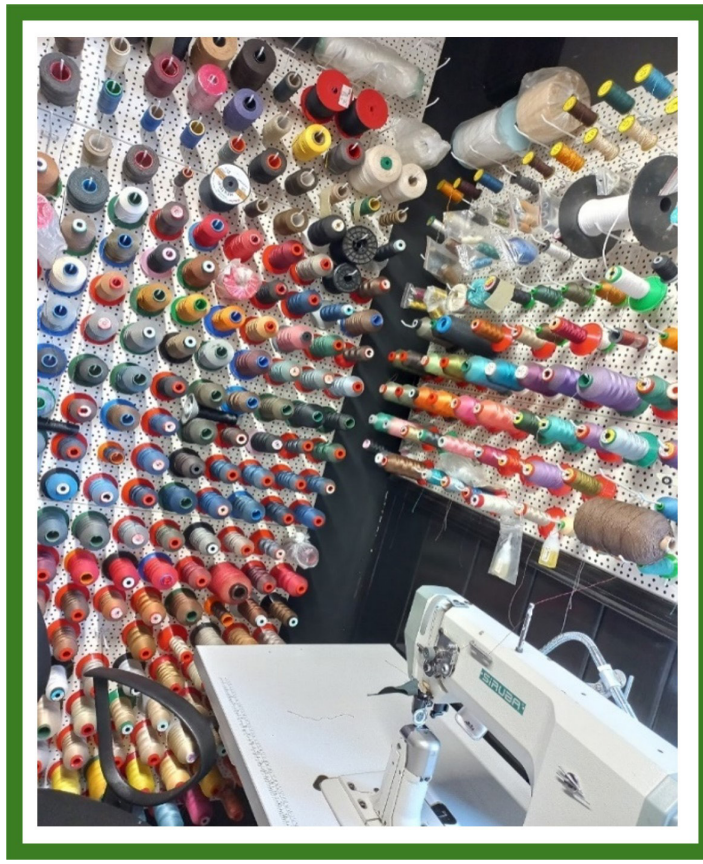

FIGURE 14.12 Various types of thread used for leather sewing. (Photo from shoe design studio Vicelli, Kyiv, Ukraine)

14.5.4.1 Manual Clicker Press for Leather and Other Lining Materials

After inspection of the leather, the next process is cutting the leather parts according to the single parts of the shoe uppers. This step uses manual clickers for leather and other materials used as lining materials in shoe production.

Figure 14.15 present a manual clicker press for lining materials.

The cut parts are then gathered according to their corresponding size and models. Figure 14.16 presents parts of shoe uppers following the cutting process.

14.5.4.2 Sewing Process for Assembling Different Parts

Sewing the upper part of the shoe is one of the most important processes. Different sewing machines are used according to the type of shoe model and the materials used for its production. Figures 14.17–14.18 show the preparation step for the sewing process and the sewing process of different parts.

FIGURE 14.13 Leather inspection at the PRODYN factory.

FIGURE 14.14 Leather cutting with manual clickers at the PRODYN factory.

14.6 CONCLUSION

This chapter provides an overview of sewing machines and their important role in the fashion industry, particularly footwear. A detailed focus on the machines used for different types of materials to produce leather products is presented. The quality of seams and the leather materials are important factors in realizing high-quality products. The main producers of sewing machines, their classification and other characteristics that distinguish them are included. Moreover, the important role that seams play in footwear products is depicted by including their functional and aesthetic purposes. To illustrate the sewing machines used for footwear production, a case study from a footwear company operating in Tirana, Albania, is provided. The main steps followed in preparing shoe parts for sewing and assembling with the sole parts show the importance of quality control to ensure high-quality footwear that meet customer requirements.

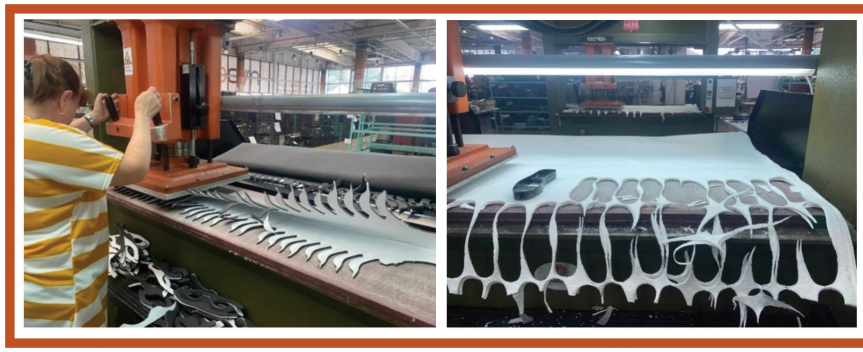

FIGURE 14.15 Cutting of lining materials with manual clickers at the PRODYN factory.

FIGURE 14.16 Parts of shoe uppers following the cutting process at the PRODYN factory.

FIGURE 14.17 Single parts of leather and lining materials preparing for the sewing process at the PRODYN factory.

FIGURE 14.18 Sewing process for the upper part of the shoe at the PRODYN factory.

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