



Assignment of bachelor's thesis

Title:	Dowry Towns of the Queens of Bohemia - Digitization of historical clothing
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Study program:	Informatics
Branch / specialization:	Web and Software Engineering, specialization Computer Graphics
Department:	Department of Software Engineering
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Instructions

Věnná města českých královen je projekt zabývající se zobrazením historického prostředí ve virtuální realitě.

1. Proveďte rešerši dostupných historických materiálů o historickém oblečení v zadaných obdobích
2. Analyzujte nástroje pro práci s 3D modely
3. Pomocí metod softwarových inženýrství navrhnete proces digitalizace historického oblečení, tam kde je to možné navrhnete automatizaci části procesu formou zásuvných modulů
4. Implementujte prototypy zásuvných modulů ve vhodných grafických nástrojích
5. Zásuvné modely podrobte uživatelským testům



**FACULTY
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TECHNOLOGY
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Bachelor's thesis

Dowry Towns of the Queens of Bohemia - Digitization of Historical Clothing

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May 13, 2021

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Declaration

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In Prague on May 13, 2021

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Abstrakt

Bakalářská práce se zabývá digitalizací historického oblečení, které je oblékáno na generované postavy. Oblečené postavy budou využity v rámci projektu Věnná města českých královen. Práce analyzuje vývoj historického oblečení od renesance až po secesi a zároveň aktuálně dostupné nástroje, které slouží k úpravě 3D modelů.

Dále jsou v práci popsány dvě metody digitalizace historického oblečení, rozdělené podle dostupnosti vstupních informací. Metoda 3D modelování vytváří oblečení z fotografie či náčrtu prostřednictvím simulace oblečení, kterou nabízí nástroj Blender. Druhým vstupem je reálné oblečení, které můžeme vyfotografovat a pomocí principu fotogrammetrie a 3D skenování rekonstruovat jeho 3D model. Některé části metod digitalizace jsou automatizovány zásuvnými moduly do Blenderu. Moduly pomáhají při sešívání oblečení, při vytváření materiálů simulujících specifické látky a při sjednocení materiálů/textur. Moduly jsou podrobeny uživatelskému testování.

Klíčová slova Historické oblečení, digitalizace oblečení, Blender, simulace oblečení, MakeHuman, Meshroom, fotogrammetrie, 3D skenování, Věnná města českých královen

Abstract

Bachelor thesis deals with a digitization of historical clothing, which will be worn by generated characters. The characters will be used within the project Dowry Towns of the Queens of Bohemia. The thesis analyses the development of historical clothing from the Renaissance to the Art Nouveau and current available tools for editing a 3D model.

Furthermore, the thesis describes two methods of digitization of historical clothing, which are divided into available input data. The 3D modelling method creates clothes from a photo or a sketch through clothing simulation provided by Blender tool. The second input is real piece of clothing, which can be photographed and reconstructed by using the principles of photogrammetry and 3D scanning. Some parts of methods of digitization are automated by plug-ins into Blender. The plug-ins help to sew clothes, create material simulating specific cloth and unify materials/textures. The modules are subjected to user testing.

Keywords Historical clothing, digitization of clothing, Blender, cloth simulation, MakeHuman, Meshroom, photogrammetry, 3D scanning, Dowry Towns of the Queens of Bohemia

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Introduction

Nothing lasts forever. Towns, buildings, furniture, clothes, guns, and so forth, are getting old and losing their beauty. We try to save them via digitization. We can look at digitized items on our laptops, on phones, in virtual reality whenever we want. Digitization is the topic of my thesis, specifically the digitization of historical clothing. This thesis is a part of the existing project Dowry Towns of the Queens of Bohemia. The project deals with depiction of the historical environment (including clothes) in virtual reality. Style is changed with each historical period and when we want to display the specific period, we must display plausible data such as buildings and people with period clothing. Historians are professionals of history but not in modern technology and so they need to have a tool or method how to digitize these items.

I chose this topic because I wanted to deepen the knowledge of 3D graphics tools. The digitization is important for the future and I wanted to conduce to development methods of digitization. In the theoretical part, we will focus on the fashion of assigned periods. We will talk about fashion in the Renaissance, the Baroque, the Rococo and the Art Nouveau, and analyse each clothing, their shape, fabric, and fashion accessories. The attachment dictionary will help you with some special historical terms. For the practical part, we need to have researched some software which can help us with the digitization. The thesis analyses software for modelling, for adding animations into 3D model and for generating textures and texture maps. It will be discussed their possibilities, advantages, and disadvantages. In the practical part, we will talk about the two methods of digitization of clothing. We will look at the process of digitization by scanning a 3D model and by modelling. Processes will be simplified with a few automations, which will be implemented in the form of plug-ins. Finally, these automations will be subject to user tests.

State-of-the-art

The main goal of the thesis is to create a process of digitization of historical clothing. The theoretical part will be divided in two other subsections. In the first subsection, historical clothing will be searched in the specified periods for available historical materials. Historical clothing will be introduced as typical clothing for historical periods in the whole of Europe. In some cases, historical clothing was dissimilar to European one in Bohemia, these clothing will be added.

In the next step, there will be an analysis of tools for working with 3D models. Tools will be chosen by functions, usage, simple control, good user interface and price. The main goal of the practical part is a draft process of digitization of historical clothing. The process will be divided into 2 methods. One method will be based on scanning a 3D model with aid of photogrammetry. In the second method, we will use 3D modelling for creating a 3D model of cloth. Where possible, there will be designed the automation of part of the process in the form of plug-ins. Prototypes of plug-ins will be implemented in suitable graphical tools analysed in the theoretical part. Plug-in models will be subject to user tests.

Analysis

In the first part of the analysis, historical clothing in the Renaissance, the Baroque, the Rococo, the Art Nouveau will be researched. In the second part we will analyse tools for editing a 3D model.

2.1 Historical clothes

We need have 3D models of historical clothes in the our project Dowry Towns of the Queens of Bohemia. Some of them we can get by scanning real clothes from the museum. Unfortunately we don't have all dresses especially from 18th century and older. We must model these models by description in the each historical period. Following information are taken over from books of Ludmila Kubalová [7][8][9], Zikmund Winter and Čeněk Zíbrt [10]. The section Glossary helps us with understanding of some historical terms.

2.1.1 Renaissance

The first epoch which we are going to talk about is the Renaissance. Antiquity's topics could be seen again. Human and nature beauty were appreciated, naked body came into drawing, which was for the Middle Ages unthinkable. We could see an effort to difference, human was not worried to be imaginative. Travelling, discovering new lands and traditions brought new traditional costumes.

Overall

The fabric became a larger and more penetrating article of the trade. In the lower classes, various types of silk and velvet came into vogue. Clothing was widely decorated, more and more gold and silver were used for embroidery, which was widely criticised. Not only was the clothing expensive, but it was also heavy. In order to prevent the impoverishment of people and landscapes,

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the assembly ordered rules on the maximum of how people could be dressed.

For our needs, we will focus on the late Renaissance.

From the middle of the 16th century upper class began to dress in Spanish fashion. Townspeople in the Czech lands were wearing vestments, ropon, skirts made from velour (silk fabric with short thick hair), damask and other silk fabrics.

Footwear

Although the footwear no longer had a sharp and narrow toe, it still remained very uncomfortable. The blades were now round or angular, but their height did not change, they were flat and very low, so they barely covered the heel and toe. Sometimes they had to be strapped over the instep to keep them from falling off the foot. A low heel began to appear under the heel.

Headwear

The universal headwear worn by the entire community were a beret 2.1. Beret was originally an intermediate stage between a hat and a cap, called a "woven hat". It had a large number of variants in terms of size, shape and colour. Scholars wore small, narrow-brimmed berets close to their heads. The monarchs, the noblemen and some of the townspeople put on a flat beret decorated with feathers and gold stripes with a narrow or wide edge. There were also berets covering only the top of the head, or on the contrary reaching up to the forehead. Some men wore the beret very diagonally, so that it almost fell off their heads, so they had to wear a tight hat called a calotte under the beret.

Accessories

The basis of clothing accessories was the handkerchief, *facalit* (It. *Fazzoletto*), which was decorated according to who it was intended for. These handkerchiefs were not meant to wipe the nose, but were worn only as decoration in the hand.

Gloves were beginning to be an important fashion accessory, which were both hand protection but also played an important role in the ethic. The first sleeves, lined sleeves, called muffs, or fans 2.2 (*Flabellum*) appeared. The fans were made of feather or paper, some of them could already be folded.

Women's clothing

The basis of women's clothing, as men's, was the doublet, which determined the basic silhouette. Women used it with various kinds of fur and bright pat-



Pokrývky hlavy v Evropě 16. století

Figure 2.1: Headwear in Europe in the 16th century



Figure 2.2: A portrait of Joanna of Austria (holding the fan) (1547–1578), Kunsthistorisches Museum Wien, Bilddatenbank

turned fabrics with large striking designs to create a luxurious part of clothing. Czech women wore a lavish cape over their shoulders – a cape, made of precious fabrics decorated with rare furs.

A very significant change in women's clothing was the separation of the dress into two parts: the skirt and the bodice. This process took place at the beginning of the Renaissance. In the late Renaissance, the bodice became tighter, as if it were small for a woman. The richly decorated sleeves (finestrella sleeves) looked mostly unnatural due to the multiple transverse contractions, which created a kind of cone on the sleeve. The bodices began to reveal neckline of the shoulder and bust. Through the bodice, women wore the so-called collar. Originally a collar that covered a large neckline, it gradually became a sleeveless stomacher, extending a narrow line of the bodice in the shoulders.

Skirts did not lag behind in a demanding arrangement; they were regularly



Figure 2.3: The woman on the left is wearing the traditional German fashion from the Renaissance period, with puffed sleeves, a small hooped skirt, and a fur hat. The woman on the right is dressed in the Scandinavian style, with a brocade palatine or capelet over her shoulders and a white cap. Both women are wearing decorative aprons and a “housewife” hanging from their waists. 1660

pleated at the waist and created funnel-shaped thick folds. The skirts were lengthened again so that the women had to drag them with their tails behind them or lift them while walking. Skirts and trouser legs were worn in many different colours and were embroidered. A farthingale - topmost petticoat, hooped to give shape to the skirt was also coming into fashion. The farthingale was wooden, iron or also wire. The train on the women’s clothes kept shrinking over time, until it disappeared completely.

Aprons

The women emphasized their roles as housekeepers, fire keepers, and protectors of household by wearing aprons. Women wore aprons 2.3 not only as work clothes, but also as a part of their everyday attire.

Headwear

The bourgeois conservatism was most pronounced in the design of the head. Many women wrapped their heads and partially covered their faces with a reinforced veil. Noble women preferred beret or bourrelet, usually in conjunction with valotte or a hairnet that tied hair. Some berets or hairstyles were decorated with ostrich feathers. During this period, the diversity of headwear was incalculable.

Hairstyle

Beautiful flaxen hair is becoming a major fashion trend. Some women tried to get the best hair tone by exposing hair to the sun in the gardens to turn it more fair. They covered their faces during the procedure, because it had to remain white. The hairstyle of the early Renaissance has two basic variants - the hair is arranged in a knot perched on the top of the head and either all the hair from the forehead is combed into a knot or some is slightly wavy and frames the face 2.4. The hairstyle could be decorated with a knotted cord or with a strip of cloth wrapped around the knot. Some women wear diadems extending to the forehead, decorated with a pearl in the middle.

Over time, hairstyles became more voluminous and were decorated with gems or gold.

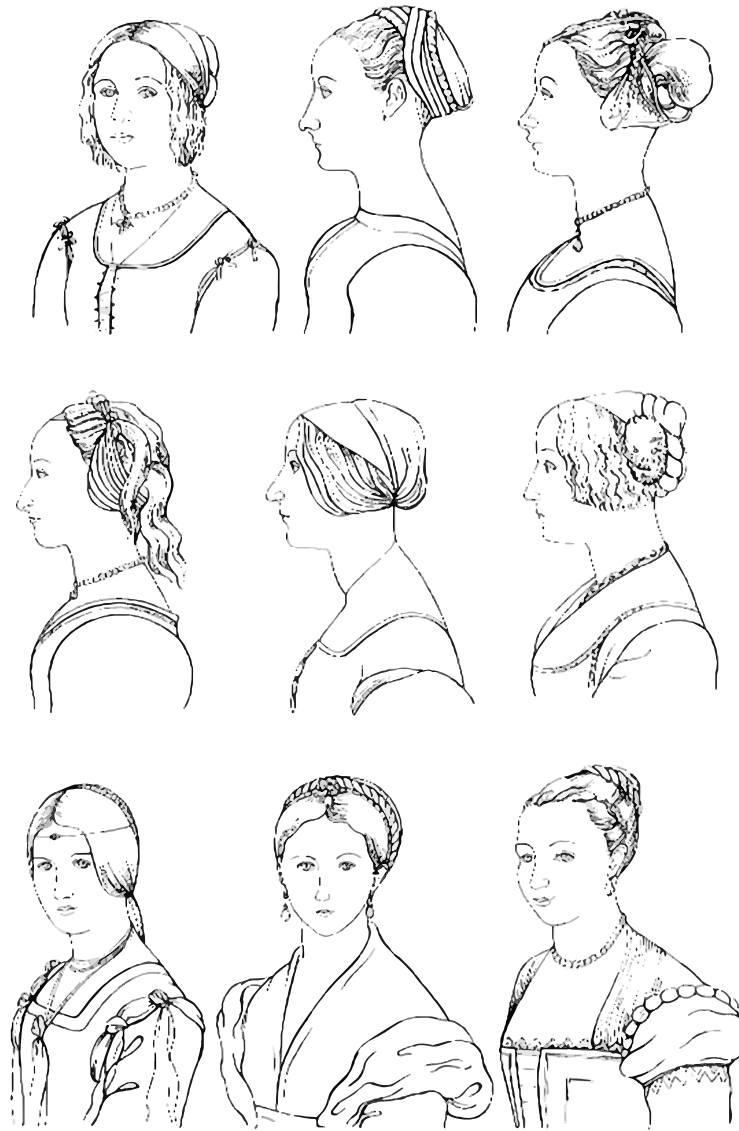
Men's clothing

The doublet and the ropon 2.5 (Czech "čuba", Ger. Schaub) became the basic outer garment. It was a follower of the late Gothic houppelande: a broad cloak falling to the knee but also to the ground, with long wide sleeves, a shawl collar, often accentuated by fur, completely open at the front, the lining of which was in contrasting colour. Men who were fashionable wore richly gathered doublet. The number of variations of the doublet was large.

2.1.1.1 Breeches

The legs were covered by tight knee-length breeches and hosen (often poufy), which were either attached to the breeches or were sewn on. As in the late Gothic and Renaissance, the breeches were equipped with a padded fly, which reached the size of a child's head and was often complemented by ribbons.

A novelty of the middle of the 16th century was a new type of breeches – trunk (pumpkin) hose 2.6. Trunk hoses were scooped lumpy bags to the knee, according to the Spanish pattern, unstitched and assembled from slits, the so-called fashion of slashing and puffing. A lighter, more colourful fabric was sewn between the slits. They used a huge amount of fabric, up to 9 meters.



Ženské účesy v Itálii 15. a 16. století

Figure 2.4: Women's hairstyles in Italy in the 15th and 16th centuries



Tři typy šuby: prostá reformační; okázalá s mohutnými rukávy; krátká, zdobená kožešinou

Figure 2.5: Three types of the ropon: simple reformational, with large sleeves, short decorated with fur

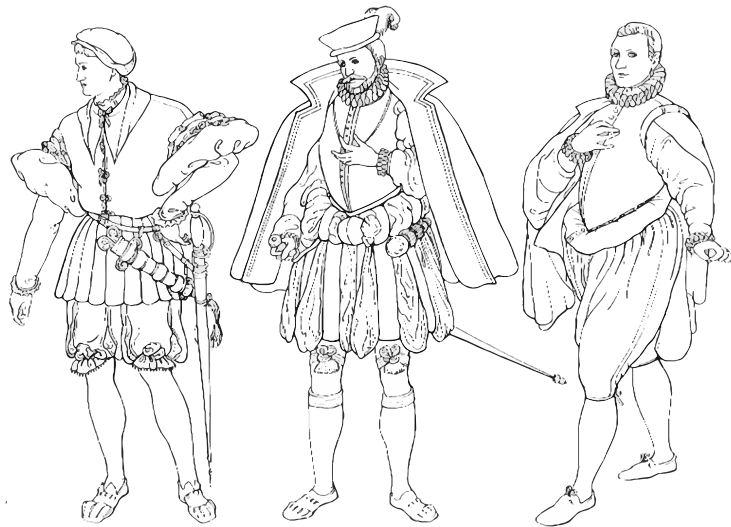
The pumpkin hose made a strange rustling sound as they walked. Men's calves were covered with knitted stockings.

