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EVALUATING THE MANUFACTURING OF A WORK OUTFIT

Case SWW Smart and Safe Work Wear

ABSTRACT

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This thesis focuses on observing and evaluating the manufacturing of a fitting series of a work outfit that consists of a pair of pants and a jacket. The theory part includes work analysis, optimization of the patterns, optimization of the work area and cost efficiency. The practical part of the thesis focuses on manufacturing the fitting series of the work outfit. The conclusion of the thesis consists of my observations on the manufacturing of the fitting series of the work outfit.

Work analysis observes and evaluates the work as a process. It tries to find the most efficient way to manufacture while also considering the workers and their wellbeing. With work analysis, it is possible to find ways of improving the manufacturing process.

Optimization of the patterns helps to reduce the waste and thus costs.

Optimization of the work area makes the sewing process more fluent. You can achieve efficiency by planning the sewing area in a way that it minimizes the transition times and that the workers have an ergonomic and comfortable place to work.

The cost-efficiency part of this thesis includes steps such as cutting the time it takes to produce the garment, utilizing the most optimal machinery for the job and design of the garment.

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1   INTRODUCTION

The aim of this thesis is to observe and evaluate manufacturing a fitting series of a work outfit that consists of a pair of pants and a jacket. The theory part consists of work analysis, optimization of patterns and cutting, optimization of work area and cost-efficiency in sewing.

The work analysis involves observing and evaluating the work as a process. It's about finding the most efficient way to manufacture while also considering the employees and their wellbeing. It includes the employees' point of view in addition to ecological perspective and technological advances. With work analysis, it's possible to find ways of improving e.g. lead time. After the analysis it's important to introduce the new practices at the workplace.

Optimizing the patterns is important when planning the patterns and making them. It helps to reduce the waste and thus costs. There are software solutions for creating layouts automatically but sometimes it's good to make sure and check if there's a room for improvement.

Optimizing the work area can make the sewing process more fluent and more efficient. By careful planning it's possible to achieve a work area with minimal transition times. Organization of the workplace is also important for the employees; they need to have an ergonomic and comfortable place to work.

The cost-efficiency part of this thesis focuses on what cost-efficiency steps you can introduce without considering the cost of the materials or employees. Firstly, you can introduce steps to cut the time it takes to produce the garment. Secondly, you can make sure you utilize the most optimal machinery for the job. The model of the garment also has an influence on the costs; the more detailed and more complicated the garment, the more expensive it tends to be.

The goal of the fitting series was to test the patterns and give the employees a chance to test the outfit. The pants were manufactured so that there are different models for women and for men instead of a unisex-model that was in use. In the men's model there are two height groups. The jacket was designed to be a unisex-model. In the jacket there are two height groups.

2   ABOUT THE PROJECT

The aim of the Smart and Safe Work Wear -project is to enlarge and increase the importance of the workwear business as well as to improve the competitiveness of the workwear manufacturers of the Baltic Sea Region. The term workwear, in this case, is referring to heavy-duty clothing that is used in e.g. chemical plants. It's designed to protect against dangers of the work, such as cold and chemical leaks. It can also protect the worker by increasing their visibility. The focus of the project is on health and safety. Research is trying to find ways to improve the workwear by including nanotechnology or treating the fabric in a special way. (Centria TKI 2018.)

One of the ways to make a workwear smart is to add RFID (Radio Frequency Identification). RFID can be used to track a position of a person or the clothes. There are different methods to incorporate RFID into the clothing. You can print tags, sew or embroider them or utilize 3D printing. The printed RFIDs are an easy option. It's simple to produce and the costs are low. In sewing and embroidering a conductive thread or fabric is used. In 3D printing you utilize the 3D printer to print electronics onto the fabric. Another way to make a workwear smart is using textiles that are smart. The fabric can be made of a textile that is resistant to abrasion or it can be laminated to protect the wearer against the conditions that they face. (Centria TKI 2018.)

The project uses 3D-bodyscanning to create better fitting garments. The scanner scans the human body with eye safe lasers and provides over 130 measurements. The scan itself takes about 30 seconds. The scan then creates a 3D copy of a body that can be further measured and rotated. (Centria TKI 2018.)

The countries that are participating in this project are Estonia, Finland, Latvia, Lithuania and Poland. From each country there are two industrial partners (producer of workwear and customer using the clothing) and a higher education or a research institute. (Centria TKI 2018.)

3   WORK ANALYSIS

The aim of work analysis is to improve the production system while taking both economical and humane factors into consideration (Eberle, Hermeling, Hornberger, Kilgus, Menzer & Ring 2007). Work analysis can focus on things like organization at the work. Work analysis aims to improve productiveness, efficiency, improve the working environment. Usually there are three perspectives of the work analysis: economical (things that add value, bottlenecks in the production), technological (new techniques, new machines) and employees point of view (ergonomics, monotonic tasks). (Ahokas, Tiihonen, Neuvonen & Suikki 2011.)

3.1   Timing

Taking time is still an important part of the work analysis. A few examples of the things worth timing are stage time, lead time and delivery time. The stage time is the time it takes to complete a stage. The lead time is the time in which the product is manufactured. Delivery time is the time that it takes the customer to receive the product from ordering. Timing is a good way to set goals and it also provides an opportunity to develop the manufacturing process of the product. It can help to come up with different working methods and solutions that save time. Also, you can get an inspiration to invest in new machinery to improve the process. (Ahokas et al. 2011.)

3.2   Humane factors

Ergonomics studies the limits of the human and the optimal working conditions. The aim is to find a way to utilize a person's abilities with minimal strain. You can try to fit the work to the person or fit the person to the work. When trying to fit the work to the person the focus is on studying the work flow and the work environment. The aim of personnel planning is to use the employees based on their personal qualities and fitting the person to the work. (Eberle et al. 2007.)

When the workplace is ergonomic, it helps the employees to focus on their job. It also lessens the pain in back and neck, which is often a result of poor posture. (Eberle et al. 2007.) The employees need to be introduced with the right methods and the most optimal trajectories. Recovery and relaxation are also

important parts of ergonomics. (Lahti, Pulli & Varpula 2005.) It's important to implement correct work methods from the beginning. This can be done by training the new employees.

There are different kinds of strains. First, musculature strain. There's also sensory strain, e.g. staring at the screen, and environmental strain, e.g. steam. (Eberle et al. 2007.) The most important strain to consider when sewing is muscular strain. If your work station is not ergonomic or you have poor posture you can easily get strains. Depending on the surroundings sewing can be straining for your senses. An example of this is eye strain that can be a result from such things as poor lighting of the sewing area.

