Production of Car Seat Covers

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The garment industry not only produces clothing, but also technical textiles, e.g. for car interiors. In principle, the making up of car seat covers is similar to the technological processes of clothing production, but due to the specificity of the leather and the technical textiles used in the production of covers, there are significant differences. The differences are shown in the share of various machines and equipment in the process of cutting and sewing. Car seat cover production processes require different expertise, different types of professional cooperation in the technical preparation of production and technological production processes, the presence of computer technology for the preparation and management of the production process and for the management of the production process. In addition, the size of production batches, the requirements for production accuracy and the investment costs per workplace also vary. Regardless of the percentage differences mentioned above, the basics of ready-made clothing technology are very similar to those of the technological processes in clothing production, so that a clothing technician can very quickly master the basic features of making up covers for car seats.
Keywords: *car seat cover; leather; organisation; machine sewing needle*

1. Introduction

The first idea of a self-propelled vehicle was sketched by L. da Vinci at the end of the 15th century [1]. Two centuries later, in 1769, the inventor N. J. Cugnot constructed the first steam-powered car. Many engineers worked on the further development of cars, i.e. internal combustion engines. However, a significant change to the car was made by Ch. Dietz in 1835, when he lined the wheels with felt and later with rubber to increase driving comfort. The German engineer N. August Otto together with E. Langen founded the Deutz engine factory in 1864, where in 1876 they invented and successfully tested a four-stroke engine. In 1885, Daimler designed a car with a kerosene engine, and in 1886, C. Benz built a tricycle with a petrol engine, which promoted the rapid development of cars. J. B. Dunlop invented the first air-filled tyre in 1890, and in 1893 H. Ford

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designed his first car. Ford is considered a pioneer of automobile production because he was the first to organise production using an assembly line, which made mass production of cars possible [2]. The first cars had a rather non-ergonomic and uncomfortable interior design. In addition, the interior was quite simple in design for reasons of production convenience. In the early days of the automotive industry, seats were made of solid materials (e.g. wood), as carriage seats were used [3]. The accelerated development of the car occurred in the 30s of the 20th century when the vehicle design, but also the engine construction were improved. The growing production of cars and their popularisation has promoted interior design and thus the development of ergonomically designed seats.

In recent years, passenger cars with hybrid drive systems have entered the market. Due to sudden climate change, manufacturers worldwide are now working intensively on the development of electric vehicles [2]. Electric vehicles are also being developed in Croatia. Mate Rimac has achieved great success in building electric cars worldwide with the Concept One and Nevera models.

The leading Croatian factory for the production of car seat covers Boxmark Leather d.o.o has its production facilities in Trnovac Bartolovečki near Varaždin and in Zlatar Bistrica.

2. Organisation of the production of car seat covers

Boxmark Leather d.o.o manufactures car seat covers for Audi, Mercedes, Porsche and other car manufacturers. Given the specificities of the production process of car seat covers and other forms of professional cooperation in the technical production preparation and technological production processes, car manufacturers hire specialised companies for interior design and technical production preparation, and manufacturers of car seat covers are engaged only in production. Therefore, it receives the following documentation important for the process of manufacturing car seat covers:

- data on material properties,
- cutting parts of car seats covers,
- technological operation plans,
- detailed descriptions of cover parts and lamination procedures,
- plans of technological manufacturing processes,
- calculations on the consumption of threads and materials,
- permissible thickness of the leather, because the leather is not uniformly thick over the entire piece, so that the parts that are too thick have to be thinned out in order to qualitatively join the parts of the covers,
- detailed instructions for making patterns or emblems,
- types of sewn seams for individual sewing operations,
- needle types,
- information on possible changes in the dimensions of leather cover parts during further processing (when processing a workpiece using methods such as embossing during the technological processes of cutting the workpiece, the contour dimensions in individual parts change. Therefore, fine cutting must be carried out),
- tolerances for deviations when performing technological operations (minor deviations are permissible, but must not become the standard),
- ways of sorting the final product for a specific vehicle, including the car chassis number,
- quality control plans.