Hairstyle

All men had indecent hairstyles called topknot. The hair was cut straight under the ears, and the entire hairstyle was completed by a short straight-cropped "fringe" above the forehead. Over time, the hair gets shorter until it doesn't cover the ears. As the hair shortened, beards began to appear. Beard was at first in the form of a narrow strip from ear to ear, later in the form of a moustache and goatee. Beards were signs of masculinity.

2.1.2 Baroque

Victoria and Albert Museum in London provides this definition of Baroque style [12]: *"The Baroque is a highly ornate and elaborate style of architecture, art and design that flourished in Europe in the 17th and first half of the 18th century. Originating in Italy, its influence quickly spread across Europe and it became the first visual style to have a significant worldwide impact."*



Tři němečtí šlechtici v plundrách, z let 1538, 1580 a 1582

Figure 2.6: Three German noblemen dressed in trunk hoses, 1538, 1580, 1582

In the Baroque period, the fashion of the Thirty Years' War faded, but gradually the overall line of the body changed. However, men were still wearing a hat with the wide brim decorated with feathers, or bucket boots with folded cuffs. The silhouette was fundamentally by a shortened coat. The doublet was so short that it lost coat-tails, reaching even above the line of the natural waist. Its sleeves were also shortened and it was fastened in the middle with a buckle. The doublet revealed a pleated shirt decorated with ribbons, thus disappearing the waist line. Breeches were stripped of padding, dropped to the knee and took on a tubular shape. They were equally wide along their entire length. After 1625 in France pants, called 'pantaloni', were narrow and reached up to their calves, later spread throughout Europe.

We could notice the first version of the cravat. Men were wearing the cravat "Steinkirk" during the wars. Steinkirk, named after the Battle of Steenkerque, was a long, narrow, plain piece of clothing wrapped once around the neck in a loose knot, with the lace fringed ends. Another cravat was called a jabot [6].

A baldric changed the silhouette as well. The baldric was a sash, a wide band which was hemmed, embroidered, worn over a shoulder and knotted in the waist. A rapier was inserted into the knot. Kind of apron was begun to wear instead of the striking protruding fly. In general, a lot of lace was used for cloth.

The coats took the form of manteaux, in fact they did not differ much from the older ones. However, they were less picturesque, they only blended softly,

decorated with a number of ribbons and lace and in a combination with wide trousers, and they contributed to an already very bizarre silhouette.

In the second half of the 17th century, the first production of wigs was established in Paris, and their number grew rapidly. According to tradition, the wearing of wigs was also initiated by the king himself, who allegedly had rich hair in his youth but very soon lost his decoration and began to help himself with a wig. However, the real expansion belonged only after the time from 1661. Until then, men wore their own long, curly hair. The wigs were to be an expression of wealth, so over time they became bigger and bigger, until it was not built into special racks and reached up to 20 cm in height.

There hadn't been much change in women's clothing since the Thirty Years' War. The women dressed in lavish dresses with large necklines and bodices extended to the tip. This tip used to be decorated with elaborately made planchettes, made of wood, mother-of-pearl, ivory or metal.

The skirt was lined with petticoats. The top skirt was opened at the front to reveal the ornate bottom skirt and the lining. The upper skirt used to be stretched into a train; it was decorated with ribbons, lace and frills and contrasted in colour with the lower skirt. Fabrics of various materials, colours and patterns were used to make the dress. The top material was often transparent so that the bottom layer material shone through it. The whole outfit was complemented by an intricate hairstyle. Around 1650, women began to curl their hair, used the paper curls, backcombed it, and curled it into locks.

We will focus in more detail on the Rococo period which is called Late Baroque in the middle of Europe .

2.1.3 Rococo (Late Baroque)

“Rococo emerged in France in the 1720s and remained the predominant design style until it fell out of fashion in the 1770s. Excessively flamboyant and characterised by a curved asymmetric ornamentation and a use of natural motifs, Rococo was a style without rules. Compared to the order, refinement and seriousness of the Classical style, Rococo was seen as superficial, degenerate and illogical.” Victoria and Albert Museum gives a definition of the Rococo style that way [13].

Women's clothing

The crinoline (hoop skirt) became the basis of the overall female and male silhouette. The crinoline and the corset made it possible to create a narrow waist that contrasted with the wide skirt. This way of dressing was considered

erotic. Whale's bones began to be used to make crinolines, which made the garment lighter. The crinoline consisted of five hoops connected by a wax canvas. This rigid support did not adapt to the woman's movement, only swaying back and forth and making a creaking sound. The crinoline was called by the French word *panier*, which means a basket.

In the middle of the 18th century a more comfortable form of crinoline (*demi-panier*, *panier-double*, *janséniste*) was created for women 2.8. This variant of crinoline consisted of 2 separate parts, which were attached to the corset on the sides by means of ribbons. The crinoline itself had only 2 hoops and the original wax canvas was replaced by lighter materials (wave, cotton, silk). Over time, it also shortened to the knees, the lower part was adjusted with a ruffle, and the foot in the high-heeled shoe was exposed to the ankle. Around 1745, the shape of the crinoline changed. It widened to the sides and flattened at the front and back, making its floor plan oval-shaped 2.7. At the same time, the skirt was raised above waist level, allowing women to rest their elbows on it. The skirt used to be up to 150 cm wide, which made it difficult to pass through the door, so the women had to enter the door sideways. The crinoline affected the overall movement of the woman. Wearing these clothes required not only a certain practice, but also adaptation of the furniture. A woman could only sit on a wide sofa with a wide skirt.

All variants of crinoline were the basis for a skirt made of a large amount of fabric by pleating into folds, folding back and forth and layering. The upper skirt was opened at the front so that the lower contrasting and decorated lower skirt could be seen. This type was named "robe à la polonoise" and was the most common form in all of Europe.

The women wrapped themselves in a loose-fitting cloak with rich folds. It was open at the front and buttoned up, or just lightly held. A variant of the cloak, completely open at the front, tied at the chest with an agrafe and belted at the waist with a sash (*robe à la lévite*), became a walking outerwear worn by the women over a bodice and a skirt. The *robe volante* variant (Fr. fluttering) had an ermine hem.

Bodice

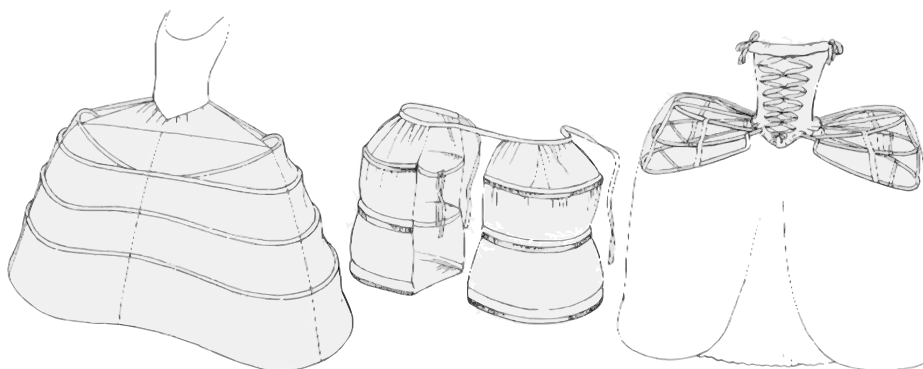
The richly gathered sleeves with pleated cuffs, often decorated with lace were a noticeable part of the garment. The bodice retained its shape, but had a much larger neckline and was laced up at the front. The women tried to emphasize the contrast between the wide skirt and narrow waist by tightening the corset more tightly. An important decoration of the corset was the shirtfront, which evolved from the shirtfront scarf (it survives in folk costumes to this day). The shirtfront (*punt*) was triangular in shape and was intended to hide the

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Typy krinoliny v letech 1730, 1740-50, 1759

Figure 2.7: Types of crinoline in years: 1730, 1740–50, 1759



Konstrukce krinoliny: „panier à coudes“ 1740, „demi-panier“ 1750, „considération“ 1770

Figure 2.8: Crinolines' constructions: "panier à coudes" 1740, "demi-panier" 1750, "considération" 1770

lacing. It was made of thick cardboard (sometimes tortoiseshell or ivory), which was coated with fabric. It slid into the front corset and was caught on the sides by the hooks. Underpants were not a normal part of the garment, they were perceived by the majority as inelegant and inappropriate. They were worn only by maids at work, old ladies and dancers. Young ladies wore them only for sporting activities, i.e. horse riding. Due to the still inadequate and neglected hygiene, people were forced to use very strong perfumes to suppress body odour.

Fabrics

Heavy Baroque fabrics were replaced by delicate fabrics in matte tones, popular colours were pink, light blue or green. Other favourite colours of vague shades had the strangest names: 'street dirt', 'London smoke', 'poisoned monkey', 'Happy Widow', 'the guts of a dandy', 'sick with smallpox'. Printed cotton fabrics from the Middle and Far East competed with lower acquisition costs for fabrics interwoven with silk and metal threads. Printed cardboard and various cotton fabrics used to use mainly less wealthy layers

Hairstyle

Voluminous high hairstyles called fontage were a thing of the past. Women's hairstyles had shrunk extremely. The hair was combed to the head and covered with a lace bonnet. Among the typical hairstyles was a tape hairstyle (from Fr. taper = curling, combing hair). The tapes were curly hair in the front, completely smooth in the back. The hairstyle exposed the forehead, forming an oval edge of the face. In the middle of the 18th century, the hair at the back was lowered to the neck in large ringlet or plaited, the ends of which formed curls 2.9. Later, long curls were formed from highly combed hair above the forehead. Hairstyles were becoming more complex and voluminous, with some hairstyles up to four times larger than the head itself. The complexity of the hairstyle increased the time required to create it.

Headwear

Purposeful caps used for sleep and washing were used to protect complex hairstyles. They gradually replaced the still predominant small bonnets. These larger bonnets were decorated in various ways, so they could be used for home wear instead of intricate hairstyles. The special cap with spikes (cornette) covered only the top of the head, and its long ribbons were not tied, but women kept them hanging loosely on their shoulders. Berets also remained in vogue, along with a large variety of wide-brimmed hats, which were also richly decorated. A flat hat (Á la Watteau) was worn deep to the forehead and adorned with feathers at the back. A man's three-horned hat or hood with a veil was used for hunting.

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Figure 2.9: Women's hairstyles in the Rococo period in the first half of 18th century: 1st and 2nd France, 3rd Austria and 4th Germany

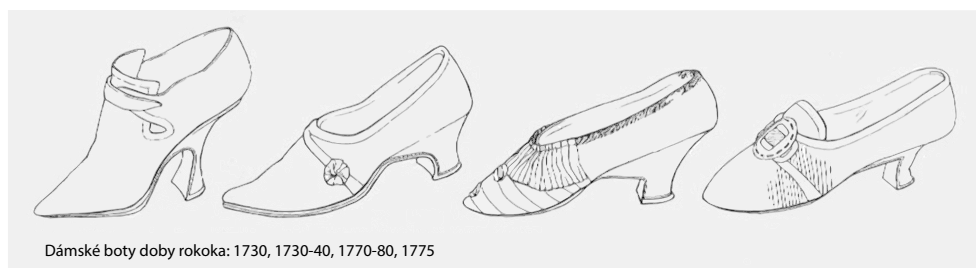


Figure 2.10: Women's footwear in the Rococo period: 1730, 1730–40, 1770–80, 1775

Footwear

People took great care to their shoes, even though it was still hidden under a long skirt. The shoes had a round tapered toe, heels of varying heights 2.10. The shoes used to be sewn from the same fabric as the outer garment. Despite minor changes in design, the shoes remained uncomfortable, especially when walking longer.

Accessories

Shortening the sleeves brought with it the fashion of gloves that covered the hands up to the elbow. Since the 16th century, a muff, which was also worn by men, also served to protect hands. The fan remained a fashion accessory, and a small soft pouch for trifles and alms was added, which used to be richly decorated with embroidery, laces, beads and stones.

Makeup

In the Rococo period, fashion was artificial and over-decorated, the makeup, which was very striking. Corresponding to this, women applied much more face powder not only to their faces, but especially to their wigs. The powder was made from rice flour in various colours. In addition to the basic colour of white powder, they could also encounter yellow, brown, red, blue and black powder, which was applied before horse riding. The wig was sprayed against the ceiling of special rooms to achieve an even layer. At the same time, the powder was spread all over the cabinet, and therefore it was necessary to protect the face with a mask and a special cloak. The makeup was often complemented by small ornaments of rubberized black silk or paper called flies. The flies used to be shaped like hearts, stars, crescents, animals, etc.

Men's clothing

Men's clothing, unlike women's, developed more slowly. The basis of a man's suit called *babit* was formed. The suit consisted of *justacorps*, waistcoat and *culottes*. The suit's components persisted until *justacorps* was transformed into a modern-day jacket. The shape of the *doublet* was adapted to the women's *crinoline*. The coat tails, which were reinforced with wax canvas, horsehair or paper, widened to the sides to match the width of the *crinoline*. The coat opened to reveal a waistcoat buttoned on several buttons. The sleeves of the *doublet* extended to the elbows or wrists, where they were decorated with the cuff and the edge of a decorative shirt.

Formal attire

There was a more comfortable type of *doublet* for horse riding and wearing a cord called a *tailcoat*. *Tailcoat*, called in Czech "frak" (from the English word *frock*), was created by shortening the tails of *justacorps* 2.11 due to the wearing of a sword and horse riding. The shape of the tails evolved, from angular to rounder, with longer or shorter tails. Wearing of the *tailcoat* began to expand, it would become a formal attire, and its appearance survives to this day as the most glorious part of the male wardrobe.

Waistcoat and tie

The waistcoat has become a very luxurious part of men's clothing, both in choice of material and decoration. It was gradually shortened and closed with just a few buttons. Thanks to the opening of the *doublet* and the shortening of the waistcoat, a tie was created, often elaborately arranged, which gradually replaced the lace *jabot*. The ties were wide and worn in white and black.



Siluetta justacorpsu v době baroka a rokoka ve Francii (1693-95 a 1715) a v Anglii (1760)

Figure 2.11: Silhouette of justacorps in the Baroque and the Rococo period in France (1693–93 and 1715) and in England (1760)

Hairstyle

Men, like women, wore large allonge's wigs. Initially, only older men or men of some liberal professions wore wigs. The most common hairstyle was long hair pulled back at the nape with a ribbon and placed in a black taffeta bag, combed smoothly around the face 2.12. The strands of hair around the ears were worn loose or curled into the ringlets, which in Czech were known as (wobbles) “vuklíčky”. The male wig was smaller, similar to the female one, and had a huge number of variants. The wig was not only a hairstyle; it also served as a headwear or a sign of the status. That's why some men wore it deliberately sideways.

Breeches

The culottes, variant of breeches, had undergone the biggest change. They were lengthened so that they could be pulled over the puff, where they were fastened with a buckle. The double fly was covered by pendants, which clinked as they walked. Most often, the fly was covered with a watch chain.

Outerwear

Redingot appeared next to the sleeveless cloaks. The redingot was sewn in various variants. The most common was a long double-breasted redingot with



Figure 2.12: Men’s hairstyles in France in the Rococo period: ”ailes de pigeon”, 1728 and 1750, ”à marteau” alias ”à noeuds”, 1763, ”catogan”, 1770

two collars. One of the collars used to be worn raised and the line of the cloak was more or less fitted, so that the silhouette became more and more relaxed. Reginot was primarily intended for travel.

2.1.4 Art Nouveau

We will borrow the definition of Art Nouveau again from the website of the Victoria and Albert Museum in London [11]: *“Decorative, sensual, and uncompromising, Art Nouveau (‘New Art’) emerged as a dynamic and expressive style in the visual arts from the early 1890s to the First World War. Taking its inspiration from the natural world, its characteristic motifs include delicate tendrils, organic forms, swooping, swirling lines, eccentric geometry and exotic bodies.”*

Femme fatale (fatal woman) is described at the turn of the 19th and 20th centuries as a seductive woman whose slender body was accentuated by tight clothing, which was complemented by a fur or feather boa. This combination was meant to create the image of an attacking beast.

A typical motif for the Art Nouveau period was a plant motif and a passion for decorative decoration. This was reflected in the new ideal of the woman-flower. Women-flowers were dressed in garments reminiscent of artificial flowers; popular flowers included orchids, which, although alive, were as perfect as if they were artificial. Hairstyles were also decorated with flowers that could resemble the shape of lilies or carnations.

The Western world had begun to look up to Oriental Chinese and Japanese fashion, admiring garments made of silk materials with various patterns.