What you can expect from a person is based on their abilities. The person's abilities are based on their education and experience. The person's personal attributes, as mood and tiredness, also affect their performance. (Eberle et al. 2007.)

To get the benefits of the analysis, workplace must implement the new, more efficient ways at the workplace. However, this doesn't mean you should stop trying to develop. The world is changing constantly and we must adapt to it. Proper introduction to work is essential. A proper introduction helps with the wellbeing and efficiency of the new employees. It can also be beneficial for the employees that have worked for a longer time. (Ahokas et al. 2011.) There are no benefits in making an analysis if you're not going to implement it.

The methods used to help this thesis making process was photographing and filming. I videotaped while the pants and the prototype of the jacket were sewn. Filming the process gives some idea on how much time it would take to produce the garment. Also, it's a good tool to examine the ergonomics of the work and the efficiency of the trajectories.

4   OPTIMIZING THE PATTERNS AND CUTTING

In garment manufacturing patterns are used to indicate a panel that is then cut out of fabric. These fabric panels are then used to assemble a garment. These panels can be modified to fit different sizes and body shapes. (Heinrich & Smith 2015.) The patterns can be made of paper or they can be digital. They can include markings e.g. notches or direction of the grain. They can also include seam allowances.

There are things that can be considered when planning the patterns that can help to reduce the costs. If the patterns have straight lines they are easier to arrange and less fabric can be used.

The most important things that determine the pattern layout are the length and width of the fabric and the type of the fabric. Mainly the width of the fabric is the deciding factor for the layout; especially if you have more fabric to roll out from the roll.

It is good to consider in which way the seam allowances turn. The excess "spikes" can be removed to save fabric. In some cases, it is possible to straighten the sharp corners despite the way the seam allowances turn. Sometimes removing the seam completely creates savings in both fabric and sewing time, e.g. a collar with a straight edge can be cut from the fold.

There are software solutions for optimizing cutting. These programs can determine the optimal orientation for the patterns on the piece of fabric to maximize the fabric usage (Heinrich et al. 2015). However, sometimes it's good to look critically at the software's layout suggestion. There can be some room for improvement.

Here are some things that were considered when making patterns for the prototypes of the work outfit. The bottom piece of the sleeve is as high as the bottom of the bodice. This allows that the pieces can be arranged neatly in rows while cutting. This reduces the length of the fabric needed and waste. The pants have a gusset at the crotch, this can make the layout more efficient. You should try to fit the patterns together to create as much common cutting lines as possible. It helps if the patterns have straight lines. When designing the cutting plan, place the biggest pieces first and the smaller pieces e.g. pockets can be arranged in between the bigger pieces.

5 OPTIMIZING THE WORK AREA

Optimizing the work area is important. When optimizing the work area, you should consider the most optimal placing of the furniture, as an additional desk to put the pieces that need sewing. This will help the employees to get the pieces, sew them and put them away with minimal strains and in an efficient way. Everything the employee needs should be within clear visibility and reached easily. With optimization you can improve work efficiency and employees' health by providing them suitable work environment.

5.1 Ergonomics

One of the most important things to consider when planning the most optimal work area is the ergonomics of the workplace.

From ergonomics point of view, the chairs and tables in which you can adjust the height are the best. It's even better if you can adjust the back rest. The footrest should also be adjustable in height and angle. (Eberle et al. 2007.) The worker must be able to sit straight. The treadle should be easily controlled. To achieve this, it's best if the thighs are horizontal and knees bend slightly over 90 degrees. Move the traverse if necessary. Make sure there's sufficient space under the table. The height of the table is important; if it's too low, the employee must hunch forward, if it's too high, it strains their shoulders. Arms should hang at forward angle and shoulders should be braced. The edges of the table should be well rounded for employee to comfortably rest their arms. Sometimes the sewing machine can restrict the view of the needle. There are tables that can be tilted to improve visibility. If the table isn't adjustable, you can install a wedge under the table. The distance between the needle and the head should be between 30 – 50 cm. The tilt of the head shouldn't be more than 25 degrees. The direction of the sewing machine should be parallel to ceiling lights and window. Adding additional lighting prevents high contrasts. (BG ETEM. 2013.)

The sitting position is considered better than standing in sewing. It gives more support and so helps with accuracy. Disadvantages in sitting are e.g. one-sided strain and limited movement. It's necessary to emphasize the meaning of a good posture and that the tools and accessories are adjusted correctly to the employee's height. (Eberle et al. 2007.)

5.2   Machines

There are many machines and appliances to them that can make sewing easier. Fashion has influenced the development of the sewing machine; they're more versatile. They can also be modified and programmed. (Mannila & Rinne 1992.)

There are different kinds of special presser feet for lock stitch machine that can make sewing easier. Hemming presser foot turns the edge of the fabric. There are presser feet for sewing zippers and attaching strands. There are presser feet for stitching also. Different kinds of guides can be used to ensure that the stitching stays straight. Guides can be magnetic or they can be attached to the frame of the sewing machine. (Mannila et al. 1992.)

Multiple needle sewing machine can have two or more needles. On the lock stitch multiple needle sewing machine one of the needles can be switched off to sew corners, in the chain stitch one this isn't possible. The advantage of the multiple needle sewing machine is fast and clean stitching. Different guides and helping attachments can be attached to the machine, e.g. for sewing a waistband. (Mannila et al. 1992.)

Overlock sewing machine can have two, three or four threads. They have a blade that cleans the edge of the fabric. Overlock sewing machines with a safety stitch have four or five threads. In addition to overlock they do a chain stitch. They are popular especially in clothing industry because two steps can be sewn at the same time. (Mannila et al. 1992.)

Buttonhole sewing machines sew and cut a buttonhole to a garment. Bar tack machines sew one stitch of designated length. The length can be adjusted. The bar tacks are used to reinforce e.g. pocket openings. (Mannila et al. 1992.)

There are different sewing automats. For example, an automat for small pieces, e.g. collars, an automat that can sew long seams, e.g. side seams of trousers, a pocket automat that attaches pockets and cuts them open. (Mannila et al. 1992.)

5.3 Transportation

Transportation devices range from clothes hangers to conveyor belts. They are used to transport the clothes that are being manufactured from one stage to another. Good transportation devices are an important part to make the production more fluent. (Eskelinen & Kemppainen 1990.)