Based on the defined data, work orders are created according to the agreed delivery dates. Since the submitted technological documentation already contains calculated data of the necessary materials for the production of car cover seats, the factory identifies and completes the existing stocks and adjusts the production line to the work order. Technical textiles, i.e. the leather necessary for the manufacture of covers, are delivered to the factory and deposited on racks in the space located at the entrance to the cutting room, from where they are transported to the first stage of the technological process of cutting, Fig.1.

Fig.1 Leather storage at the entrance to the cutting room

The first step in the technological process of cutting covers for car seats is leather control, i.e. controlling the leather to mark its damage. Each piece of leather is placed on the device to examine deformations and leather damage. Above it there is a camera that records the shape of the leather to perform the digitisation of the leather shape and its damages. The digitisation is done with a point coordinate recording device equipped with a lens with engraved thread cross that determines the positions of the characteristic damaged areas on the leather. It also has a visual display

for accepting the values of the coordinates read and a keyboard with which the characteristics of the characteristic points are most often entered [4]. The recorded damage is graphically displayed on the monitor. Afterwards, the scanned piece of leather receives its unique numerical code, which is linked to the work order and the data created during the control and is used to monitor the further processing of the leather piece, Fig.2.

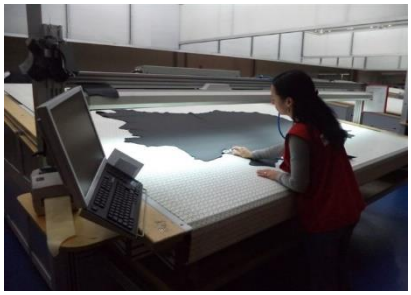

Fig.2 Examination of a piece of hide and recording of observed damage

When a piece of leather is laid on the cutting table, a barcode is scanned to detect and identify each piece of leather. Parts of the covers are projected onto a piece of leather using laser beams. Weights resembling rectangular shaped tiles are placed on the contours of a piece of leather in order to align the cut layers of leather.

Computer-controlled cutting units with a supersonic jet of water and punches for cutting out leather are used for cutting out parts of the covers. In units with supersonic water jet, a very thin high-speed water jet is used. The high speed of water particles allows them to have high kinetic energy used to destroy the bonds in the material from which the garment is to be made. The speed of the water jet is about twice the speed of sound (about 2000 km/h) with a jet diameter of about 0.3 mm. These speeds are achieved at pressures of 3800 to 4000 bar. Such units consume about 0.5 l/min of demineralised and degassed water. Steel mesh is used as support when cutting. These aggregates are expensive due to complex water treatment devices, and can be used to cut one to several layers of material. In addition, they are unsuitable for cutting materials that absorb water well, so they are very rarely used for cutting textile materials.

Punch cutting is very precise and fast. For this type of cutting, specially shaped steel knives are used whose shape is adapted to the contour of the part of the car seat to be cut. The knife shaped in this way is placed on the leather and is stamped into the leather using the arm of the hydraulic punch. Stamping continues until electrical contact is made by the knife between the upper arm and the working surface of the punch. This ensures safe cutting of the parts of the covers. The forces required for cutting are regularly very high, so that punches are particularly suitable for cutting parts of covers made of leather [4].

An NC-controlled machine with oscillating knife is used to cut parts of covers made of technical textiles, which, unlike leather, have a regular shape. The cutting head of this type of device has an electric motor and a mechanical system for converting the rotary movement into a straight rotary movement, as well as a system for aligning the knife, so that the weight of the head can be several tens of kilograms. The higher mass of the cutting head prevents greater accelerations and sudden changes in movement (due to greater inertia), and lateral loads can also be more significant [4]. Above this unit there is a monitor that displays the cutting pattern and the current phase of the technological process. The cut parts of the seat covers are controlled sorted and assembled into bundles suitable for processing in the technological process of sewing car seat covers.

According to the customer's wishes, emblems are made on individual cutting parts using an embroidery machine, a plate with an engraved emblem and an embossing roller. If a part of the cover needs to be completely perforated, an embossing roller is used, and if only an emblem needs to be made, then a decorative embroidery machine or a plate with an engraved emblem is used. The embossing roller and the plate engraved with an emblem stamp the shape of the emblem onto the corresponding part of the leather seat cover under the effect of pressure.