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The white flannel costume, which was intended for a stay in a seaside spa, was named after the Russian ruler, the Tsarina. As a result of the promotion of sport, doctors and sanitation workers were also stepping up their efforts to remove the corset from the women's wardrobe, which, however, was opposed by conservative society.

Materials

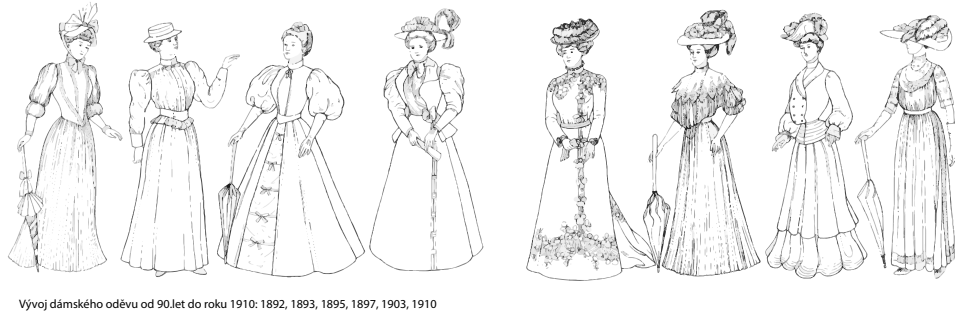
A typical feature of Art Nouveau clothing was the combination of different types of fabrics, their layering and decoration. The range of materials became widespread, in addition to shiny, soft fabrics, chiffon was often used and viscose silk called charmeuse appeared as a new material. The dress was decorated with coral embroidery, velvet applications, chiffon combined on the sleeves with lace lining and grogrene ribbons at the waist. There was also a new technique for making lace, the so-called Irish crocheted lace with motifs of plants and insects. There were even dresses all crocheted by this technique. At the turn of the 18th and 19th centuries, the processing of furs was accelerated by sewing machines and so they expanded. Fur was worn by both women and men and became one of the symbols of the wealth and luxury of the bourgeois class. Otter, Persian, sable and mink furs were popular.

Women's clothing

The bustle, still shaped by the corset, created an irritating S-line 2.13. Excessive decoration with ornaments, decorative techniques on various materials, which were combined and layered on one garment, was applied, as had been the case in the past. Over time, the bustle would be definitely postponed, first in Paris and then gradually throughout Europe. It was not possible to determine the exact date of the bustle postponement; it depended on the distance from the place where the fashion was set. It also depended on availability; clothing was still expensive not everyone could afford to buy a fashion novelty. The slim waist, slender hips, and bosom shaping were the constant stringent requirements required by the S-line. The flat stomach began to be accentuated by a tighter corset, which was taller and longer 2.14. This corset was sometimes called "fashion against child" because it was worn by all women, including pregnant women.

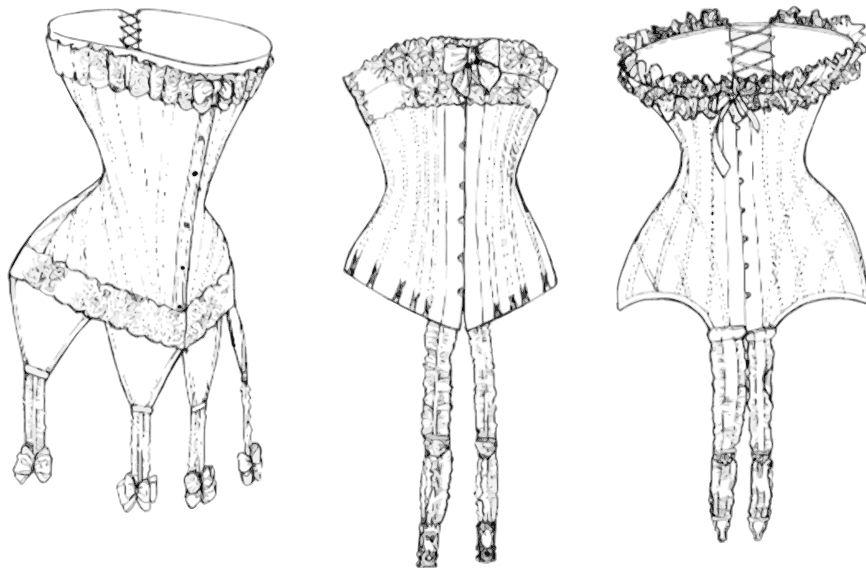
Basic clothing

Skirts were a few centimetres shorter in the early 1890s, but soon afterwards they were extended again and reached the ground. The skirts were also again complemented by a siding, which was not missing in both formal and casual clothes. After 1893, the skirt received a new style, bell or circular. The circular style had inserts or deep sewed folds that were loose at the bottom. Wearing a long skirt was not very practical, so new etiquettes were created



Vývoj dámského oděvu od 90.let do roku 1910: 1892, 1893, 1895, 1895, 1897, 1903, 1910

Figure 2.13: The development of women's attire, 1892, 1893, 1895, 1895, 1897, 1903, 1910



Různé typy korzetů, prodloužených přes boky a opatřených podvazky, 1900, 1900, 1907

Figure 2.14: Various kinds of corset, lengthened over hips and equipped suspenders, 1900, 1900, 1907

that determined how to hold the skirt. In France, etiquette dictated holding the skirt and the train with both hands, while in England, only with one hand. Clothing remained in terms of cut, it was not simplified. The production of one robe requires a large amount of fabric, which folded to form a skirt, folded into wide folds, and arranged. The garment consisted of several parts, not sewn together. The bodices were newly complemented by the popular shorter and longer jackets, which emphasized the shoulder line. After 1890, the so-called “ham sleeves”, came into vogue, which were gathered, widened, filled and lifted upwards in order to achieve a larger volume. Later they formed small balloons, which were replaced by completely smooth sleeves. Around 1904, demanding formal wear was created, which had a relaxed line and extended skirt and still accentuates the line of breasts and hips. Skirts, whose siding gradually disappeared, move higher to the waist.

Garbs were more closely differentiated according to opportunity. In the morning, a costume was usually worn; and for church visits, women change into broadcloth dresses (this rule was a standard that was observed by people in the Czech countryside until the Second World War). During the day, a closed garment was worn, which was decorated with stripes, fringes and pleats. Evening dresses with deep necklines were embellished with real lace, ribbons, wax or glass pearls and real jewellery.

Blouses and skirts

The blouse and skirt were initially preferred to the costume due in their practicality. Blouses made of opaque material were loose and there was no need to wear a corset under them. The combination of blouse and a skirt was popular in all walks of life, and thus almost became the uniform of employed women. There was a wide range of different types of blouses, luxurious, evening 2.15, richly decorated and also simple, which later form an integral part of the costume. The skirts were formed in various shapes; they could be wider, narrower, slightly bell-shaped with ironed folds, or without ornaments.

Costume

The costume consisting of a jacket and skirt was inspired by a man’s suit, but with an emphasis on the female line 2.16. It was first introduced in England. In the years 1907–1910, the women’s costumes were most similar to men’s suits. They had a relatively long jacket with narrow sleeves, only half-fitted, complemented with a narrow piece of skirt.

Just as day and evening dresses differed, there were day and evening cloak variants. The day cloaks were much simpler and similar to men’s coats. In Central Europe, raincoats were also popular, which were actually a variation of earlier bedspreads. They were worn for walks around the city and on the



Anglická slavnostní blůza, *The Ladies Field*, 1903
(krepdešínová blůza ze skládané látky, s mohutnými
trychtýřovými rukávy, ozdobená stuhami a krajkou)

Figure 2.15: English dressy blouse, *The Ladies Field*, 1903 (blouse made from folded fabric with large funnel-shaped sleeves; decorated with ribbons and laces)

road. The evening cloaks were loose-fitting, sometimes not even fastened, and only folded over each other in the front and held by hand. They used to be lined with fur and fur collars. All-fur coats were also worn, made of expensive furs - chinchilla, ermine, sable, skunk, possum, ocelot, squirrel or silo. Women didn't even put them down in the summer. The consumption of fur had endangered some animal species.

At the end of the century, a teddy eclipse, which was a kind of underwear jumpsuit consisting of an upper chemise and knee-length underpants, appeared as a novelty. This was followed by a corset connected with the panties, and at the same time a new part of underwear - a bra 2.17 - was gradually being created from the corset.



Paní Vlasta Vrázová (manželka cestovatele Stanko Vráze), 1908 (výcházkový zimní kostým s rukávy v ramenou rozšířenými, tzv. šunkovými, zdobený kožesínou, z níž je zhotovena i čapka a rukávník)

Figure 2.16: A picture of Mrs. Vlasta Vrázová, 1908 (walking winter costume with enlarged sleeves in shoulders (ham sleeves); decorated with fur from which cap and muff was made)

Home clothes

Rococo women wore comfortable negligees as home clothes. In the Rococo period, a corset was still worn under the negligee, which was replaced by a linen bodice.

Hairstyle

Fashion dictation still dictated the wearing of an elaborate rich hairstyle, for the creation of which women needed thick hair, for which they had to help themselves with hairstyles. Hair was worn with a parting in the middle, slightly curled, and slightly raised by backcombing in front of the forehead, tied in a knot at the back. This style was later complemented by a side fringe above the forehead on one side or by wavy hair around the forehead, temples and ears 2.18. Evening hairstyles were much more complicated, it was necessary to backcomb more hair, add more hair postiche and ornaments, which were dominated by bird of paradise feathers or strass stones. Young



Podprsenka zdobená saténovými stužkami a s kosticovými vyztuhami, 1910
(jeden z prvních modelů nové součásti prádla, zatím ještě poměrně rozměrný)

Figure 2.17: A bra decorated with satin ribbons and with underwire bracing, 1910 (one of the first models of new underwear's part)

girls began to "crepe" their hair. This treatment not only burdened the hair, which was extremely dry, but also did not flatter the appearance, the girls often looked like "sheep".

Headwear

In addition to staying at home, a head covering in the form of a hat or a cap was a necessary and integral part of the garment. Women liked to wear especially fancy hats richly decorated with flowers, very popular feathers, even whole stuffed animals and birds. Around 1910, hats reached the size of a vehicle wheel, which was the largest size up to now. There were also other types of hats, such as the triangular style of Louis XV, a shepherd or a large straw hat, from the edge of which fell a wide ruffle made of mull or embroidered fabric. So that hats, especially larger and heavier ones, did not fall off the head, they were attached with a veil tied under the chin, or they were attached directly to the hairstyle using hat needles.

Footwear

As the range of activities that women engaged in expanded, it was necessary to adapt the shoes to the movement in different environments. For daily walks,

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Módni účes, The Ladies Field, 1904
(vlasy vyčesané vzhůru a zdvižené nad čelem)



Antonín Häusler, Podobizna paní Horákové, 1894
(typický dobový účes s vlasy na spánkách těsně přiléhajícími k hlavě a na temeni vyčesanými vzhůru do malého uzlu)

Figure 2.18: Picture on the left: Trendy hairstyle, The ladies Field, 1904 (hair combed upwards and raised above the forehead); Picture on the right: Effigy of Mrs. Horáková, 1894 (typical period hairstyle; hair skintight to the head on the temples and combed up into a small knot on the top)

ladies wore higher leather boots or boots with leggings, in the evening they went out with low shoe on a higher arched heel, or put on flower chafer boots with rainbow leather sheen 2.19. Footwear was decorated in the pattern of the Orient (Japan, Turkey); homemade silk slippers decorated with embroidery were popular.

A new type of footwear had been developed for sporting activities – laced-up shoes, which had a similar shape to men's shoes, were divided into a toe and a front and back part, backstitched and perforated emphasizing their shape. The right and left shoes did not begin to take shape until the end of the 19th century. Earlier unshaped shoes were called “ampaletky“ in Czech lands. There were also other types of exercise shoes and children's sandals. Sandals were also worn by women on summer walks.

Accessories

The classic women's handbag began to take shape at the turn of the century, until then the handbag was not a necessary part of women's equipment. There



Dámské vysoké boty, Vídeň, 1900
(černé kožené botky s peřorací a ozdobným zapínáním po straně)

Dámské večerní botky, kolem roku 1895
(velmi oblíbené botky na zvýšeném podpatku ze zlaté kůže s vyšivkou, kterým se říkalo zlatohlávkové)

Figure 2.19: Picture on the left: Women's height boots, Wien, 1900 (black leather boots with perforation and with decorative fastened on the side); Picture on the right: Women's evening shoes, around 1895 (very favourite shoes (flower chafer) with heels; made from gold leather with embroidery)

were special bags for travel and small bags for handicrafts. The first purses used to take the form of a large purse, either tightly closed or drawstring sometimes adorned with tassels or fringed beads.

Significantly arched and large parasols and umbrellas were a necessary accessory. The material for the canopy was silk or white linen, often complemented by lace. Their handles were made of rare woods and carved into the shape of an animal's head. Women wore gloves with their garments. They wore gloves of various colours made of glazed leather for daily walks. The gloves designed for the evening reached up to the shoulders, were buttoned at the wrists and were made of wild animal leather or suede. Only older people wore fingerless gloves that survived as work gloves for a long time. They were gaining fan popularity as part of the ball gown. They were made of white ostrich or a marabou stork feathers. Thanks to the reduction in the price of colour printing, simple paper fans were available, which served as a reminder or advertisement (reminiscent of world exhibitions, famous theatre performances, etc.).

The Art Nouveau ladies were partial to the demanding and colourful jewels, which were made of gold and precious stones, and the décor was once again dominated by floral ornaments.

Men's clothing

In the Art Nouveau era, men's clothing changed only slightly.

Basic clothing

The key question became on what occasions to wear a suit jacket, tailcoat, morning dress, or tuxedo 2.20. The tailcoat began to be worn only for certain selected occasions, such as attending a wedding, a ball, going to the theatre, etc. Therefore, the tailcoat ceased to be part of every man's wardrobe.

Unlike the tailcoat, which disappeared from some men's wardrobes, the suit jacket was becoming an increasingly common part of the garment. The original baggy shape changed, the suit jacket was slimmer, longer, had a fitted line, the connecting button was located at the waist, from which the coat-tails were cut slightly diagonally. Only the tie knot was visible from the smaller neckline. The suit jacket usually had straight, cut-out pockets with flaps and a sloping chest pocket. The sleeves, which were rarely decorated with a cuff, were narrower. The jackets were sewn mainly from dark or light mottled fabrics.

The fashion icon defining men's fashion was English King Edward VII, whose perfect suits were imitated by all men longing for elegance. This trend of dressing is called the Edwardian style. The suit included trousers and a suit jacket, the length of which covered the seat. The suit jacket had one row of three or four buttons, with a small neckline in the front with short revs (hatches), which were stitched at the edges, and a slit at the back. Around 1905, a combination of a suit jacket and trousers of different but harmonising colours and fabrics come into vogue. The combined suit was dressed for casual walks, summer stays by the sea, or as a tennis outfit.

Polish-Lithuanian chamara also entered the Czech environment. The chamara was another black coat, which had a standing collar and was fastened at the front with a number of buttons and laces. The chamara was worn at festive events as a symbol of Slavic nationality and patriotism.

Trousers

At the turn of the 18th and 19th centuries, a new type of trousers, the so-called "accordion", was created. These are longer trousers that formed a number of transverse folds on the legs. With the fashion of creases on trousers also came a turn-up, which typically occurred in sports suits. The man's suit, including a dinner jacket, hardly changed between seasons. Around 1900, a silk-covered shawl collar became fashionable, and remained popular until the First World War and resumed in the 1950s.



Figure 2.20: Various kinds of men's formal clothing in the Art Nouveau period, The Jno. J. Mitchell Co., c1899 August

White suit

The white suit (called miller's suit) could only be worn for certain occasions during the summer season, especially to stay by the sea or in the countryside. Men didn't pay much attention to the rules, so the white suit was worn more and more casually. In the late 1990s, the English exchanged the evening suit waistcoat for a waistline. A black or deep red waistline later became part of a summer dinner jacket.

Shirt

White shirts still predominated, but gradually coloured shirts with white collars were coming into vogue. Conservative men continued to wear a shirt with a rigid stand-up collar for formal wear, which was detachable for easier ironing, just like cuffs.

Cravat

The tie, as we know it today, is rarely tied by men. The men wore cravats that they tied themselves, or already tied ties, which they fastened to their shirts. At the end of the century, these ties were called iron or soldered ties. In certain social classes fashion trends in the way cravats were tied were very much looked at. The use of outdated binding methods was considered a major offense. In addition to cravats, a number of different types of bow ties were also worn; the most commonly a bow tie with hanging ends was attached to the day suit.