Small transportation devices, such as clothes hangers and boxes, are necessary to production. They can be used on their own or combined with bigger transportation systems. They can be made of wood, metal or plastic. (Eskelinen & Kemppainen 1990.)

Delivery wagons are trolleys with wheels that are used to transport and store larger quantities of materials. The frame is usually metal and shelves can be wood or fabric. Wagons can be open or have borders. (Eskelinen & Kemppainen 1990.)

Transporters are used to move a piece to a bundle or a box automatically, so employees don't need to move the pieces, which makes the process faster. In some cases, the employee might need to launch the transfer. The transporters can be operated with gravity, e.g. chute, or compressed air, e.g. suction tunnel. (Eskelinen & Kemppainen 1990.)

Bundling devices transfer and bundle the sewn pieces. They work with compressed air and can be operated either manually or automatically. (Eskelinen & Kemppainen 1990.)

Roll track consists of rolls or discs that can be made from plastic or metal. It can be operated with gravity or electricity. The gravity based roll track functions because the track is tilted and the boxes etc. can slide downhill. (Eskelinen & Kemppainen 1990.)

The conveyer belt transporter consists of a conveyor that moves with rolls. The conveyer can be made from cotton fabric or thin sheet of metal that is covered with e.g. rubber. Along the conveyer belt there's a station for every employee. When the box arrives at the right place it is directed to the right station. When the stage is completed the employee sends it to the next station. (Eskelinen et al. 1990.) In a larger factory setting a more complex, more automated systems with clips can be installed that will transport the pieces all the way from the cutting area to finishing station (Eton Systems 2012).

6   COST-EFFICIENCY

For the cost efficiency part of this thesis I considered how the different techniques and different sewing order can create savings by reducing time and improving productivity. I didn't take into consideration the costs like fabric or manufacturing choices.

Firstly, the time spent making the outfit. By making the sewing process as efficient as possible it takes less time and thus creates savings. What needs to be considered are sewing order and transitions both between steps and machines. Between steps the way of taking the pieces and putting out the sewn pieces can make the job easier. By planning how it's easiest to take out pieces in the next step and putting out the pieces accordingly can make the sewing process more fluent. Sewing small pieces in chain one after another also helps fluency and costs like thread and reduces time. The transitions between the machines should be planned to be efficient and sewing steps should be planned in a way that everything that can be sewn with a single machine is sewn before moving to the next machine. This reduces the transition times. Also, the layout of the manufacturing facility impacts the transition times. If possible, the layout should be designed so that the transitions are seamless and as efficient as possible, e.g. setting the machines in order in which they're used.

Secondly, choosing and using the right machinery for the job. In this case, the double stitchings were made with a single needle machine. By using a double needle machine, the stitching process would've been more efficient and faster. Instead of sewing the same seam twice only one time is needed. In the fitting series, some seams were first sewn with an overlock sewing machine and then with a single needle lockstitch sewing machine. These seams could be sewn with an overlock sewing machine with a safety stitch. In this case, using only one machine instead of two would've saved time in terms of sewing and transition.

Also, the model of the outfit contributes to the costs. Mainly the model affects the materials and time. The more complicated and more detailed the model the more time it takes to manufacture.

The main things that can be done to improve efficiency are shortening the time of the work process and making it easier to do. These objectives can be achieved by e.g. minimizing the number of movements, developing different kinds of aids or better tools. By training employees, they learn the most efficient work methods.

7 MANUFACTURING THE FITTING SERIES

As a part of SWW project a scan and a questionnaire was conducted to the employees of a metal company. The results on the questionnaire impacted the design and sizing of the outfit. Main findings of the questionnaire were that women wanted to separate the design of the pants to men and women instead of a unisex-model that was currently in use. As for the jacket, the main complaint was that the sizing; the circumflex looseness of the jacket was too big. The model of the jacket was compared to a tent. The unisex-model of the jacket lead to complains from the female workers about tightness in the hip circumflex. The taller workers complained about the length of the garments; they were too short.

As a part of this thesis, I took part in manufacturing the fitting series. I documented a part of the manufacturing of the series and I did some cutting and sewing. The fitting series is being produced to give the workers, the end users, a chance to try the clothes and choose the best fitting size. The fitting series was produced on Centria University of Applied Sciences Pietarsaari campus.

7.1 Machines used

The machines used to make the fitting series were lock stitch machine (Brother Excedra E-40), overlock sewing machine with 4 threads (Mauser Spezial 9652) and bar tack machine. The ironing equipment was Veit.

7.2 Pants

Three series of pants were manufactured: one for women (162 cm – 174 cm), and two different height groups for men: one for shorter (162 cm – 174 cm) and one for taller (174 cm – 186 cm). The only differences were in the length of the leg and body rise. The women's fitting series consists the sizes 34-50 and the men's series consists the sizes 44-66. At the time of filming the women's fitting series was done and the men's series were in manufacturing.

The sewing order of the pants:

The first step of manufacturing the pants is to sew and overlock the pocket facing to the pocket pouch (PICTURE 1). If the pocket pouch is different material from the pants the facing hides it. If the seam is turned the right way it can help to prevent things falling from the pocket. The facing seams can be overlocked in a row to help save time. By using an overlock sewing machine with a safety stitch the step can be even more efficient.
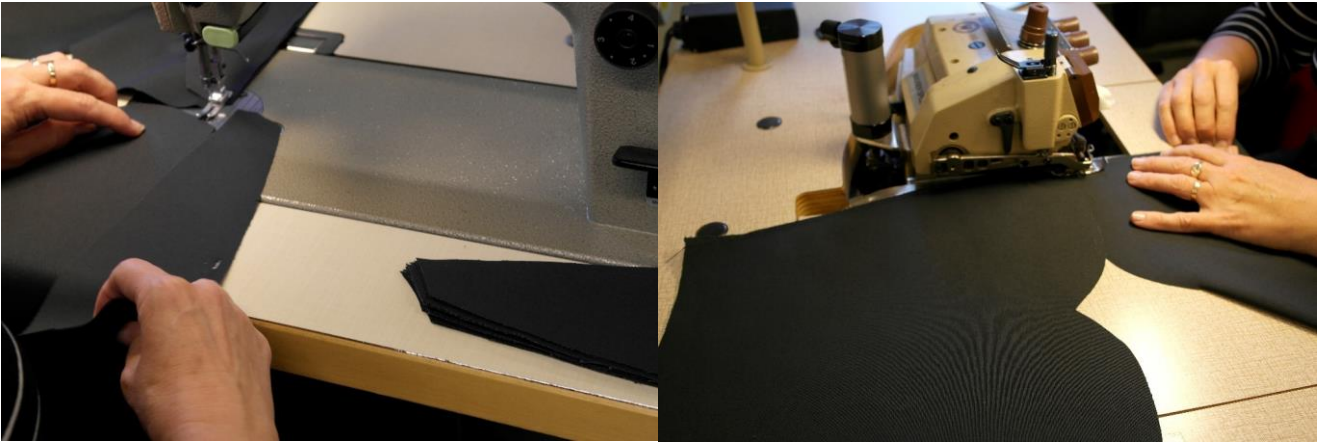
PICTURE 1. Sew pocket facing to the pocket pouch and overlock