Some parts of the car seat cover require backing and laminating, i.e. joining a sponge, cotton wool or knitted fabric to the back of the leather. The process is carried out by applying a suitable glue to the back of the cutting part of the leather and then a sponge or other non-woven material, Fig.3. The workpiece passes through a thermal tunnel so that a sponge or other non-woven material can be glued to the back of a part of the leather car seat cover.

Fig.3 Placing the cover parts in the thermos-tunnel to activate the laminating adhesive

Upon completion of the technological process of cutting, the control of pattern takes place. The control staff thoroughly check each part of the car seat cover for dimensions, thickness, quality of the contours of the cutting part, quality of the additional aesthetic and functional finishing of the

Fig.4 Sorting and checking of the seat cover parts after cutting

cutting part and surface appearance (Fig.4).

Between the cutting room and the sewing room there is a warehouse for auxiliary materials and equipment, where workers pack all the parts required for the production of car seat covers into appropriate boxes according to the work order (Fig. 5a). A warehouse worker has a handheld on the wrist of his right hand, which is connected to a laser barcode reader on his index finger.

a)

b)

Fig.5 a) Storage room at Boxmark, b) laser barcode reader linked to a personal digital assistant [5]

Sewing is performed using universal, special and NC sewing machines. The most important element of the numerical sewing machines is the process computer, which controls the operation of the three-axis amplifier and interacts via it with the actuators of the drive along the x, y and z axes. Sewing programs can be entered directly on the machine, via a memory unit or computer network. Thus, a numerically controlled sewing machine can perform many different sewing programmes by creating a wide variety of seam types and shapes. This feature gives it an advantage over other types of sewing machines in terms of versatility and almost instant flexibility by loading a new sewing programme [4].

Computer-controlled sewing machines perform decorative seams according to a pre-made program. Other universal and special sewing machines are used in technological operations for sewing two or more layers of material (leather).

In the sewing room, the production lines are organised so that each production line produces a single cover (e.g. front or back seat cover). In a production line, there are about 30 workplaces where technological operations are carried out in a specific chronological order to enable a continuous flow of materials and ensure productivity. Fig.6 shows a production line in the technological process of sewing car seat covers.

Fig.6 Production line in the technological process of sewing car seat covers

At each workplace there are written instructions for each technological operation (type of seam used, length of the seam, type of needle, method of joining parts of the covers and other data for performing the technological operation) as a graphic representation of the arrangement of the material layers to be joined, the position and appearance of the seam to be sewn.

On the cover of the car seat are sewn various elements with which the cover is attached to the structure (plastic profiles, strips, wires, etc.). When performing the technological sewing operations of fastening elements, the workplaces are equipped with a stand with shelves on which the fastening elements are placed. Each shelf is equipped with a motion sensor and a light indicator for the order of taking the cut parts of the cover. The execution of the technological operation is computer monitored and the display on the shelf with the part of the cover to be sewn next is switched on in time. If the worker reaches for the wrong part, all the indicators light up as a warning to the worker. In this way, it is ensured that all the necessary elements are sewn and in the correct positions.

Upon completion of the technological process of sewing car seat covers, the final control is carried out, Fig.7. The control is carried out by the workers with the help of an interactive screen that displays the data for each seam and accessories such as ribbons and buckles. In order to obtain high-quality products, it is necessary to comply with the prescribed standards with a tolerance of often no more than 1 mm, but to sew as accurately as possible, which is also checked during the final control. The results of the control are stored in the information system and allow for a subsequent

Fig.7 Final control after completion of the technological process of sewing car seat covers

review of all errors and controls that have occurred and been carried out on the car seat cover.

After the car seat covers have passed all the necessary controls, they are transported to the warehouse where they are packed and sorted according to customers, orders, colours, designs and the like.

The selection of the sewing needle is very important when sewing leather because, along with the looper, it is an element that is directly involved in forming the sewing stitch. Its function is to pierce the leather with its point, and by the friction of the thread with the material it helps to form a loop of the thread [6]. In addition to the fineness of the needle, the shape of the needle point must also be chosen according to the type of the sewing machine, i.e. the type of stitch and the leather to be sewn. Due to the special requirements placed on the technology of sewing parts for car seats and sewing machine needles, they have undergone many improvements.