Outerwear

The woollen cloak of the ulster remained popular, and like other outerwear: the raglan, the havelock, the paletot, and the fur coats, changed only slightly until the 20th century. The novelty was a covercoat, a light disposable wide to bell-coat with accentuated shoulders, long to the knees, with hidden fastenings and flaps on the pockets. The sleeveless cape was worn not only in the rain, but also in sports. The richer and wider wrap, which was similar to the cape, was used mainly by artists and intellectuals, because being slung over one shoulder it looked good. Men also wore fur coats, mainly made of otter, Persian, sable or mink. The fur of a wolf, a sheep or a raccoon was used to make a car tire, which was intended for driving in an open car.

Hairstyle and beard

Male hairstyles were shaped using a large amount of pomade. Men often divided their hair by a parting in the middle above the forehead or on the side. Some men preferred an inconspicuous haircut with a clean shaved face. Beards were also shaped hand in hand with styling. Men began to realize how much hair and beard alternations could affect their appearance and emphasized their individuality. Beard changes did not always have to be a sign of excessive care for appearances, but also an effort to maintain their anonymity.

Headwear

The previously neglected soft hat was becoming the most common headwear. The top hat and bowler hat still remained part of the wardrobe. A novelty was a homburg, a sturdy hat with a triangularly sunken cap, the edges of which were hemmed with a ribbon. The homburg, made of black or grey felt, was a variant of the bowler hat.

Footwear

Lace-up shoes used in leisure activities or sports were becoming a more common part of a men's wardrobe. The low shoes were extended to the toe, they



Námořnická („matrózová“) blůza,
univerzální dětské oblečení, 1908

Figure 2.21: Navy (mattress) blouse, universal children’s clothing, 1908

had a heel up to 5 cm high, in addition to black, a gray or sand variant was also popular. The luxury ankle boots had patent leather heels. In winter, shoes were worn either higher or lower, to which they were attached with small leggings.

Accessories

The composition of the supplements changed only slightly. Objects that served as an status badge of the estates were being worn by the middle bourgeois strata. Expensive watches were a lavish insignia of prosperity. Some men attached a number of pendants to their watches to underline their wealth. In summer, men, as well as women, protected themselves with parasols and umbrellas, which were much larger than women’s. Parasols and umbrellas were gradually replaced by canes.

Children’s clothing

For girls and boys, mattress clothing 2.21 persisted, which had a limited number of variants. The main feature of this garment was a large navy collar with a decoratively tied large knot, sewn on a blouse or outer jacket. A navy cap with fluttering ribbons, often with an inscription above the forehead, was worn on the head.

2.2 Software

Tools will be split into three section. Tools which are used for 3D modelling, for adding animation into a 3D model and for generating texture.

2. ANALYSIS

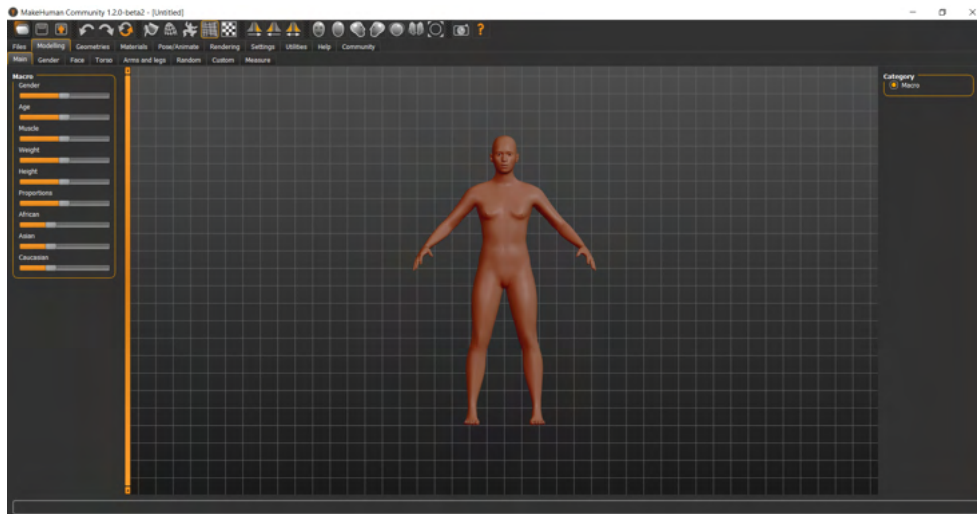


Figure 2.22: GUI of MakeHuman

2.2.1 3D modelling

Website archicgi.com [14] says definition of 3D modelling as: "In 3D computer graphics, 3D modeling (or three-dimensional modeling) is the process of developing a mathematical representation of any three-dimensional surface of an object via specialized software."

MakeHuman

MakeHuman 2.22 is a tool for creating 3D model of person. This tool has a lot of parameters by which we can edit character using our ideas. This tool is very useful for our generation especially by a number of parameters, for instance height, age, weight, nationality and so on. Parameters are necessary for our usage, other tools do not have these parameters. MakeHuman includes a few basic cloths by which we dressed characters. MakeHuman can add not only clothes there but also eyes, a tongue, teeth, hair, eyebrows, eyelashes and many different skin tones. If we want to create something specific, for example a character with the face of my friend, we can import the texture of my friend's face and I can put it on the character.

We can import our own cloth. There are some Blender plug-ins by which we can export and import cloths from Blender to MakeHuman and back. The best way how to transfer a model between MakeHuman and Blender is use file format .mhx2 and use MakemHuman add-ons MakeClothes2 in Blender for transfer between Blender and MakeHuman. File format .mhx2 came out with the latest version 1.2.0. Importing into MakeHuman has some rules on

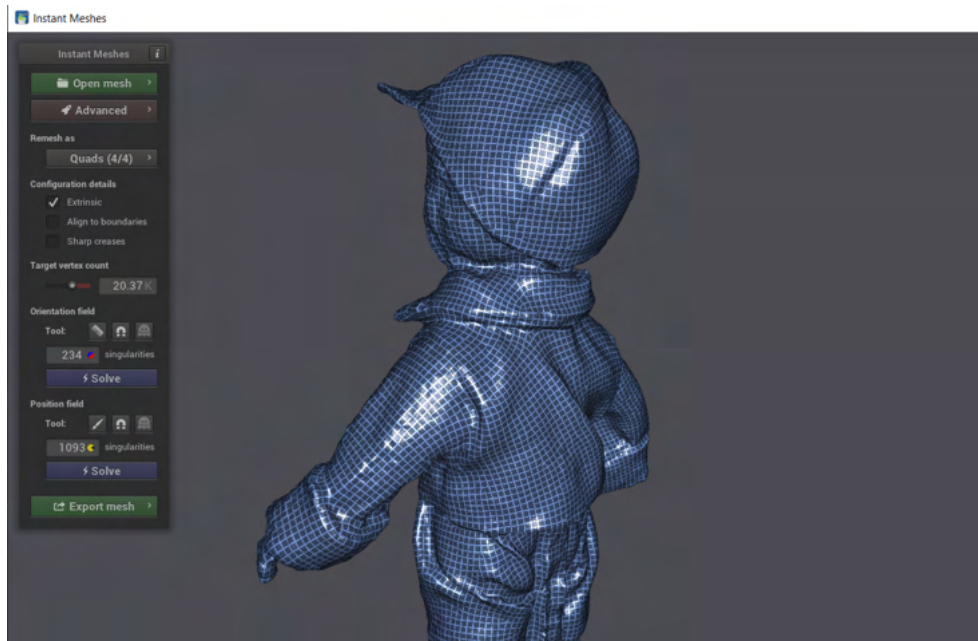


Figure 2.23: GUI of Instant Meshes, example of quad-dominant mesh

which we must pay attention. Plug-in MakeClothes2 checks these rules and it helps with solving problems.

These rules are:

1. no stray vertices
2. faces do not have more than 4 vertices
3. object is a quad or triangle mesh
4. at least one vertex group must exist
5. all vertices belong to a vertex group
6. no vertex belongs to multiple groups
7. no vertex is assigned to a non existing group
8. number of poles ≤ 8

The disadvantage is importing of complex materials. MakeHuman can work just with basic settings of material such as base colour, specular, roughness.

MakeHuman is open-source and available for Windows, Linux and Mac OS.

Instant Meshes

A big number of vertices, edges, faces is created during scanning. A scanned model is huge, and its topology is chaotic. Instant Meshes is a tool which

Meshroom is "user friendly", users need three clicks for reconstruction of a model. Meshroom has three main panels 2.24 Into the left panel we drag our photographs, a result is showed in the right panel and in the panel below there are nodes which are individual parts of the process of the reconstruction. Each nodes has got own settings which is required to look at before reconstruction. In the node Texturing we can change the resolution of textures, in the node Meshing there are limits of inputs and output points. The node Meshing brings settings of minimal observations angle for SfM space estimation. It is very important to know about this variable behaviour because different values give us different results. Higher values focus on one object in a scene. Default value is 10 and software reconstructs almost the whole environment around which it sees. Minimal observation angle around 40 makes reconstruction focused on a one object and environment close to its.

Meshroom creates high quality 3D models however it has big requirements on hardware. Computer has to be equipped with NVIDIA GPU card with a CUDA, minimally 8GB RAM memory (recommended 32GB) [18]. We can download executable or binary file which we must install by hand. Manual installing is complicated because AliceVision has many dependences on libraries. The list of dependences is written on the GitHub of AliceVision. There is a script which installs libraries by tool vcpkg. Unfortunately, some libraries are not available on operation systems such as Linux. Usage of the executable file is the easiest way.

Blender

Blender is a free, open-source and multi-platform 3D creation application [20]. According to Blenders specification [19], Blender supports the entirety of the 3D pipeline—modelling, rigging, animation, simulation, rendering, compositing and motion tracking, video editing and game creation. Blender is becoming a competitor for corporate well known and popular modelling software such as Maya by Autodesk, Houdini by SideFX, Maxon's Cinema 4D or Autodesk 3ds Max. Blender is developed voluntarily by many artists, teachers and enthusiasts. Its development has brought a lot of new features and simulations.

Blender provides range of modelling tools for creating, transforming, sculpting and editing models. User can employ brush spectrum, multi-resolution, dynamic topology, mirroring or masking during sculpting. Blender delivers some simulation such as smoke, fire, fluids, hair, cloth, rigid bodies and particle systems.

Rigging is the process of making a posable model. Envelope, skeleton and automatic skinning, weight painting and mirroring belong to Blender's rig-

2. ANALYSIS



Figure 2.25: GUI of DAZ Studio

ging tools. Animations are made with the aid of Animation Toolset. Simple keyframing or complex cycles are edited in Character animation pose editor, Non-linear animation and Forward/Inverse kinematics.

Blender boasts ultra-realistic rendering engine Cycles that is based on ray-tracing. Cycles renders not only image textures but also environment maps, procedural textures, bump and normal maps. Cycles engine allows to bake cycles shaders and lighting to an image texture.

DAZ Studio

DAZ 3D Studio 2.25 is a tool, which has huge library of 3D models, clothes, hair, accessories and poses. Basic items are free, but there are just a few of them, others are paid. We can edit characters by some parameters, they can be edited fully or in parts. Parameters for the whole model are weight and muscularity. All parts can be edited by fundamental transformation such as rotation, scale and translation.

We can create animation by putting library's animation poses into a model in different periods of time or we can make our own animation. The own animation is created similarly as in Blender (by keyframes - setting up position of parts in individual frames), nevertheless possibilities of movement are limited by a number of adjustable parameters. The final animation looks very beautiful and natural.

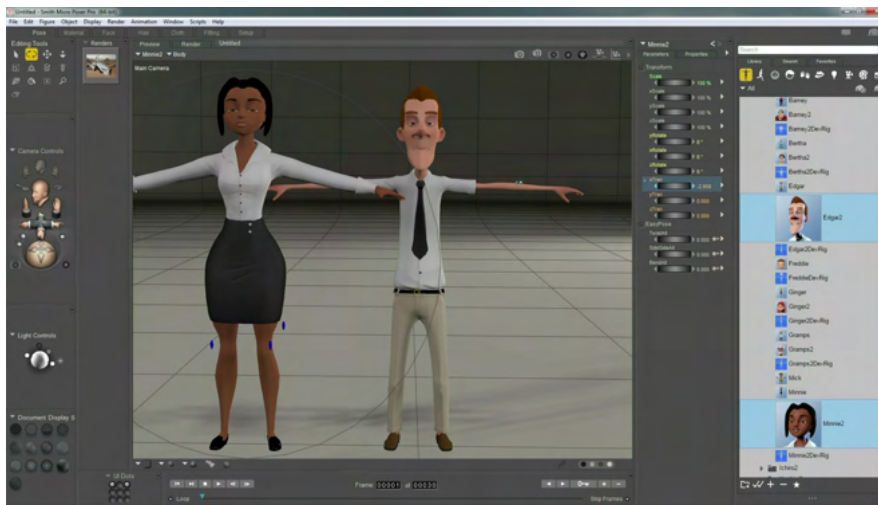


Figure 2.26: GUI of Poser

We can add some 3D models, environment, lights in a scene. Rendering gives us in a short period of time a pretty image. Software enables export model into tools as are Maya, Blender, Cinema 4D, 3ds Max, Unreal Engine or Unity really fast.

Daz Central offers apart from Daz Studio tool Hexagon, which is good for modelling. We can export 3D models from Hexagon directly into Daz Studio. Hexagon is a very simple and intuitive tool but modelling by this tool has limited possibilities. Unfortunately, it is the only way how to import own models into Daz Studio.

Using DAZ Studio is free, available Mac OS and Windows.

2.2.2 Add Animation

Animation includes just posable models which are animated with the aid of keyframes or complex cycles. When the model is not posable, it is necessary to insert a skeleton and make it posable. We will focus on tools which offer creating skeletons and applying animation from library to the skeleton.

Poser

This software 2.26 is designated mostly for creating animation of an uploaded model. It boasts rigorous character movement. Characters must be posable, must include skeleton and skinning. The tool can work with characters' hair, clothing, stage, lights and camera. We can choose a 3D model in the Poser's library or upload our own model. Final animations can be rendered as well.

2. ANALYSIS

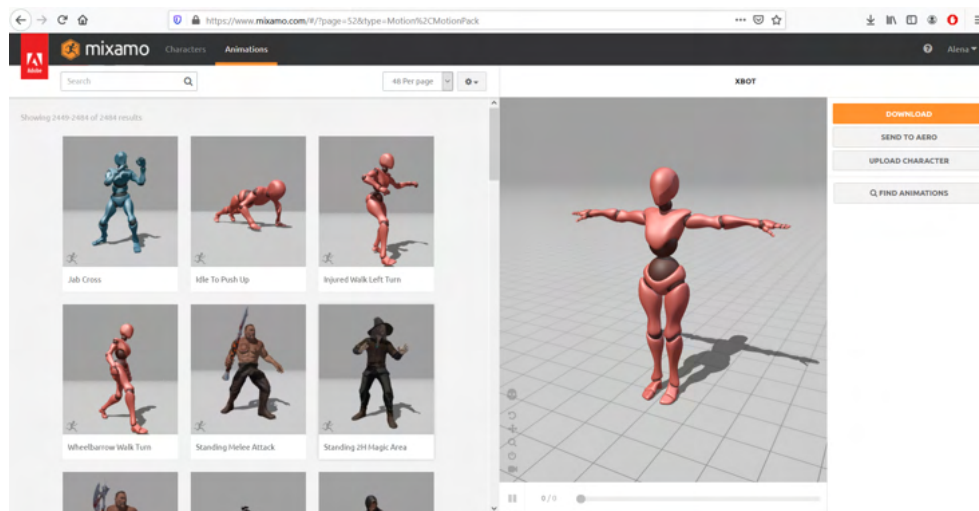


Figure 2.27: GUI of Mixamo

We can try this software in a trial version, which is 21 days long, after this period we must buy the full license.

The price of Poser Pro is \$249.95. Operation system Windows and Mac OS.

Adobe Fuse CC (Mixamo)

Adobe Fuse CC was created by company Adobe, which cancelled developing on 13 August 2020. Adobe developed new innovated tool Adobe Dimension. Besides working in 3D spaces, it works with virtual reality. Adobe Fuse CC was located into web 2.27 in corporation Adobe and Mixamo. Mixamo continues to develop.

This tool includes library of prepared 3D models and an extensive offer of animation, by which we can make our character movable. When we have a 3D model we can upload it to the web application of Mixamo, add automatic rigging skeleton and finally choose animation. The animation can be edited by a few parameters, for example duration and speed of movement. With the tool we can have very nice results in a few minutes, which would take us several hours with other tools. The 3D model can be uploaded in file formats such as FBX, OBJ, zip (OBJ files with mtl file and textures). The result can be downloaded in file format FBX, FBX for Unity or Collada.