Overlock the facing and front seams (PICTURE 2). Overlocking cleans the edge of the fabric by cutting it and reinforces the seam. This helps the parts to stay together

PICTURE 2. Overlock the front seam

Sew the front seam and the zipper (PICTURE 3). The zipper was sewn to create an angle to the front.

PICTURE 3. Sew the front seam and the zipper

Sew the pockets (PICTURE 4). This step includes the hemming of the pocket opening, connecting the pocket pouch to the bodice and sewing and overlocking the pocket pouch.

PICTURE 4. Sew the pockets

Sew the back piece (PICTURE 5). Sew the back pocket by hemming the upper border of the pocket and sew the pocket to the bodice. Sew the back yoke and the gusset to the back piece of the bodice. The yoke and the gusset helps to give shape to the pants. After sewing overlock the seams. Do the top stitching of the back yoke. The top stitching helps with the durability and it helps to keep the seam allowance in place. It is also for decoration. Different equipment can be used to make this step more efficient. For example, a guide that turns the edge. There are also automatic machines that can sew pockets.

PICTURE 5. Sew the back pieces

Sew and overlock the two back pieces together and do the top stitching of the back seam (PICTURE 6).

PICTURE 6. Sew the back seam

I couldn't photograph the finishing stages of manufacturing the pants. The pants couldn't be finished at the time because of lack of high-visibility fabric.

The women's pants were ready. The following final steps were taken from the manufacturing of them.

Pantlegs; sew the pieces of leg openings to the orange pieces (front- and back pieces in chain), sew the orange pieces to the bodice (as a chain), stitch the seams, overlock the bottom of the pocket for padding, sew the padding pockets to the front pieces of the bodice according to the notches, attach the pockets to the seam allowances of the bodice, mark the places and sew the bar tacks.

Combine the front pieces and back pieces; sew the side seams and inseams.

Belt loops; sew a long strand and cut to desired length (longer for right front piece because of d-link).

Waistband; sew the waistband to the reverse side and set the belt loops according to the notches, sew the ends of the waist band, turn the waistband to the right side and stitch the bottom, stitch the ends and top of the waistband (fold the ends of the belt loops at the same time).

Leg openings; sew a 1 cm hem to the leg openings, fold and sew an additional 4 cm cuff.

Bar tacks; sew the bar tacks to the zipper, pocket openings and belt loops.

7.3   Prototype of the jacket

The first prototype of the jacket was sewn to test the patterns and their dimensions. It didn't include pockets, adjustments in the hem or anything else extra. In the first prototype, the sleeves were too long for a shorter sizing. This was adjusted before making the second prototype.

The jacket is a unisex-model. However, there are two different height groups one for shorter (162 cm – 174 cm) and one for taller (174 cm – 182 cm). The length difference was in the overall length of the jacket and sleeves. The jacket fitting series consists of sizes S-XXL for shorter and taller M-XXXL. The prototype was created to test out the size of the finished garment. The prototype was also a good opportunity to test out different options for pockets and adjusting the hem.

The sewing order of the prototype jacket:

First step is to sew together the parts to the upper back of the jacket (PICTURE 7). The parts create pleats that give more ease to move, so called hugging ease.


PICTURE 7. Sew together the upper part of the back

Sew and top stitch the pocket flaps; sew and top stitch the draw piece of the hem (PICTURE 8). The draw piece was an experimental method of adjusting the hem.
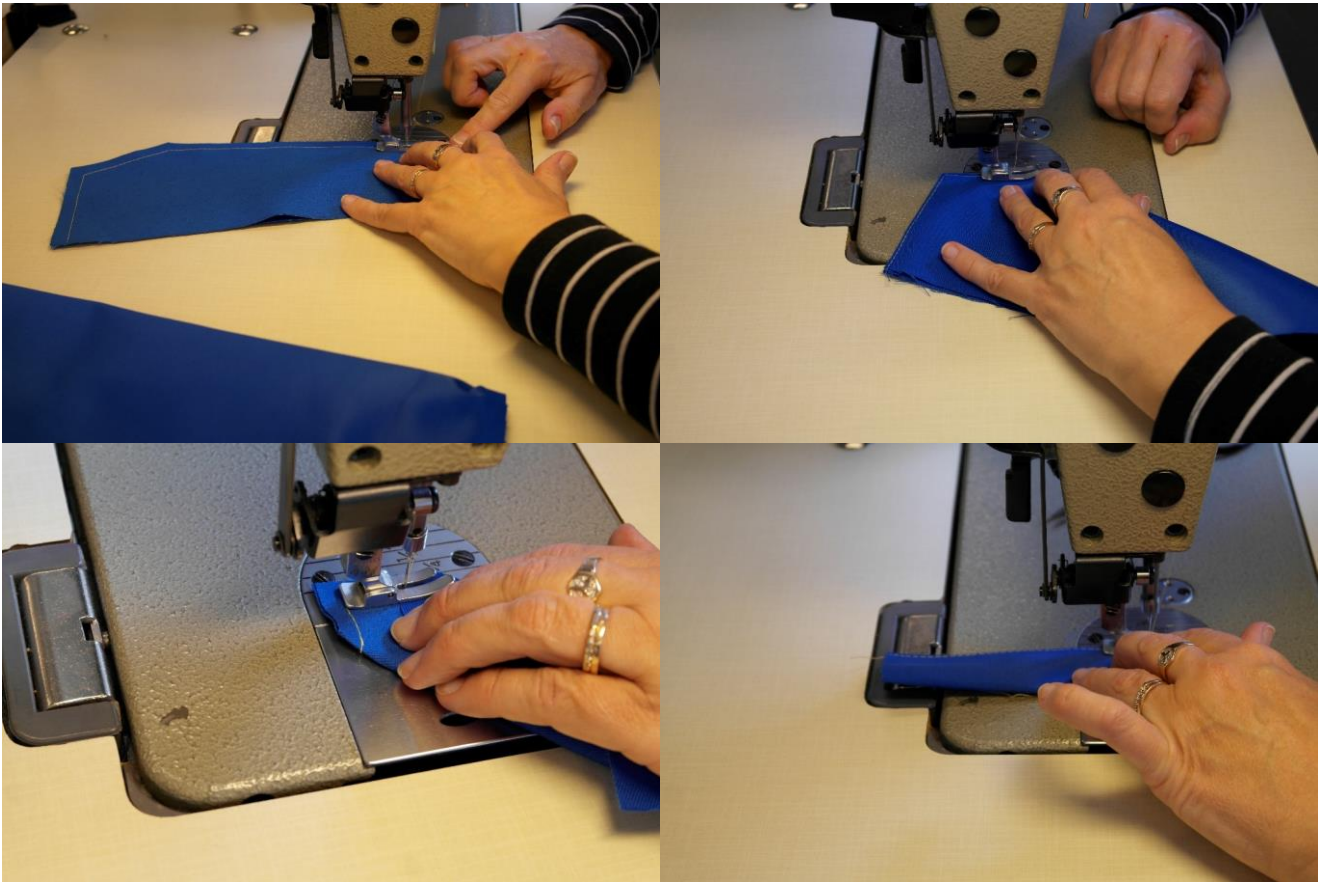
PICTURE 8. Sew and stitch the pocket flaps and the draw piece of the hem