Leather and technical textiles have a much higher density and hardness than light textiles, so when sewing there are large penetration forces and much higher friction between the needle and the material, which leads to wear of the material on the needle surface. Therefore, the surface of sewing machine needles is usually coated with titanium nitride (Groz Beckert Company) or DLC - Diamond Like Carbon, coating (Schmetz Company). These coatings give the needle surface a significantly higher hardness, especially in the area of the point and the eye, so that the needle can be used in the technological sewing process for a significantly longer time.

Since sewing leather and hard materials made of technical textiles as well as their laminates causes permanent damage to the material by holes due to the penetration of the needle into the material, not the slightest sewing error should be allowed, as in this case the sewn material will be permanently destroyed. One such frequent case is skipping stitches, which are visible on the surface of the material and, in addition to aesthetic defects, cause a significant reduction in seam strength. This can happen with needles formed by wire extraction technique and milling a short and long groove (Figure 8a). The new cross-sectional geometry of the machine sewing needle with rounded edges with a shorter and longer groove has proved to exert a very favourable effect on loop formation when chaining threads during the formation of a machine sewing stitch, Figure 8b [7].

The point of the machine sewing needle for sewing leather has changed the most compared to

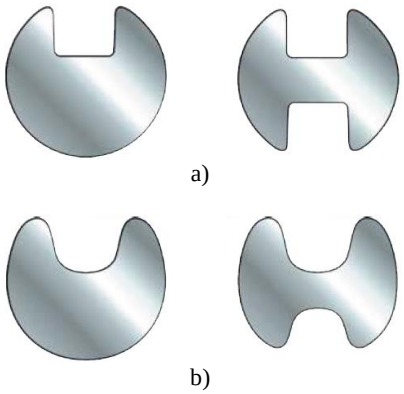

Fig.8 Cross-sections of the bodies of: a) conventional machine sewing needles, and b) new needles for sewing leather according to tt. Groz Beckert [7]

conventional needles for sewing textile materials (woven fabrics, knitted fabrics), as the needle not only has the ability to spread textile fibres, but also takes on the function of a blade for cutting leather. Depending on how the leather is cut, the machine stitch and thus the seam take on a different aesthetic component.

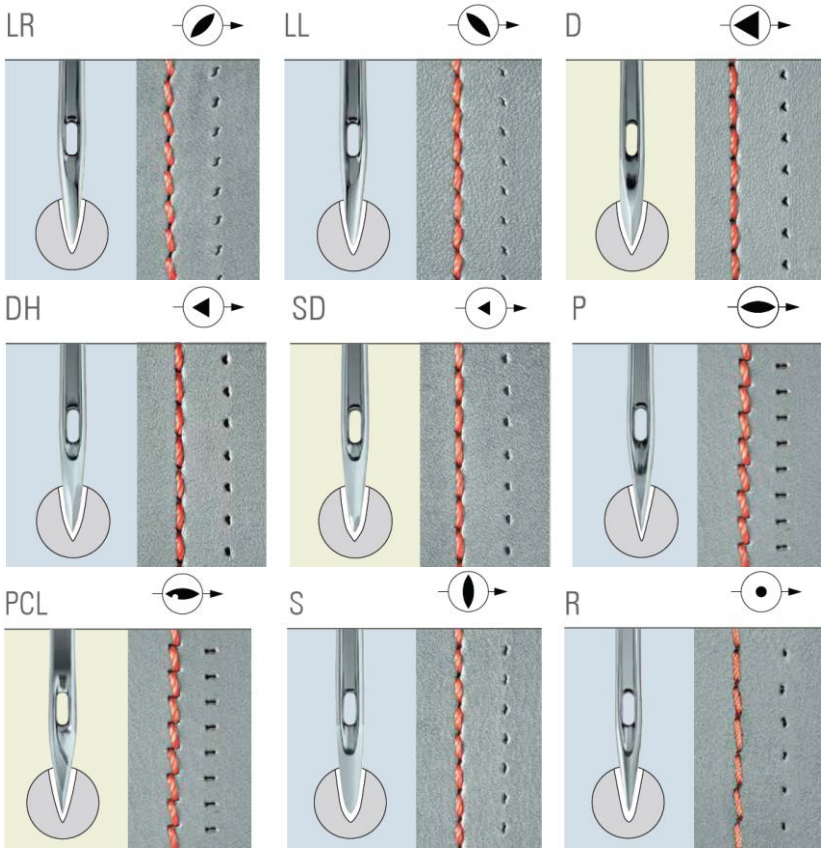

Fig.9 Shape of blades of machine sewing needles for sewing leather according to tt. Groz Beckert [7]