Mixamo has some disadvantages. We can only use Mixamo's animation, we cannot create our own and upload it. However, this library includes over two thousands animation. The web application is free since it has the new owner Mixamo.

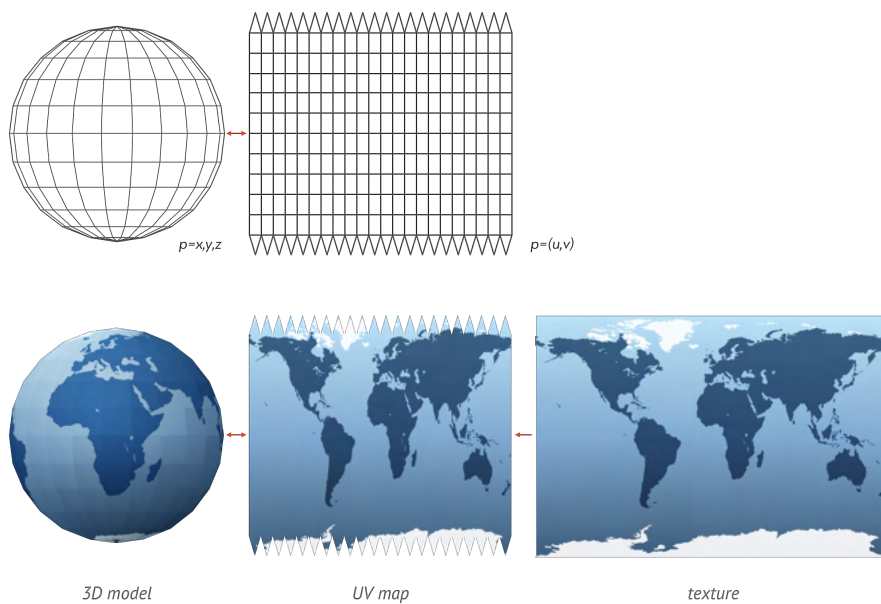


Figure 2.28: Principle of texture mapping, source artec3d.com

2.2.3 Texture mapping

A method that defines high detail, surface material or colour information on a 3D model is called texture mapping 2.28 or UV mapping. Edwin Catmull described a primary idea in 1974. Today it is known under the designation diffuse mapping, which is based on simply mapping pixels from a texture to a 3D surface [27]. Nowadays, it is possible to simulate photorealistic 3D scenes in real time with the aid of known techniques multi-pass rendering, multitexturing, mipmaps, and more complex mappings such as height mapping, bump mapping, normal mapping, displacement mapping, reflection mapping, specular mapping, occlusion mapping and so on.

Bidirectional reflectivity distribution function (BRDF) defines how light is reflected at the specified point on the material. Input variables of the function are an incoming and outgoing light direction. BRDF creates a realistic behaviour of materials. The first definition of this function was written by Fred Nicodemus [25].

Bidirectional texture function (BTF) is a six-dimensional function depending on view and illumination directions as well as on planar texture coordinates (u,v) [24]. Thousands of images covering a view of direction and varying light typically define the function. Because of the huge size of BTF data, it is necessary to use some compression and modelling method for any application [26].

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Figure 2.29: GUI of Materialize

CrazyBump

CrazyBump is a commercial standalone texturing software for exporting normal, displacement or ambient occlusion texture map from photographs or scanned images [21]. CrazyBump falls into the top of texturing software. Is very simple to use and it is also quick. However, its methods are becoming outdated.

Is developed for platforms Windows and Mac OS. CrazyBump Professional version costs \$299, CrazyBump Personal version costs \$99 and for students it is \$49.

NormalMap Generator

NormalMap Generator is a free web application which offers generating textures such as normal, displacement, ambient occlusion and specular texture map. It has no limitation of the image size despite the fact that it is a web application.

Materialize - bounding box software

Another texturing software is called Materialize. It can generate height, metallic, normal, edge, occlusion texture maps. User interface 2.29 looks very simply but in the first steps users can be confused with an unexpected behaviour. It is a very useful tool once you familiarize with it.

Materialize is an open-source application. We can get Materialize for Windows or Matrialize shader pack for Unity or for Unreal.

AwesomeBump

AwesomeBump is a graphic application similar to Materialize. It was made as an alternative to known Gimp plug-in InsameBump or a commercial tool CrazyBump. It is an open-source application which generates normal, height, specular or ambient occlusion, metallic, roughness texture maps from a single image [23].

A number of icons in the application makes the application non intuitive as in Materialize. AwesomeBump is not available for Mac OS, for Windows and for Linux it is.

Insame Bump

As it was said, Insame Bump is Gimp plug-in which can generate normal, ambient occlusion, height and specular maps. Insame Bump also incorporates a real time viewer which includes some material properties, for example four light normal mapped lighting. The generator runs on Windows and on Linux.

2.3 Result

We will model clothes in Blender current version 2.92. Our Faculty of Information Technology gives lessons about modeller tool Blender. Due to the lessons, we decided to use the 3D modeller Blender. MakeHuman is convenient with its possibilities for generating various 3D human models and for following dressing. 3D scanning will be provided by application Meshroom. Meshroom has a simple controlling and brings great models in a high quality. Software Instant Meshes will be used for a retopology of a mesh. Web application Mixamo is the best solution for inserting an animation into a 3D model.

Methods

Designing was divided into methods of digitization of historical clothing on the ground of different input data. In the first method, input data is a historical substantiated drawn sketch or image. The second method demands to have a real model of clothing.

Non-function and function requirements are determined for methods as follows:

- independence of operation system
- size of final result
- good accessibility
- input variability
- learnability
- efficiency
- memorability

Technologies were chosen to meet our requirements.

3.1 Method: 3D modelling

3D modelling is a process of creating a 3D model in a modeller tool. We use a 3D modeller Blender for modelling, MakeHuman for generating a 3D model of character.

3.1.1 Design

It is designed production pipeline 3.2 which shows order of processes of 3D modelling method. Data flow diagram 3.1 shows flowing and transforming data between processes.

3. METHODS

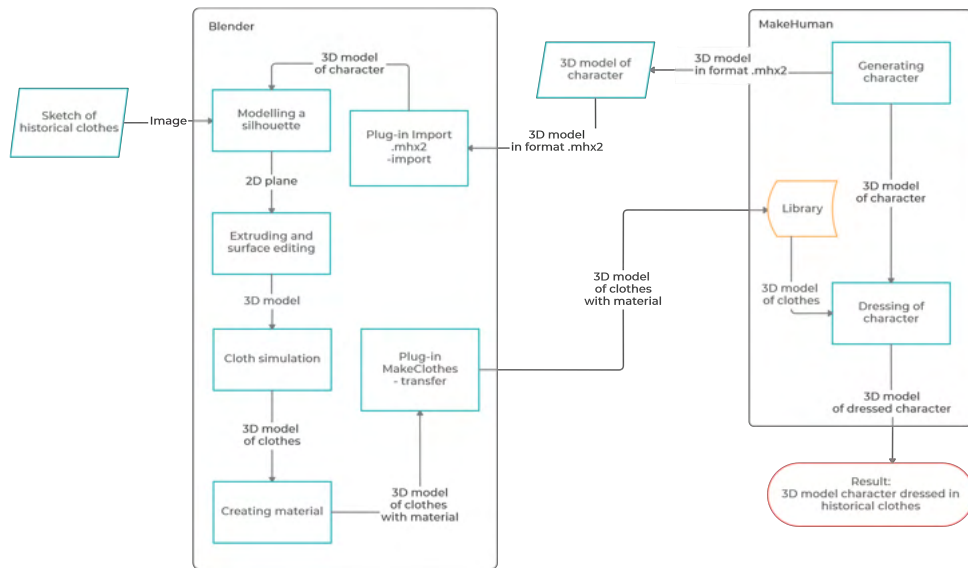


Figure 3.1: Data flow diagram of 3D modelling method

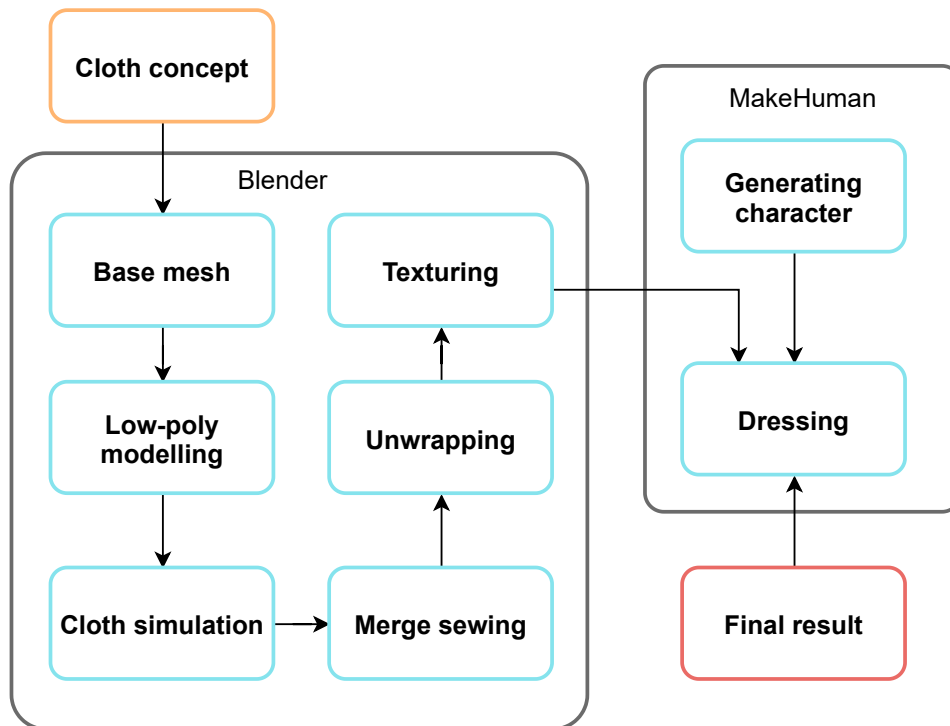


Figure 3.2: Production pipeline of 3D modelling method

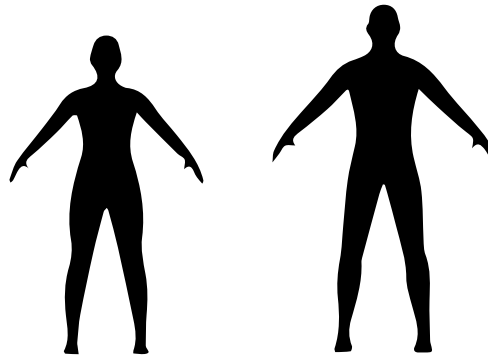


Figure 3.3: Silhouettes of women and men



Ilustrace z knihy Sebastiana Münstera *Cosmographia*, 1564
(rybář s úlovkem v baretu a kabátci s sošy ke koleni)

Figure 3.4: An illustration from the book *Cosmographia* by Sebastian Münster, 1564 (a fisherman dressed in a beret and in a doublet with knee-length coat-tails)

3.1.2 Preparation

First of all, we must realise that every human body has diverse proportions. We want to create clothes which fit to all kinds of human bodies.

As it was said, the input of the modelling method is an image. The image is drawn with aid of a silhouette 3.3 which is in the attachment. Simple silhouettes of woman and man are created via default 3D models of MakeHuman. Usage of the silhouette makes modelling of clothing a bit easier. Combination of using silhouettes and attached models gives us the same proportion of body. The user can easily find positions of the image and the model in which they are covering.



Figure 3.5: A sketch of a fisherman created on the basis of an illustration 3.4

A clothes of a fisherman from 16th century 3.4 is going to be modelled by this method. We searched a picture of an illustrated fisherman and drawn a sketch of its 3.5.

The sketch is imported into Blender by pressing Shift + A → Image → Reference. We locate the image to have "feet" on the origin point by transformation such as rotation, scale, movement (key R, S, M). In the second step, we import .mhx2 file of man or woman model from the attachment. Blender does not import this file format by default so we can download plug-in from official web site of MakeHuman or we can find it in the attachment. It is important to have this kind of file format because MakeHuman has problems with importing different file formats, we can received errors and the model can look deformed. This 3.6 is example of importing OBJ file via plug-in MakeClothes2. The human model is located in the position where the model and the image are in the same axis 3.7.

3.1.3 Modelling

Piece of clothing is created from a basic 2D mesh - plane. Creating a plane is hidden under the same short cut as adding image Shift + A, we find the plane in the section Mesh. We transform the plane into vertical position in front of the human model. The plane is formed into a silhouette of clothes by hand in Edit mode. We can notice advantages of using the silhouette and the imported model. It is recommended to use Mirror modifier because most of the clothes are axial symmetrical. We can use the cut tool or extrude (key E) for creating new vertices. We must be careful on a number of vertices, creating the shape becomes more difficult with a bigger number of vertices.

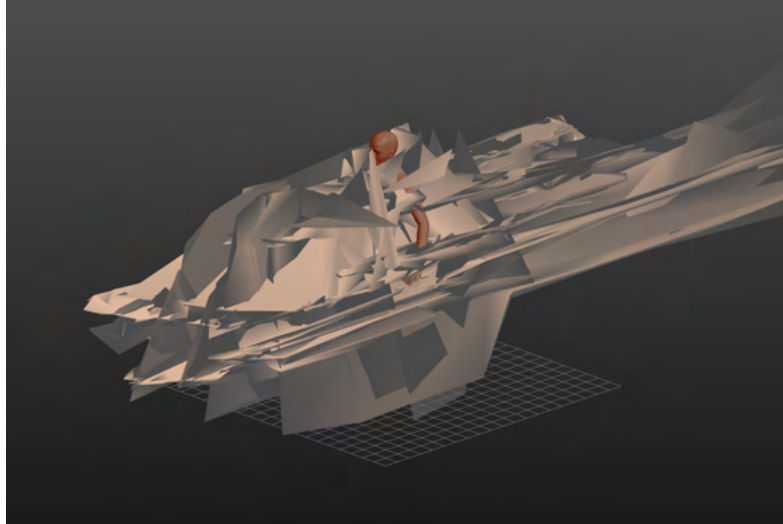


Figure 3.6: A deformation of a model causes importing the model in OBJ file format into MakeHuman via plug-in MakeClothes2



Figure 3.7: A human model and an image located in the same axis

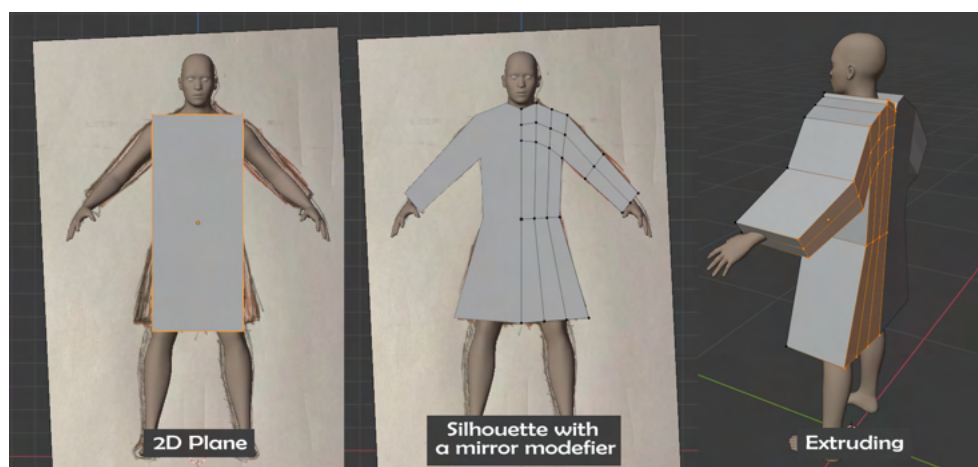


Figure 3.8: The process of creating a fundamental shape of the model from creating the silhouette to extending a dimension, create a 2D plane, model a shape of silhouette by using a mirror modifier, extruding the silhouette into a 3D model

We can see clothing just from one view and it is sufficient for creating a 2D model. For 3D models we need to have the third information about the depth. We must realise how the human body looks like and what proportions it has as we need to know where the clothes need more or less material. The shape must overlapped the sketch. If the shape is finished, we select all vertices (key A) and create the third dimension by function extruding (key E). If we want to extrude by specific axis, we press key ESC and move (key M) vertices along a fixed axis (key X, Y, Z) 3.8.

The human model is hidden by the current 3D model in parts where it is going to be dressed. We create holes and sewing onto the clothing. We change selection mode on the face mode, select all faces where holes are in the clothes and delete faces by pressing key X or Delete with option "Delete Faces". Sewing is usually created from side selected faces. Faces are deleted as in previous steps although we choose the option "Delete only Faces". It causes keeping edges between vertices. Side faces can be cut and sewing can be built up from a line of side faces 3.9 for creating more advanced clothes.