Sew the pockets. First, hem the upper part of the pocket. You can sew them in a row forming a chain. Sew the pocket flap and the pocket to the bodice. The flaps prevent things falling from the pocket and dust etc. from entering to the pocket.

Another option that was considered for the pocket (PICTURE 9). This pocket opening was diagonal. First hem the flap and the pocket. Then sew them to the bodice.
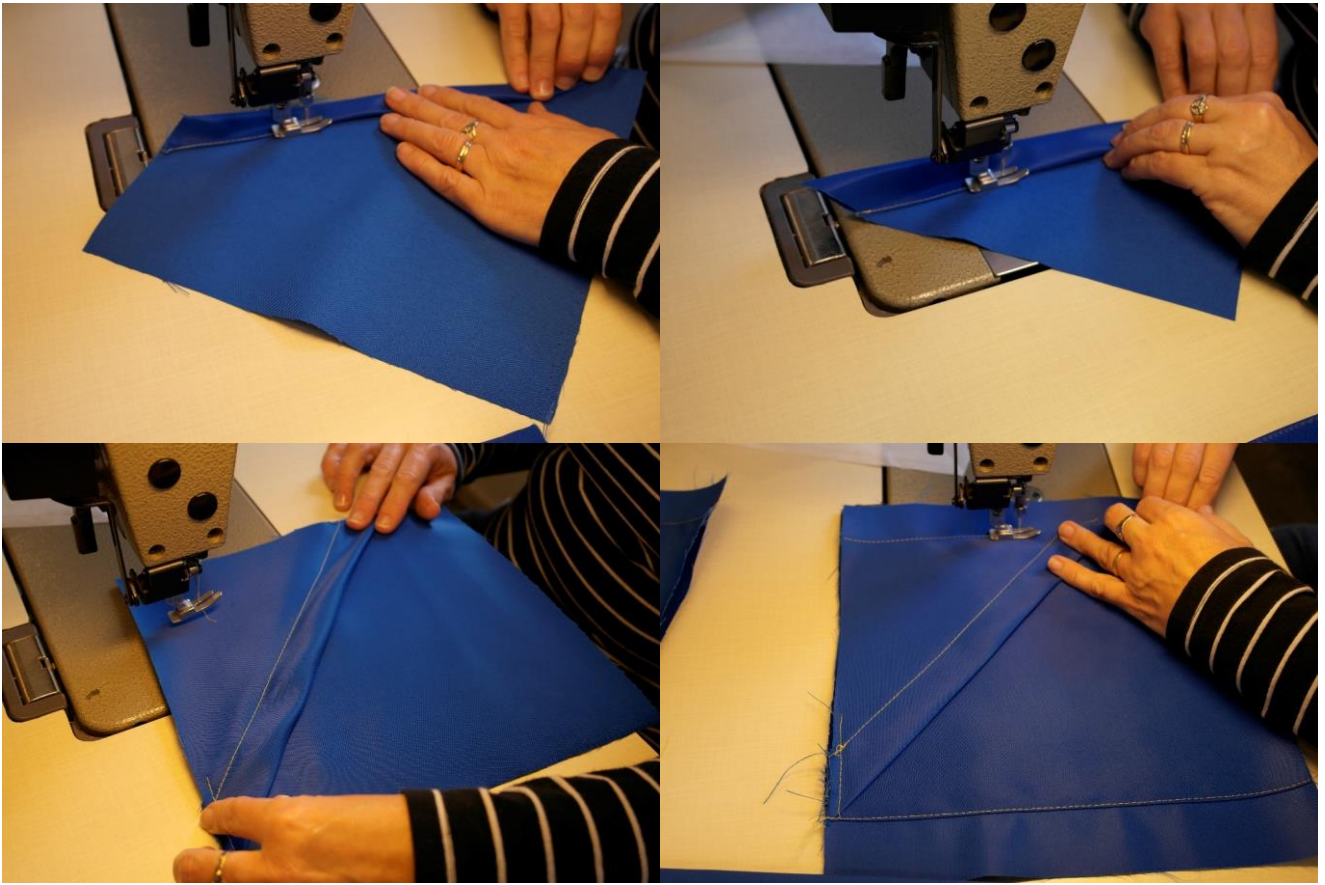