Therefore, a flat blade of the needle point can be placed at an angle of 45° to the right of the sewing direction (needle point type LR, Fig.9) or to the left (needle point LL). The point and blade can also have a large triangular shape for straight stitches (point D, Fig.9), a medium shape (point DH) or a small shape (point SD). The flat blade of the needle point can be placed perpendicular to the sewing direction at an angle of 90° (point P, Fig.9), and for heavier and harder materials it can have the same blade with groove (point PCL). Conventional machine sewing round point needles are less commonly used when sewing leather because leather has a non-uniform structure in different sewing directions and variations in layer thickness, and besides that the aesthetic appearance of the seam changes undesirably and depends on the sewing direction. Sebaceous and sweat glands as well as hair follicles have the greatest undesirable effect, so the favourable choice of the tip of the needle point ensures aesthetic uniformity in leathers of different thicknesses and types [7].

A completely new market has opened up for manufacturers of machine sewing thread for consumers who make up exclusively technical textiles, including car seat covers. This type of market requires threads of exceptional strength and weather resistance, as well as high temperature resistance during sewing and use. Gütermann Company has developed a new thread made of the so-called super polyamide PA 4.6 for the field of making up technical textiles in the automotive industry. This thread type has a softening point of 285°C which is higher than in conventional polyamide threads. The increase in softening temperature is important for use in airbags, as the activation of the explosive cartridge that inflates the airbag develops a temperature of 900°C within a few miliseconds. Likewise, an increase in the softening temperature improves the usage properties of the said thread and in all other technical applications of the thread where increased temperatures occur. The aforementioned company has also produced a sewing thread made of PTFE, which is very resistant to high temperatures and the effects of chemicals and is also characterised by good resistance to UV radiation and weather influences.

All major thread manufacturers have open access via the internet so that customers can find out about their products and their properties and get advice on problems that arise when they are used in technical sewing processes.

3. Conclusion

The growing use of cars in the world has a major impact on the technological processes used in the manufacture of cars and thus on the making-up of technical textiles. The making-up of car seat covers is a process in which specific innovative technological solutions are used. This refers in particular to the digitisation of leather shapes and their errors. Also, specific solutions are visible when creating cutting images. Technical experts are needed for the selection of suitable working methods, the design of workplaces, the selection of suitable thread types and machine needles for making up technical textiles and leather, and the determination of the optimum parameters of machines for cutting and making up car seat covers.

R e f e r e n c e s :

[1] ...: Automobile, Available from http://www.leonardo-da-vinci.net/automobile, Accessed: 2021-08-21

[2] ….: automobili, Hrvatska enciklopedija, mrežno izdanje. Leksikografski zavod Miroslav Krleža, Available from http://www.enciklopedija.hr/Natuknica.aspx?ID=4751, Accessed: 2021-12-03

[3] …: Seats In Cars; Available from https://www.youtube.com/watch?v=wFCR1GlZzDc, Accessed: 2021-06-17

[4] Rogale, D.; Ujević, D.; Frišt Rogale, S.; Hrastinski, M: Procesi proizvodnje odjeće, Tekstilno-tehnološki fakultet Sveučilišta u Zagrebu, ISBN 978-953-7105-32-7, Zagreb, (2011)

[5] …: Wearable Rugged Computer, Available from https://www.rugged-mobile-computers.co.uk/img/products/large/motorola-wt41n0-1.png, Accessed: 2021-12-02

[6] Rogale, D.; Dragčević, Z.: Tehnike konfekcioniranja tehničkog tekstila, Tekstil, 51 (2002), 2, 64-77, ISSN 0492 - 5882

[7] …: Sewing - Sewing machine needles for leather and technical textiles, Groz-Beckert, Available from https://www.groz-beckert.com/en/products/sewing/leder-und-technische-textilien/, Accessed: 2021-10-21