3.1.4 Cloth simulation

In this point, we take advantage of a cloth simulation and physics collision. It is enabled physics collision on the selected human model. We focus on variables Thickness Outer and Inner in the section Softbody & Cloth. Changes affect the distance between clothes and the body. Variables are usually adjusted between 0.001–0.01. Cloth physic is activated on the clothes model.

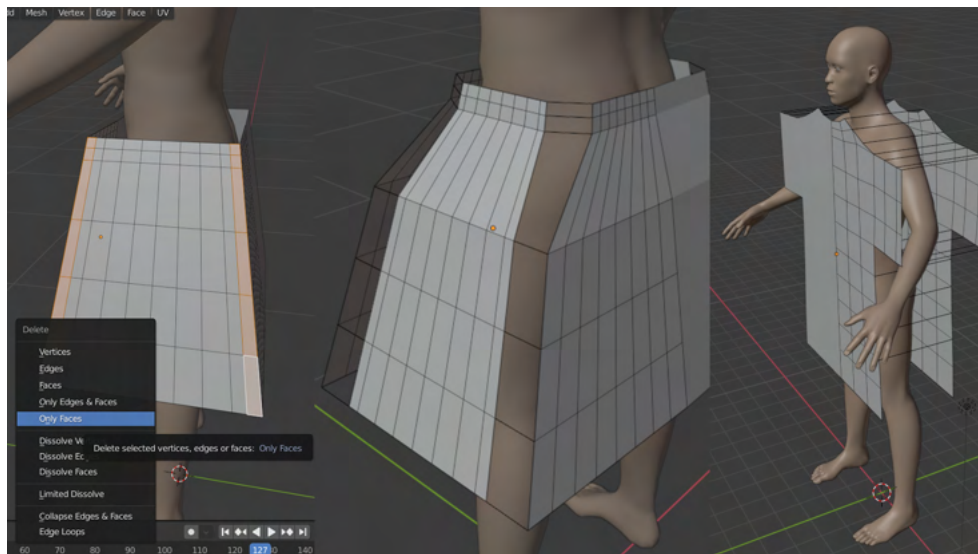


Figure 3.9: Creating a sewing on the clothes by deleting only faces. The middle image shows sewing on the more complex model. The right image shows an usual view of the sewing.

We must set up the correct settings of cloth physic otherwise the cloth simulation does not work properly. We can see the first variable Quality steps which is good to increase. An increase of Quality can be from 1 to 10. In the section Physical Properties, there is changed a property Bending model on the choice Linear. The option sewing is ticked off in the section Shape. Another setup is in the section Collision, specifically variable Distance. The distance sometimes needs to be decreased. Every clothing is diverse and needs different settings. The simulation is launched by pressing the play button the below panel. We can observe the simulation and stop it in the best result of the simulation. We must apply the cloth simulation in the physics properties for keeping current shape of clothes. Applying of physic creates a static 3D model.

We are almost done with modelling. We can notice that the model has got in surface holes which must be filled by merging vertices (key M). We have created a solid model 3.10.

3.1.5 Texturing

The 3D model needs to have a material. The material can be created as a default material with Principle Shader only with colour and configured some parameters such as specular, roughness, metallic. We can add a texture for a more realistic view in the Shader editor. The texture can be combined with a colour as well. We can use some of analysed texturing software to get texture maps. Bump or normal maps make up an illusion of high-poly

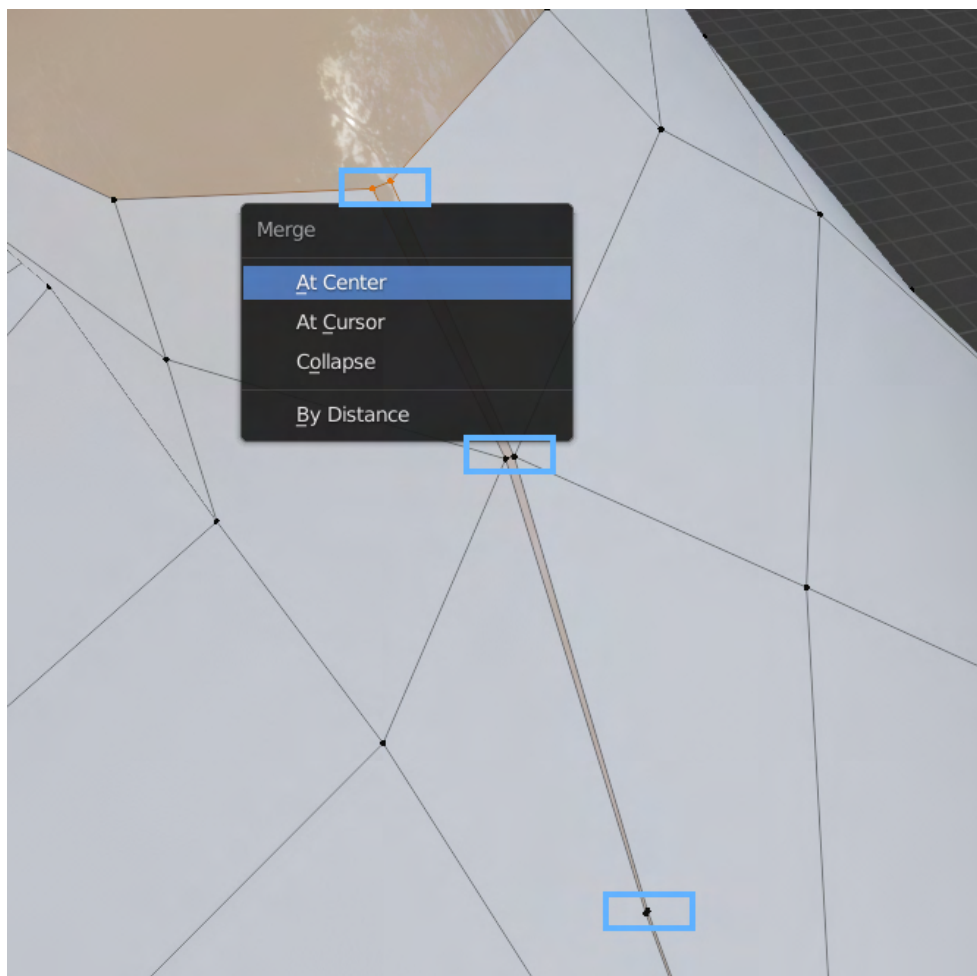


Figure 3.10: Merging vertices to fill holes on the surface

modelled surface by changing normal vectors on the surface. Unfortunately, MakeHuman does not support a complex material with many texture maps. It is possible to export a texture which defines a base colour 3.11. If we do not want to export a cloth to MakeHuman, we can create a more realistic material in Blender and export a final 3D model from Blender.

3.1.6 Make clothes

The model is prepared for transporting to the MakeHuman. We use another MakeHuman plug-in for Blender which allows the transfer of a model from Blender to MakeHuman immediately. It is called MakeClothes2 and we can find it, as the previous MakeHuman plug-in, on the official web site MakeHuman or in the attachment. Before using MakeClothes2, we create a vertex group of the human model and vertex group of the cloth model. The vertex



Figure 3.11: Possibilities of texturing in MakeHuman and Blender. Cloth with a texture as base colour in MakeHuman, The cloth with the combination of a leather material and a texture in Blender. The cloth with leather material in Blender.

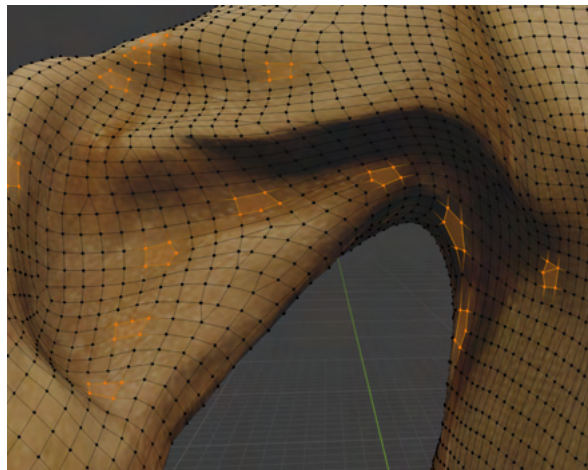


Figure 3.12: Marked vertices by plug-in MakeClothes2 which cause errors. Face has more than 4 vertices and mesh includes combination of quadrangular and triangular face.

3. METHODS

group can include all vertices of a model. Vertex groups must have the same name in both models because they build up a mapping between the model of body and the model of clothes. There can be more than one vertex group however they must be connected by the same name. If we have more vertex groups which are used for another action, MakeClothes2 is confused and returns an error.

We can find a plug-in MakeClothes2 in the right panel of 3D viewport. If we cannot see this panel press key N and it appears. The plug-in needs to know which object is clothes and which object is human. We can mark them with buttons in the panel. Objects must be tested according to conditions of MakeClothes2 which were written in the analysis 2.2.1. The human model does not any problems. We can receive errors by checking the cloth model. The plug-in logs errors and marks vertices 3.12 which can cause errors. Marked vertices can be deleted, merged, remeshed, linked and so on. A solving of errors is not unique. MakeHuman must be launched before importing. The cloth is transferred from Blender to the MakeHuman library by pressing the button "Make clothes". We can find our model in MakeHuman in the section Geometries, the subsection Clothes. On the right, there is a panel with the list of clothes where we can find our model. Clothes are put on the human by double clicking on the item.

We can make a model posable by inserting a default MakeHuman skeleton. MakeHuman offers three types of skeletons which are intended for different usage. MakeHuman also includes a library of many poses and facial expressions. Unfortunately, we cannot create an animation from poses or expressions, we can only apply them as static pose 3.13.

Models can be exported in file format OBJ, FBX, Collada, mhx2, Orge3D and stl file.

The disadvantage of transferring is an impossibility of transferring complex material created in Blender. Both software have their own rendering engine and current file formats do not allow to save much information. A solution can be baking complex material by hand with engine Cycles or use the attachment plug-in Atlas texture combiner which does basically the same thing. We will talk about this plugin in the chapter Automation.

MakeHuman is not a flawless application. Some holes can appear in a low polygon model by simple MakeHuman transformations. These imperfections can be repaired in Blender by tool sculpting or in edit mode.



Figure 3.13: One of the poses from the MakeHuman library

3.1.7 Specific body

Clothes can be made in a different way for a specific human body. The body is created in MakeHuman and imported into Blender where a piece of clothing is modelled on the final human body and it is exported directly from Blender. We avoid a transfer between Blender and MakeHuman. Units of the human model must be changed to meters before exporting the model from MakeHuman. It keeps real proportions of the model. Modelling is performed by the same process as in the general human model. This process was described in the previous sections. A material of clothes can be more advanced without the transferring.

We can get better results in a shorter time. Cloth simulation is simulated exactly on the final human model and there are not applied any other transformations. A material can include texture maps such as specular map, normal map and so on. Export file formats are limited by a number of texture maps however it is possible to add some.

3.2 Method: 3D scanning

3D scanning is the easiest way how to create a 3D model according to an original item. We use for 3D scanning application Meshroom which is based on AliceVision, Photogrammetric Computer Vision Framework. Photogrammetry is a 3D reconstruction of a model from a large amount of photography. Models are remeshed in Instant Meshes and as in the previous method, MakeHuman helps with generating of characters and dressing.

3. METHODS

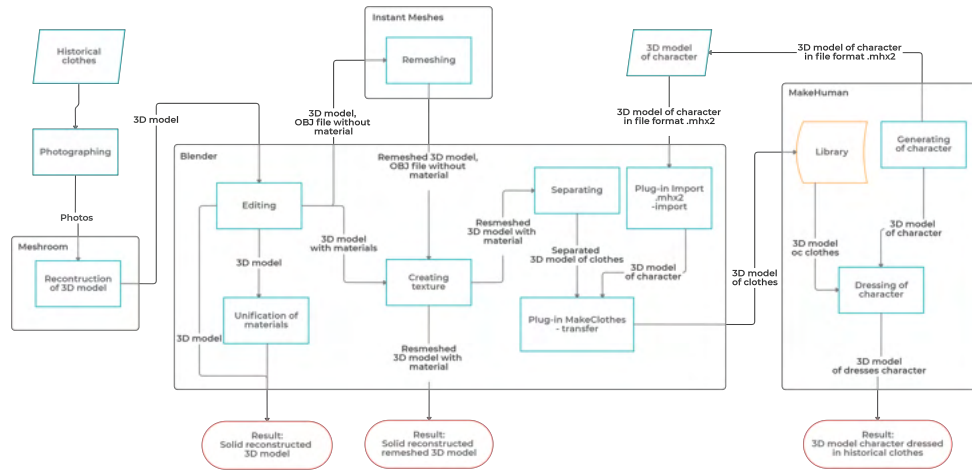


Figure 3.14: Data flow diagram of 3D scanning method

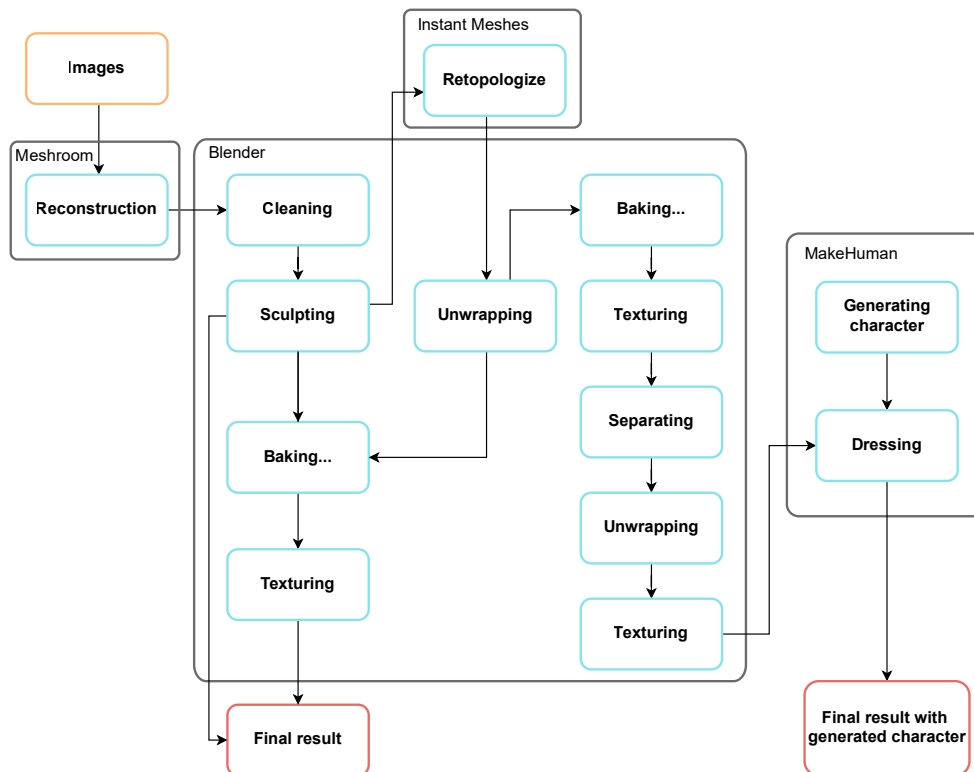


Figure 3.15: Production pipeline of 3D scanning method

3.2.1 Design

The result of designing this method is the production pipeline diagram 3.15. It introduces processes of the method and their passing. The method processes different data as the 3D modelling method. We can look at data flow diagram 3.14 to find out which data the method works with in each process.

3.2.2 Preparation

We can take photos by a mobile phone or a camera. All photos must have the same focusing, illumination and other camera settings. Professional cameras offer a manual mode, which allows us to set the same configuration, although a typical mobile phone does not. There are some applications which enable the manual mode of a phone camera.

Taking photos requires a good light conditions which are usually outdoor with natural light under cloudy skies. Light conditions can be influential in quality of results. It is estimated that a good result can be reconstructed from more than one hundred photos. Photographs try to capture the item from as many angles as possible at approximately the same distance.

3.2.3 Reconstruction

Meshroom is available on its official web site. The analysis gave us information about the required hardware and the recommendation of installing 2.2.1. We can insert photographs into Meshroom by dragging them to the left panel. Saving a project says where Meshroom saves all its data, including folder MeshroomCache. Analysis also brought a piece of information about settings of the reconstruction process. The process is represented by a node tree. Each node constitutes one step of the process and it has its own settings. Common users usually adjust the resolution of final textures and the minimal observation angles.