PICTURE 9. Another option for the pocket

Sew the chest pockets (PICTURE 10). Hem the upper part of the pocket. Sew the pleat. The pleat gives more room to the pocket. Sew the pocket and the pocket flap to the bodice. Stitch one of the chest pockets to create a place for a pen.
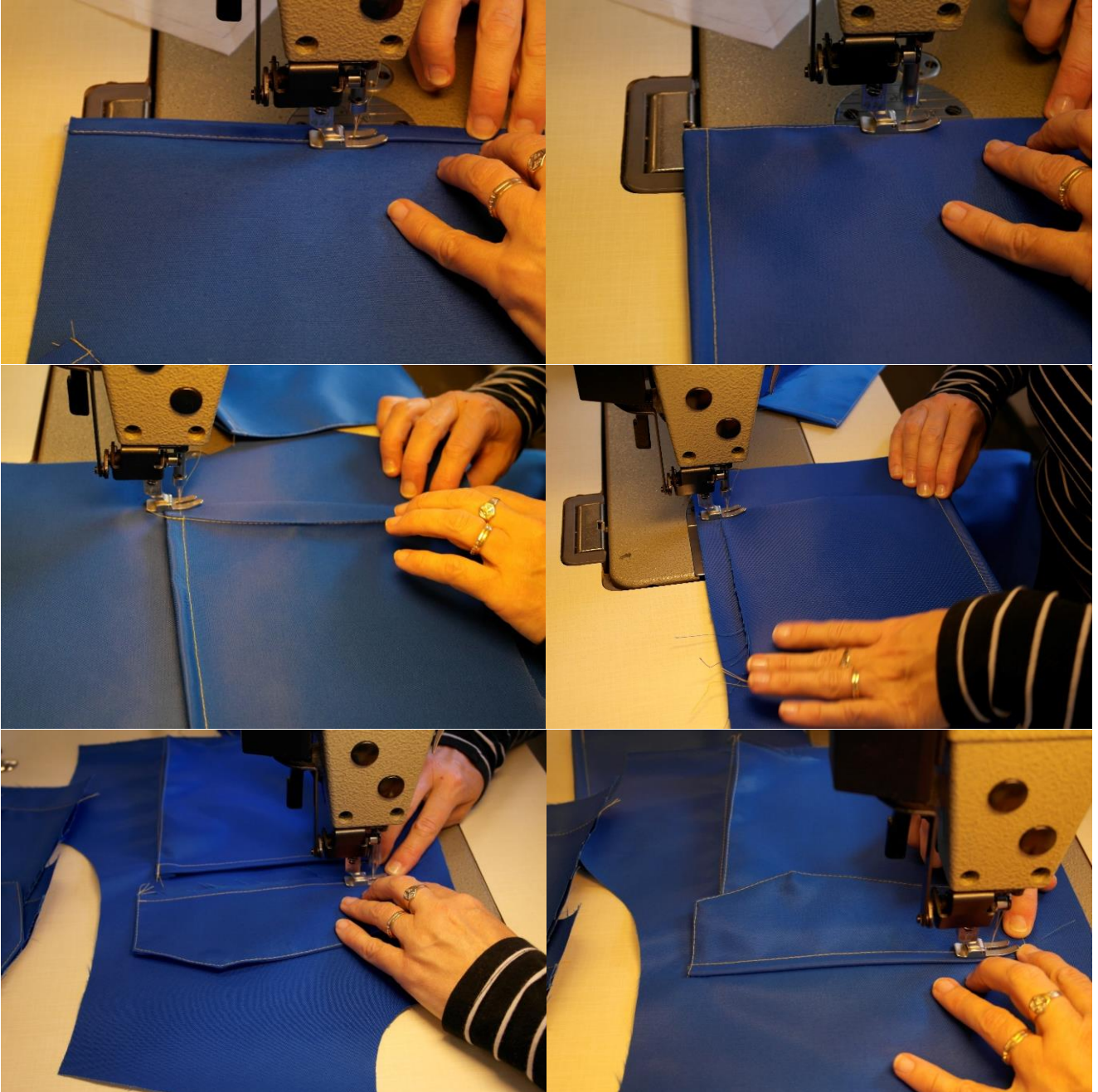

PICTURE 10. Sew the chest pocket

Sew the reflectors to the upper part of the bodice (PICTURE 11). In the prototype of the jacket a strand of grey felt was used instead of a reflector. The stitching of the reflectors also closes the bottom of the chest pockets. The sewing of the reflectors could be more efficient if a multiple needle machine and a guide is used.
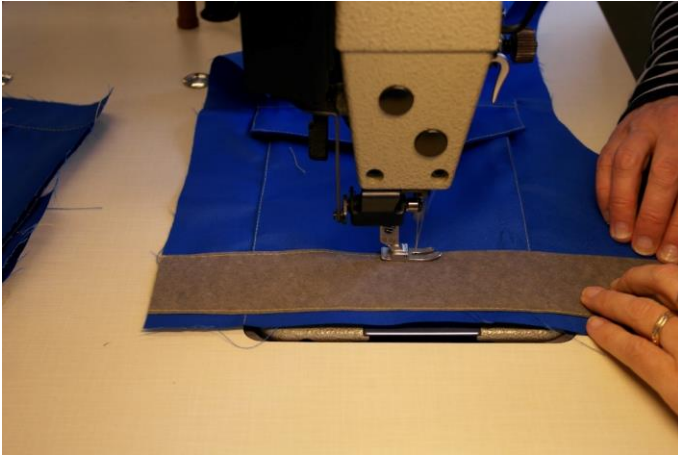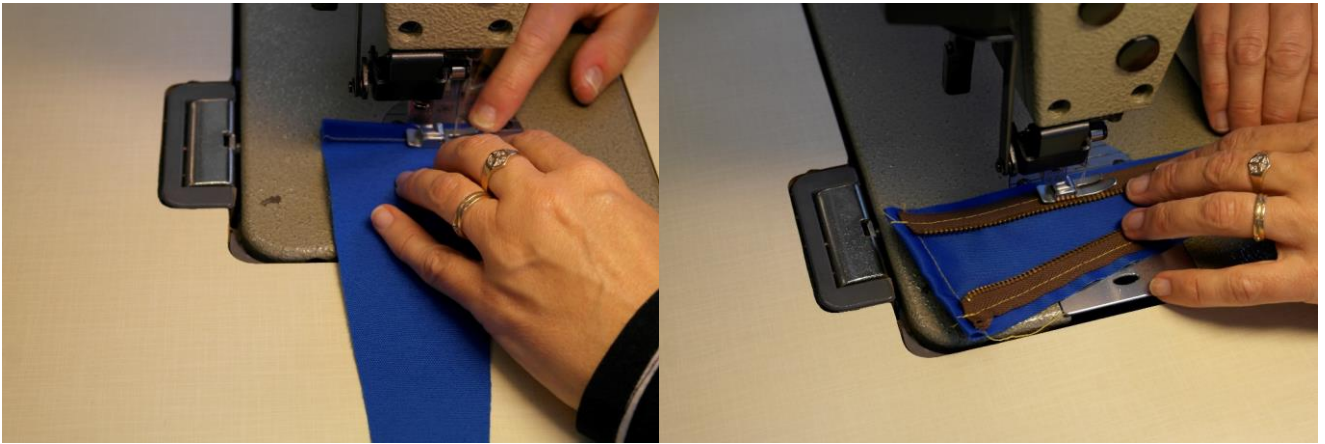

PICTURE 11. Sew the reflectors

Sew and overlock the top and bottom part of the front of the bodice together (PICTURE 12).
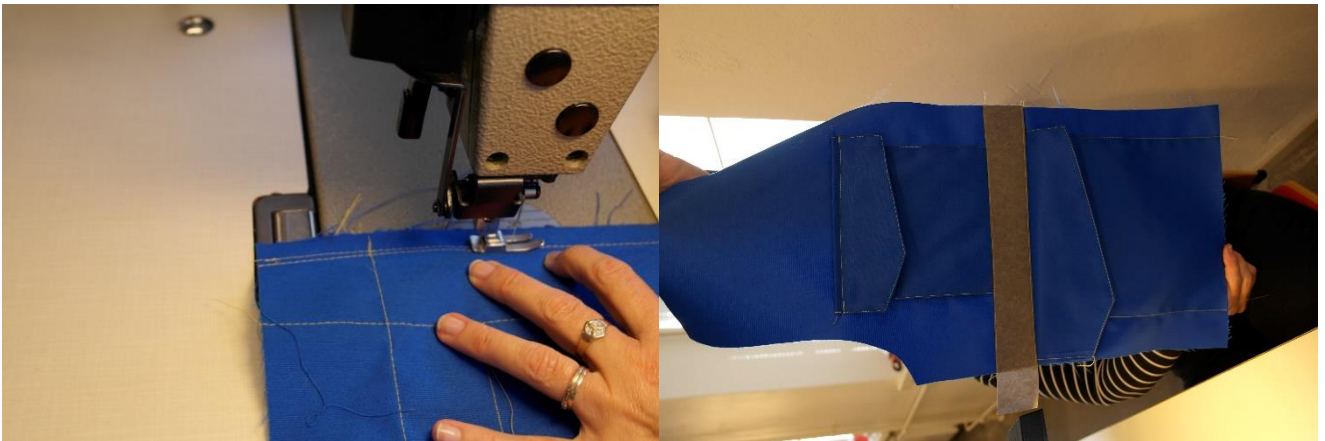
PICTURE 12. Sew the top and the bottom part of the front of the bodice together

Sew the hem wedge (PICTURE 13). Hem the bottom of the wedge and attach the zipper. The wedge gives ease to the hip if needed.


PICTURE 13. Sew the hem wedge

Sew the sleeves (PICTURE 14). Hem the bottom of the sleeve and sew the upper and the bottom part together. The sleeves were hemmed flat instead of after sewing the seam to ease the process. This was also an experiment. In the final version the sleeves were hemmed after sewing the seam of the sleeve.
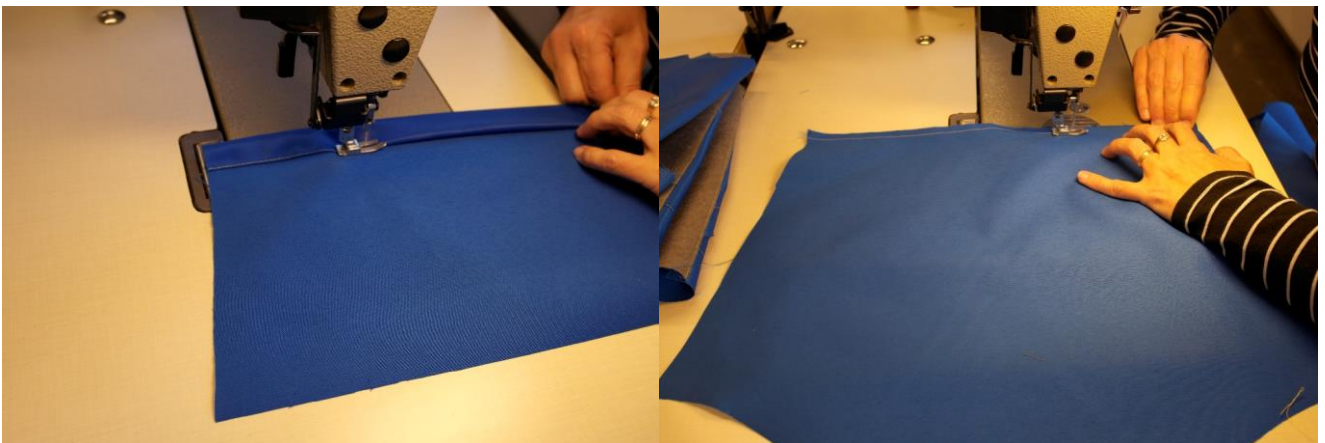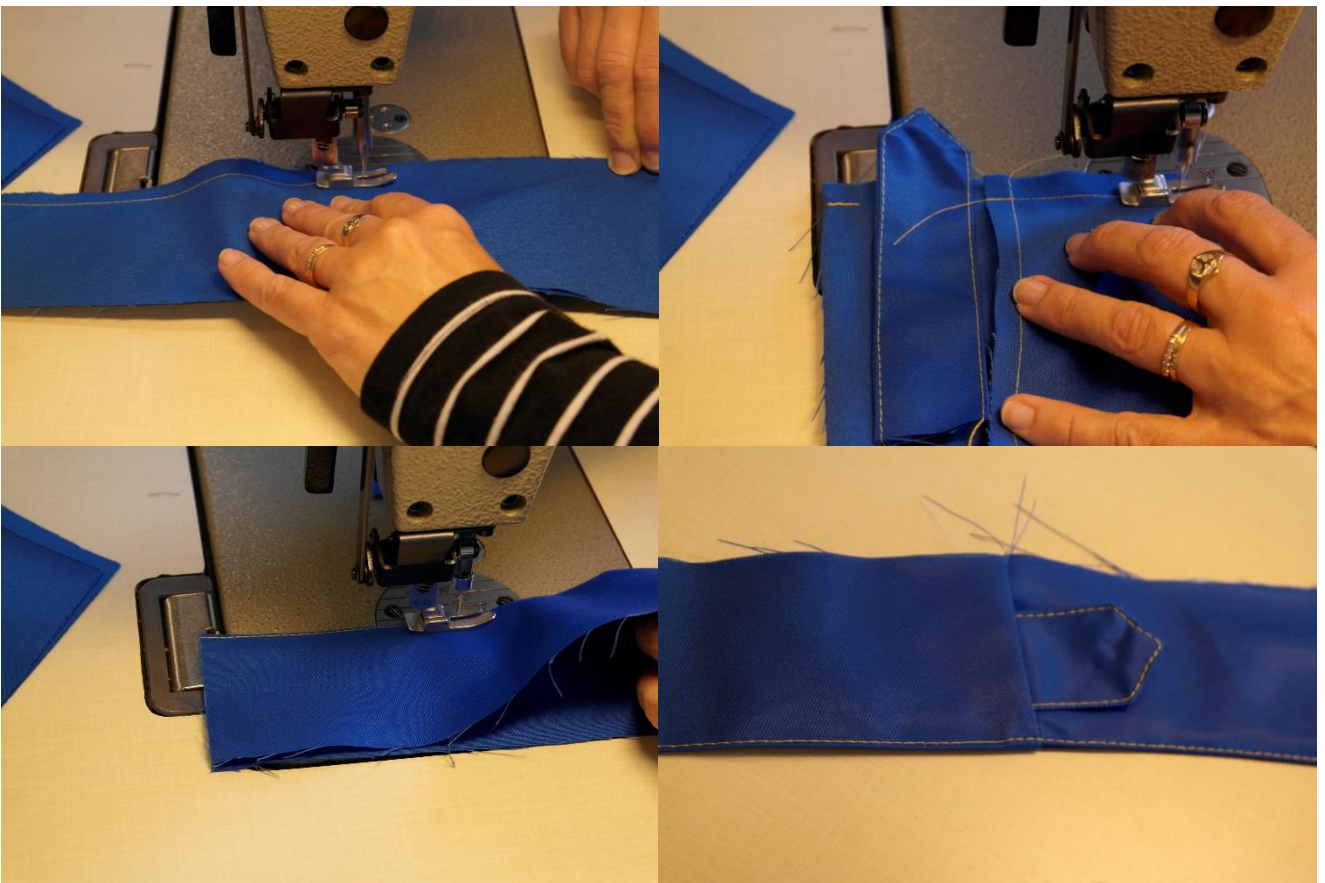