The reconstruction starts by pressing the green button "Start". It can take a few hours. We can check the progress bar or nodes which must be green, and also log information. Meshroom does not give you any notification of errors. If we have any errors and we change settings in the active node, we do not need to restart the whole process. Meshroom starts with computing in the active or changed node. Every node has its own folder in the folder MeshroomCache. The result is saved in the last node's folder which is mostly Texturing.

3.2.4 Editing

The reconstructed model is saved as an OBJ file, an mtl file and several textures. The whole model is imported into Blender by importing only the OBJ



Figure 3.16: Deformed surface made by 3D scanning

file. This file incorporates links to material files which contains texture's paths.

The scanned model includes a lot of messy points. We can easily delete redundant vertices by selecting tool - Circle selecting (key C) and then deleting them. It is recommended to relocate the origin point on the ground or in the centre of the object. If an item has too many details, scanning can ignore them and create a misshapen surface. We can always notice a rough surface on a scanned model 3.16. These defects can be eliminated by sculpting tool. This tool is very intuitive, and it is convenient for beginners. We must be careful how much the surface is changed, because we must keep in mind that model has a texture mapping, and every big modification can be noticeable.

3.2.5 Retopologize

Smooth model can be the final output for some users. Users who mind the size of the files and a mesh topology must continue with editing. Remeshing of surface can reduce a number of vertices and clean a mesh topology 3.17. Instant Meshes were introduced in analysis. Instant Meshes work only with surface and not with materials and textures. It imports just an OBJ file.

Instant Meshes allows us to choose a type of topology and a number of vertices. It shows approximately where the vertices and the edges will be created. We can change a topology of final mesh by painting lines with a brush. We can subdivide a result before exporting. From my personal experience, I recommend using value of subdividing one or two, not more.

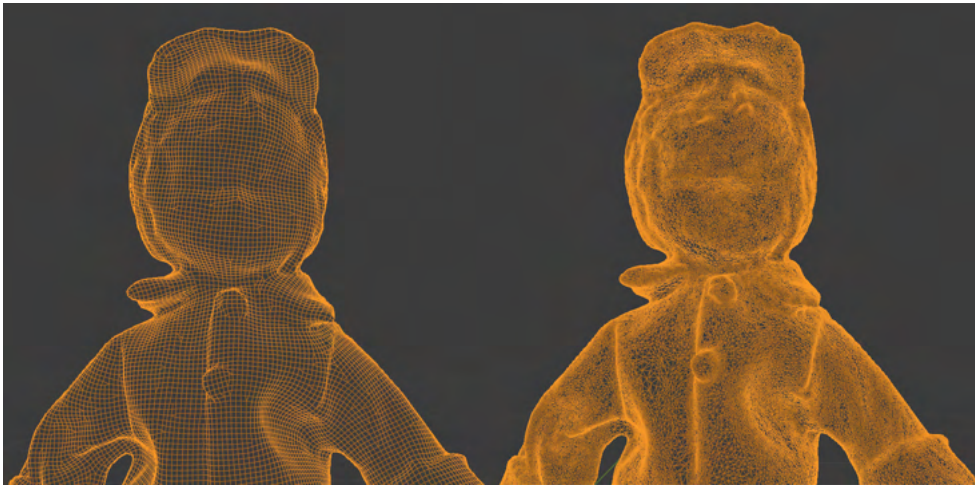


Figure 3.17: Retopologize a mesh by Instant Meshes. On the left there is a new mesh, on the right there is a scanned mesh

3.2.6 Baking texture

The model has a new mesh with a dominant quadrangular or a triangular topology and has changed a quantity of vertices. However, this model is without any materials and textures. Materials and textures are created by baking process of original model. First of all, the retopologized model must be unwrapped in Edit mode. Objects are usually unwrapped by function Smart UV Project, it can create a UV mapping of an object with more complex surface. The limited angle of unwrapping can be decreased with a more detailed object or if some points overlap in the mapping. The new UV mapping is shown in the UV editor where we create a new texture.

The baking process has its exact steps: Select a new object and create alone standing Image Texture node in Shader editor. Choose the new texture in created node. Activate the node by selecting, activating is marked by a white border around the node. Select the original model and with aid of pressing key Shift select the new object (keep order). Go to Render properties in the right panel and change the type of engine on Cycles. Find the section Bake in the list below. Choose bake type. Mark check box Selected to Active. Press the Bake button.

Default value of Bake type is Combined, this type brings good results however a model must be well illuminated. Diffuse type can calculate three information. Options Direct and Indirect add contribution of light. Option Color is not dependent on the light and object does not need to be illuminated. Diffuse type with choice Color gives us just colour information. Every setup brings a little different result 3.18.

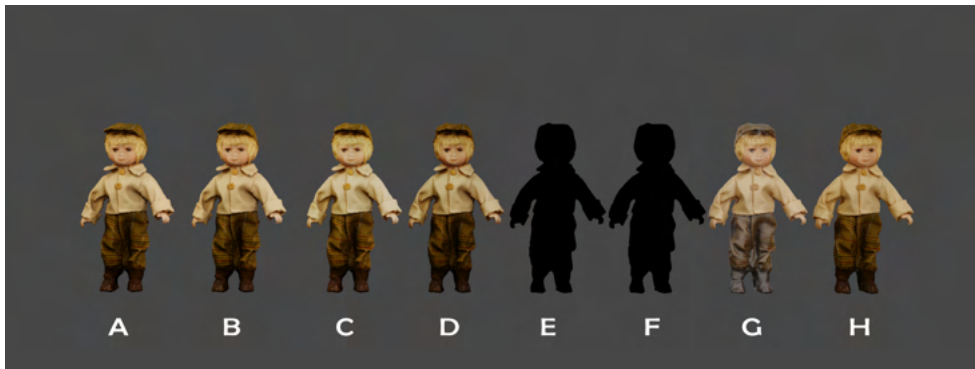


Figure 3.18: The result of baking texture with different setting. A: combine texture, an illuminated model, B: Diffuse texture with option direct, indirect light and colour, an illuminated model, C: Diffuse texture with options direct, indirect light and colour, an overexposed model, D: Diffuse texture, option colour, changed material setting, E: Combine texture, an unlit model, F: Diffuse texture with option direct, indirect light and colour, an unlit model, G: Diffuse texture, option colour, H: Original multi-texture.

The baking process can take some time, it depends on the number of textures, vertices and if the process calculates the light rays. Colour information is baked on the created texture from the original model. We can apply texture by linking Texture node with Base Color of a shader.

3.2.7 Separating

The model can include not only one cloth. We can separate cloth by deleting needless faces, for example faces of hands. We can use the Loop cut tool for creating thin faces along borders of clothes and delete them for spacing each cloth. Selecting is easier with the new topology, because most of the time faces are along the edges of clothing and we can select the whole line of faces by selecting a face and its neighbour face by pressing key Alt. Deleting faces makes the model clear and well arrange. Separating can be done by selecting one piece of clothing and by using the function Separate which is hidden under key P. It provides a menu of options of separating 3.19. The option Separate by selection creates from selected vertices/edges/faces a new object. The selection can be duplicated by a short cut Shift + D and we can separate the duplication, and keep the original model. We have made new objects whose texture has colour information not only this cloth but also the other clothes. For retaining a quality, we create a new UV map and rebuild the texture by the baking process again. It must be changed an origin point for some objects otherwise the final object can have wrong movement during an animation.

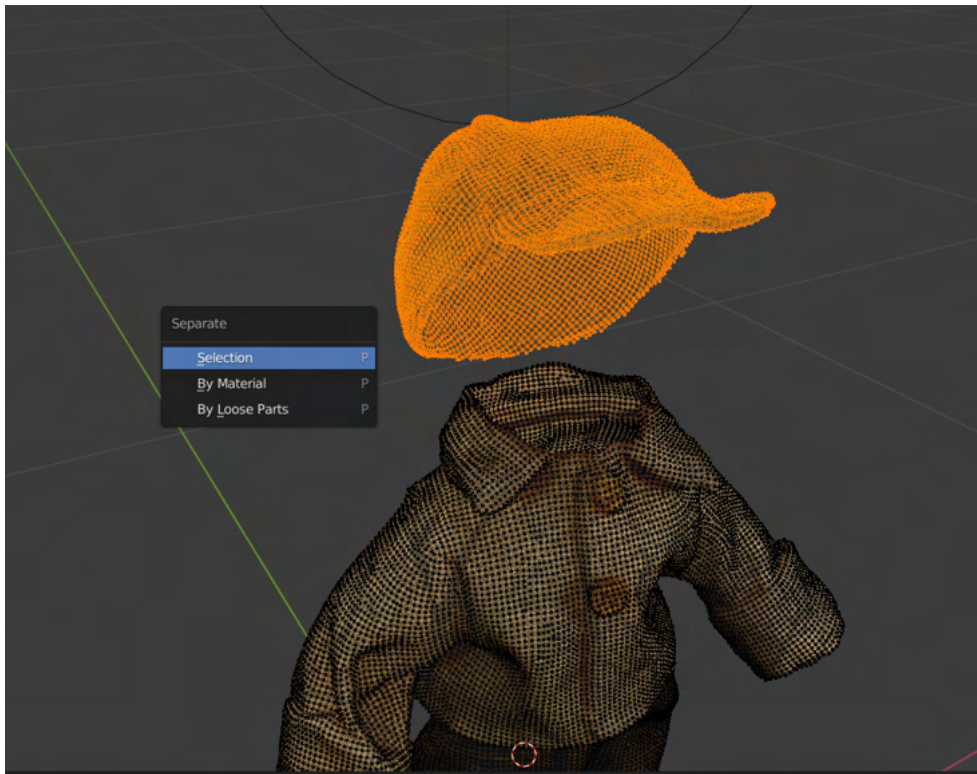


Figure 3.19: Creating a new object by separating.

Separated clothes must be fitted on the default human model generated by tool MakeHuman. Clothes can be scanned on a human body which has different proportions as the default model. We can transform separated clothes by rotation, scaling, sculpting and so on until it will fit on the default human model. Each cloth is transferred into MakeHuman library by plug-in MakeClothes2. This process had already been described in the previous method in subsection Make Clothes 3.1.6.

In a different way, we can generate the specific human body in MakeHuman and import models into Blender instead of the default one. Clothes are placed on the imported model and afterwards all objects can be exported from Blender. This way avoids other importing and exporting between MakeHuman and Blender, and modifications caused MakeHuman transformations.

3.2.8 Animation

This subsection describes a process which can be applied on final models created by both methods. Final dressed characters can be animated. Creating animations is provided by the web application Mixamo which complies with our requirements. Supported file formats of models are FBX, OBJ and zip.

3. METHODS

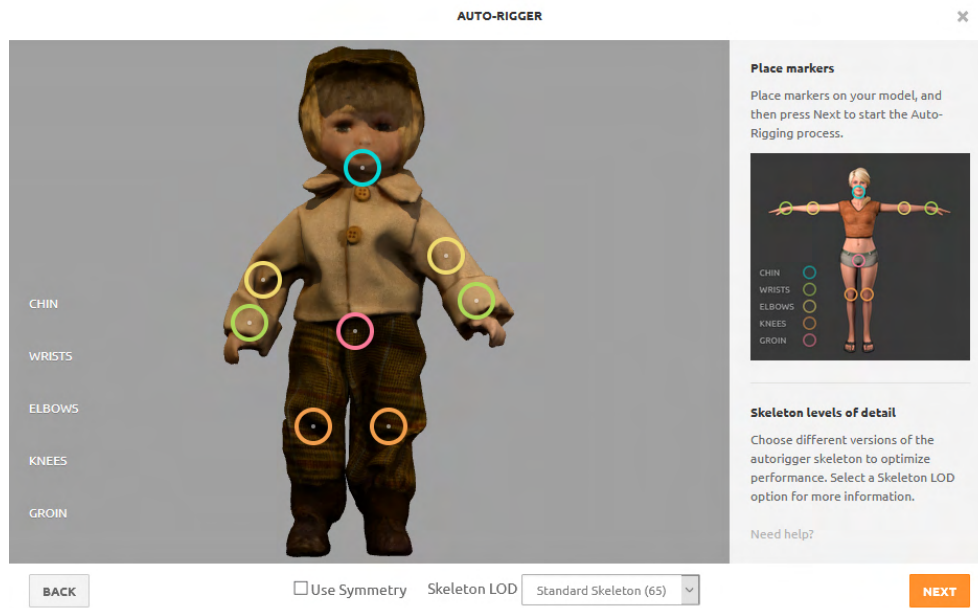


Figure 3.20: Rigging tool provided by the web application Mixamo.

Zipped files can include OBJ files or FBX files with textures and mtl files. Mixamo incorporates rigging tool 3.20 for creating a skeleton. Tool Make-Human allows us to insert default skeleton but unfortunately Mixamo cannot read this type of skeleton. Mixamo includes a huge library of animation which has some properties, for example duration of animation. The final animation is exported in the file formats FBX, FBX for Unity or Collada.

The animated piece of clothing can look ripped in some default viewers, however it is not ripped. We can see blinking and torn clothes in the first round of playing, but the clothes fit perfect in the next rounds. It is caused by a low-quality of viewer applications.

Automation

The previous parts of the methods can be facilitated by an automation. The automation is in the form of Python plug-ins for Blender version 2.92. Plug-ins are installed in the usual way via Blenders preferences.

First of all, we introduce a plug-in Node Arrange. Node Arrange arranges a node tree of a material. It is already a part of Blender however, the function does not work with calling from command line for version 2.92. The function has been edited and a new version Node Arrange 2 has the same functions even it works for scripting. We can find the function in Shader editor in the left panel, or we can call the function from a script or from a command line. Parameters of the function must have their names 4.1.

4.1 Postprocess of Sewing

The 3D modelling method makes use of modelling and cloth simulation with sewing for creating clothes. It was mentioned filling holes by merging vertices along seams to become coherent surface. Merging vertices can take a long time by hand. The plug-in Postprocess of Sewing was designed for merging these vertices even though it creates UV seams along margins which helps with UV unwrapping of a model. If a model does not have applied modifiers Cloth simulation and Mirror, plug-in applies them before the merging. Plug-in subdivides the model with two loops and with a smooth effect to get a better result.

Listing 4.1: Calling function Arrange Nodetree 2 from command line or from script

```
bpy.ops.node.arrange_nodetree2(mat_name="", margin_x
    =120, margin_y=120)
```

4. AUTOMATION

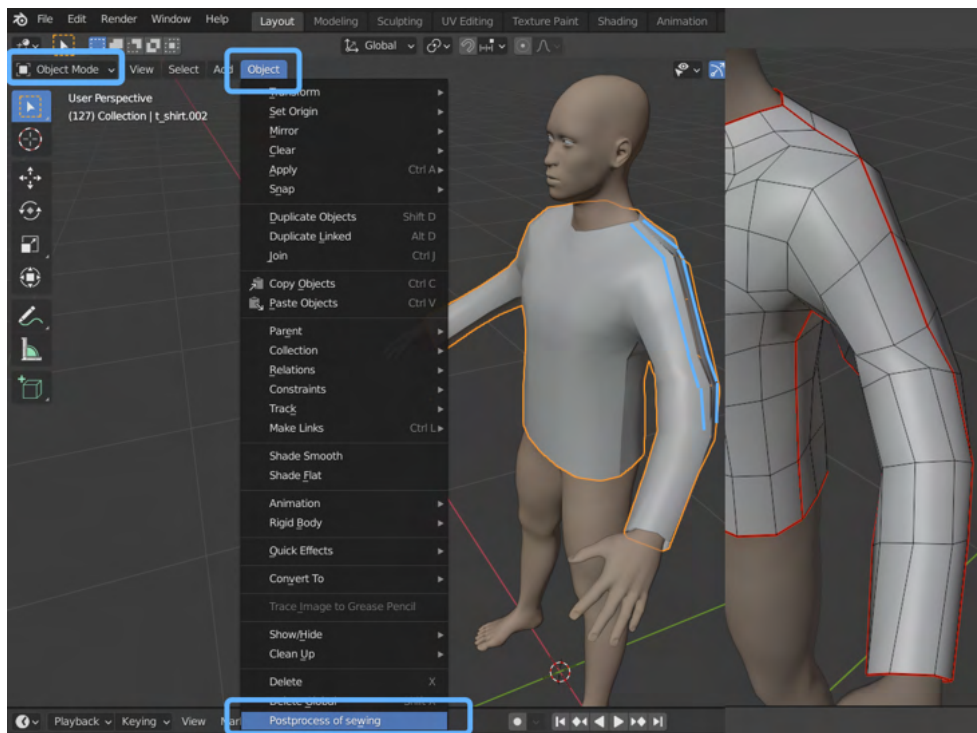


Figure 4.1: Plug-in Postprocess of sewing in the section Object. A model before merging vertices in the left part, the result of the postprocess in the right part.