PICTURE 14. Sew the sleeves

Sew the reflectors and the pocket (PICTURE 15). Sew pieces of reflector to the pocket and the bodice and sew the pocket to the bodice.
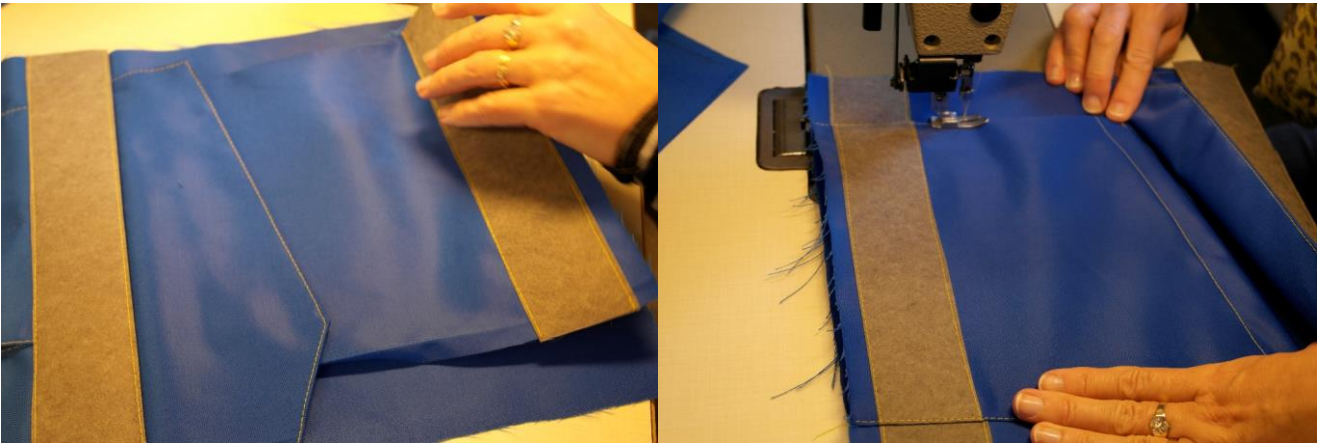
PICTURE 15. Sew the reflectors and the pocket

Sew the hem yoke (PICTURE 16). Sew the pieces of the hem yoke together. Leave an opening for the draw piece. The hem yoke was curved, adding length to the back.

PICTURE 16. Sew the hem yoke

Overlock the seams. After overlocking, top stitch the seams in the back, sleeves and shoulders.

Sew and stitch the shoulders. The shoulders were first sewn with overlock stitch and then sewn with a lockstitch machine. This could've been done with an overlock stitch machine with a safety stitch.

Sew the reflectors to the back and the sleeves.

Sew the sleeves to the bodice and overlock stitch them. The sleeves were sewn first to the shoulder and the side seam and the seam of the sleeve was sewn at once instead of making a set-in sleeve.

Overlock and sew the side seam and the seam of the sleeve (PICTURE 18). This method is faster and easier than sewing a set-in sleeve.

Sew the yoke to the hem (PICTURE 17).

PICTURE 17. Sew the yoke to the hem

Sew the wedge to the hem (PICTURE 18). Sew one side of the wedge to the bodice.

PICTURE 18. Sew the wedge

Sew the collar to the bodice (PICTURE 19).

PICTURE 19. Sew the collar to the bodice

8   CONCLUSION

This chapter is to sum up my observations about manufacturing the fitting series.

The work area where the fitting series was sewn wasn't optimal for manufacturing a series of clothes. But it was a school setting designed for education purposes; practicing and creating unique pieces of clothing rather than production of series. The pros were that the sewing machine was close to the overlock sewing machine so it wasn't needed to transfer the pieces for long distances.

There wasn't any surface to put the pieces of fabric and finished products after sewing. The pieces ended up in the back rest of the chair. Maybe a table would have been better. The best option in my opinion would be e.g. a trolley, something with a flat surface and tires for easy transfer.

The sewing order was thought from the beginning to be efficient. Everything that could be sewn with the same machine in a row was sewn in a row.

The fitting series was small. The seamstress didn't have time to develop a routine so timing wasn't comparable to those who have developed a routine.

We must consider that the fitting series was manufactured in a school setting. When the products are manufactured in a proper factory setting I assume these problems are solved.

I learned a lot during this thesis making process. I learned more about different techniques and machines used in industrial sewing. There was a lot about work analysis and work place optimization I didn't know before.

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