We can find this function after installing in the main menu in the tab Object 4.1. We start with the Cloth simulation and stop it in the best view of clothes. At this moment, we call the function Postprocess of Sewing and it edits the model to be continuous.

The function selects all edges which are not a part of faces. These edges were created as "springs" for cloth sewing. The edges are merged one by one and we must have a new selection with each merging. We cannot merge all edges at the same time. The merging changes indexes of vertices/edges/faces in the model. If we want to merge all selected edges in one step, we will receive an error regarding permission to allow memory because the memory may be changed by the merging.

4.2 Fabric Materials

Fabric Materials is plug-in for creating materials simulating fabrics. It offers a few fabric materials such as leather, lace, cotton etc. Plug-in creates mate-

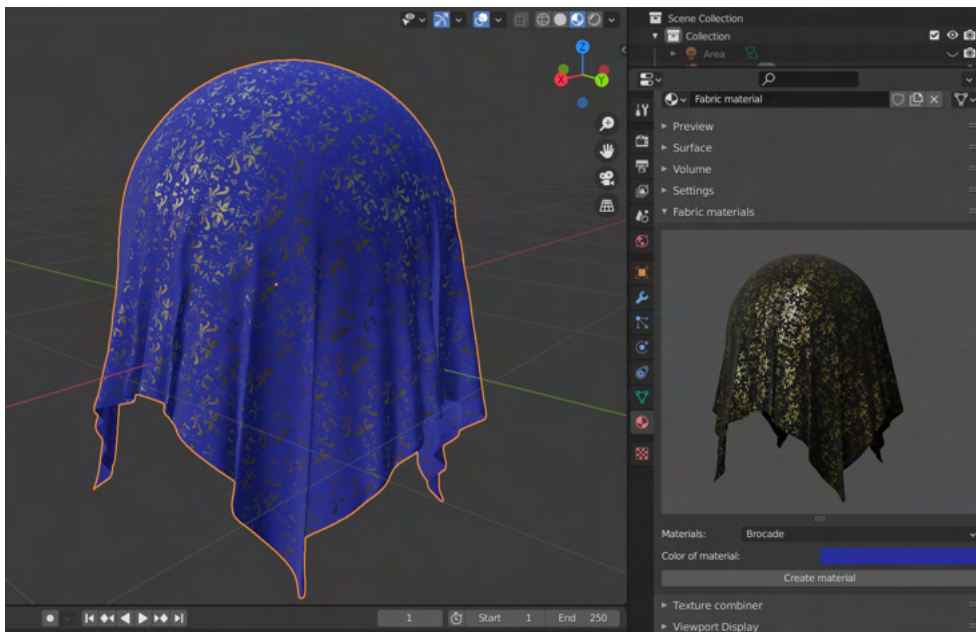


Figure 4.2: Plug-in Fabric Materials in the material properties with an example of the final result

materials for a selected object. If the object has already included some materials, plug-in modifies the active material and creates a structure of nodes which is specified for chosen type of fabric. Plug-in creates a new material for the object which does not have any material. Materials are based on textures and texture maps, which are embodied in plug-ins data.

We can find the function in the right panel in the material properties. The function has a preview of a material, list of materials, a colour palette and a button for calling the function 4.2. The colour of material is changed without creating a new material. It is recommended to call the function for creating material on a UV unwrapped object. Plug-in uses textures and if the object is complex, the created texture will look unrealistic and deformed on the object.

In additional usage, we can use this plug-in for creating a structure of nodes and insert our own textures or texture maps in Shader editor.

4.3 Textures Combiner

Scanned models have materials in a form of multiple textures. It gives a high-quality textured model although the model can include tens of textures. Textures usually have a high resolution and a big size, so models have a huge

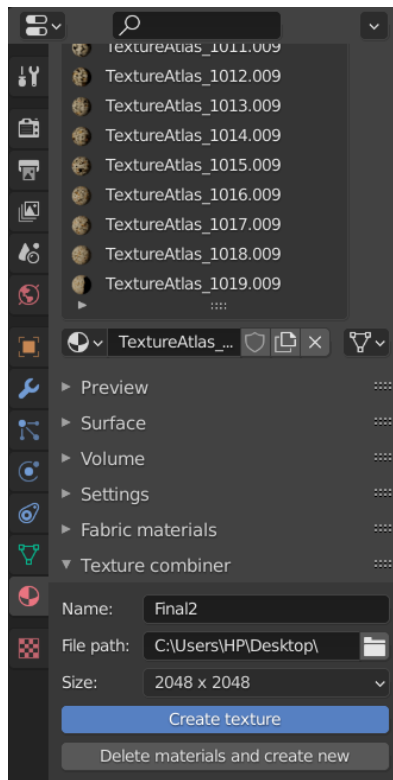


Figure 4.3: UI of Texture combiner with its setting in material properties.

size memory. Sometimes, the high-quality costs more than it is necessary or we do not make use of that resolution. We can decrease memory size of the model by baking materials into one texture.

Textures Combiner combines textures and creates a new one with the aid of baking with bake type Combined. The new texture is mapped with a new UV map. This sort of baking is dependent on light and a model with multiple material must be well illuminated.

The function allows us to choose a name, a resolution of the final texture and a location for saving it 4.3. Combiner has got two buttons "Create texture" and "Delete materials and create new". Creating texture can take some time and in the end, we cannot see any changes. It changes almost nothing on the object. We can look at the created texture in the UV editor. Pressing the second button calls the function which erases all object's materials and creates a new one with the combined texture. The function does not delete original textures.

User testing

User testing was realised in collaboration with software team of SP1 Virtual Museum.

5.1 Personae

There were created two personae for user testing. The first user is a historian, the second is a 3D modeller.

Historian

The historian can use a computer and uses the office package almost every day. He is 35–55 years old. He has heard about Blender however he has never used it. He is open to new technologies and he can find some tutorials on the Internet. He has an intermediate level of English.

3D Modeller

The user ranges from the age 20 to 30. He has grasped Blender UI without hindrance. He knows how to model and how to create a material, a texture, an animation and so on. He is able to create an animation using physics simulation. He knows about the possibility to write a script but he has never written any. He can find a solution of problems with Blender via YouTube or in the documentation of Blender.

5.2 User Tests

There are created scenarios in the form of instructions for each plug-in. A tester is guided by a moderator in every testing and fills two tables 5.35.1 during or after the testing. The Tester receives instructions for the test and

a file with needed plug-ins, Blender file demo.blend with a few 3D models, an instruction manual in the form README.txt, and a video tutorial.

Fabric Materials

The Tester got this instruction for the test Fabric material:

1. Install plug-in Fabric Materials according to a manual file README.txt and read its specification.
2. Work with plug-in Fabric Materials in next steps.
3. Create fabric material "Velvet" with pink colour and add it onto a cylinder.
4. Create a lace material and use it for a cube.
5. Use created material "Velvet" in the previous step and add it onto a model of blanket.

Goals of the test:

- successfully installed plug-in Fabric Materials
- the cylinder has got a fabric "Velvet" material
- the cube has got various lace material
- the model of blanket has added the created fabric "Velvet" material.

The test recommends to have an enlarged preview of a fabric to a faster selection. The User could have options to change an original material or add a new one. It could be useful to make a combination of materials more quickly. The colour of a fabric could be changed in the preview with the selection of the material colour, and the preview could be also changed with a different selected object in a scene.

Postprocess of Sewing

The Tester got this instruction for the test Fabric material:

1. Install plug-in Postprocess of Sewing according to a manual file README.txt and read its specification.
2. Work with plug-in Postprocess of Sewing in next steps.
3. Create a new object Plane which is foundations for a 3D model of a dress.
4. Model a silhouette of the dress with aid of the attached video tutorial to cover pelvis and torso of a 3D model human body. The silhouette must overlap a margin the human body to creating more material for sides of the human body.
5. Add the third dimension of the dress by function extrude and create a block which covers all parts.

6. Delete faces where dress has holes and use function "Delete only faces" for side faces for seams.
7. Add cloth simulation with settings seen in the video tutorial and play the simulation.
8. Call function "Postprocess of Sewing" on the selected dress.
9. If needed smooth the dress by bush "smoothing" in the Sculpt mode.

Goals of the test:

- successfully installed plug-in Postprocess of Sewing
- the 3D model of human body is dressed in the sewed dress with smoothed seams.

Plug-in gave different results which were caused by diverse settings. The instruction manual should explain each parameters of cloth simulation deeply.

Texture Combiner

The Tester got this instruction for the test Fabric material:

1. Install plug-in Node Arrange 2 according to the manual file README.txt and read its specification.
2. Install plug-in Texture Combiner according to the manual file README.txt and read its specification.
3. Work with plug-in Texture Combiner in next steps.
4. Illuminate the object with multiple material not to be dark.
5. Join all materials into one material of a 3D model of a character.
6. Join all materials into one material of a 3D model of an isolated cube.
7. Join all materials into one material of a 3D model of connected cubes.

Goals of the test:

- successfully installed plug-ins Texture Combiner and Node Arrange 2
- well illuminated scene
- the 3D model of a character has only one material which is the combination of original materials
- the 3D model of an isolated cube has only one material which is the combination of original materials
- the 3D model of connected cubes has only one material which is the combination of original materials.

The Texture Combiner is a bit confusing for users with a long process without no message. Tester may not recognize which map is a new one.

Table 5.1: Usage of plug-ins, historian

	Without problems	Had problems, however was able to finish	Was not able to finish
Installing		X	
Find function in Blender		X	
Usage		X	
	Really good	Not so bad	Unusable
Result		X	
Will make use		X	

Table 5.2: Control of plug-ins in each step and , Blender user

	Without problems	Had problems, however was able to finish	Was not able to finish
Installing	X		
Find function in Blender	X		
Usage	X		
	Really good	Not so bad	Unusable
Result	X		
Will make use	X		

5.3 Result

We have got the same result of all tables for each plug-in. The tables of understanding 5.3 instructions point out better understanding with the video tutorial. Video tutorials make plugins more understandable for inexperienced users.

Blender user was able to finish all steps 5.2 and got a final product however Historian had big problems with instructions, but with the help of the moderator he was able to finish all steps 5.1. Historian could not have been confused with a more detailed video tutorial which explained fundamental controls. Moderators mentioned if the user can model a basic 3D object, he is able to use tested plug-ins for sure. Our target group can be Blender users and archivists. Archivists know a lot about history and they are also familiar with controlling 3D models on Blender.

Table 5.3: Understanding of an attached instruction manuals

Understanding how to use plug-in	Blender user	Historian
Without tutorial, reading plug-in description in Blender before activating	UC	DN
After reading file README	UC	DN
After watching video tutorial	UC	DC
After reading file README and watching video tutorial	UC	DC
After reading description and README	UC	DN
After reading description, README and watching video tutorial	UC	DC

- UC - Understands and can use the plug-in.
- UN - Understands and cannot use the plug-in.
- DC - Does not understand but is able to use the plug-in.
- DN - Does not understand and is not able to use the plug-in.

By user tests, some errors were found out but most of them have been solved by rewriting manuals which were difficult to understand in some steps. Manuals have been rewritten based on a recommendation.

Conclusion

The thesis dealt with methods of digitization of historical clothing. We analysed fashion during the Renaissance, the Baroque, the Rococo and the Art Nouveau era. We were showing possible tools for creating and editing 3D models from which we have chosen the best ones for our usage.

There were designed and described two methods of digitization. 3D modelling method processes a sketch of clothes and delineates how to create a 3D model of generated character dressed in historical clothes. This method takes advantage of the 3D modeller tool Blender and 3D character creator Make-Human.

The Method 3D scanning employed a principle of photogrammetry which reconstructs a 3D model from photographs of real items. There was written a description of editing a scanned model which depicted smoothing of model, separating of each item and dressing on a generated character. The thesis also contains a procedure how to make dressed characters posable and how to add an animation easily.

We introduced three automations which help with the digitizing. It was edited in a Blender plug-in which arranges a node tree of a model material. This plug-in was used in implemented plug-ins. The first presented plug-in was Postprocess of Sewing. This plug-in helps with repairing a model after applying cloth simulation. We were talking about a plug-in Fabric material which creates materials simulating fabrics. The last mentioned plug-in was the Texture Combiner. The Texture Combiner joins multiple textures into a new one and it creates a material with the combined texture instead of tens of materials and textures.

Plug-ins were subject to user tests which showed requirements for users who must be experienced in using the 3D modeller tool Blender. User tests point

CONCLUSION

out a benefit of instruction manuals, especially video tutorials. Testers received a few errors which were caused by a misunderstanding of instructions or limit value of plug-ins. Limit values are not expected from experienced users.

The methods allow us to digitize historical clothing and to put them on the characters which can be a part of any application. We can find results of each method in the attachment. There are animated 3D models which represent a different usage of methods. It can draw a sketch of any clothes from analysed historical periods on the basis of the analysis and the created glossary. In future, the 3D modelling method could be automated by artificial intelligence which can study a relationship between proportion of the human body and various sorts of clothes. It could create a 3D model of clothes on the foundation of gained information and sketches of clothes.

Acronyms

GUI Graphical user interface

GPU Graphics processing unit

RAM Random-access memory

Glossary

Agraph agrafa - spona sloužící k sepnutí jednotlivých částí oděvu.

Ampaletky české pojmenování secesních netvarovaných bot.

Apron zástěra.

Babit základní mužský oblek rokoka, který se skládal z kalhot, vesty a pánského dlouhého kabátu ke kolenům.

Backcomb tupírovat - načesat vlasy do objemu.

Backstitch štepování - ozdoba nebo zpevnění látky či kůže štepem (stehem).

Baldric závěsník - druh šerpy zdobené lemy, v pase uvázané do uzlu, do kterého se vkládal kord.

Bell-coat zvonový tvar.

Beret baret - univerzální pokrývka hlavy v období renesance, mezistupeň mezi kloboukem a čepicí.

Black taffeta černý taft - lesklá tuhá tkanina používaná na dámské šaty.

Boa dlouhá kožešina kolem krku.

Bodice živůtek - krátký spodní oděv obepínající trup.

Bonnet ženský čepec, často měl vázání pod bradou.

Bourrelet biret spojený se sítkou, která spoutává vlasy.

Bow tie motýlek k obleku.

Bowler buřinka.

Breeches tříčtvrteční kalhoty běžné v 17. století.

Buckle přezka.

Bustle turnýra, honzík - dámská spodnička menší než krinolína, objemná pouze vzadu.

Calotte těsná čepička, která držela na hlavě nakloněný bíret.

Cane doplňková hůl.

Chamara čamara - delší černý kabát se stojatým límcem zapínaný vpředu řadou knoflíků a šnůrek.

Charmeuse viskózové hedvábí.

Cloak dlouhý plášť.

Coat-tails šosy.

Collar límec.

Cornette čepec, který pokrýval pouze temeno hlavy a jeho dlouhé stuhy se nechávaly volně viset.

Covercoat koverkot - lehký jednorázový široký, až zvonový plášť, dlouhý ke kolenům.

Crinoline krinolína - spodnička šatů vyztužená obručemi.

Cuff manžeta.

Culottes rokokové kalhoty.

Cut-out pockets with flaps prostřižené kapsy s patkami.

Dinner jacket (tuxedo) smoking.

Doublet dublet - renesanční krátký přiléhavý kabátec [4].

Eclipsé dámský spodní overal tvořený horní košilkou a spodními kalhotkami sahajícími po kolena.

Finestrella sleeves zdobené rukávy s příčnými staženími, která vytváří na rukávu kužely [2].

Flies mušky - drobné ozdoby obličejů tvořené z pogumovaného černého hedvábí.

Flower chafer zlatohlávek zlatý - brouk s barevně proměnlivými krovkami, které mohou být zbarvené do kovově zelené, zlatozelené, fialové, načervenalé nebo bronzové [3].

Fly poklopec u kalhot.

Folds záhyby na oblečení.

Fontage vysoký dámský účes doplněný velkým množstvím stuh a krajek.

Frills volán, nabírání na látce.

Fringes třásně.

Goatee mužská bradka.

Hairpiece přičesek.

Harmonica harmonika - delší kalhoty, které mají na nohou řadu příčných záhybů.

Hatches klopy.

Hemme lemovat.

Homburg plstěný klobouk - pevný klobouk s trojúhelníkovitě prolomenou hlavou.

Hosen (poufy) přiléhavé punčochy vyrobené z vlny, šlechtici nosili drahé pletené z hedvábí.

Houppelande široký plášť spadající ke koleni nebo k zemi, s dlouhými širokými rukávy a šálovým límcem.

Irish crochet lace irská háčkovaná (nepravá) krajka, je vyráběna pomocí jemného ocelového háčku a jemné lněné nitě.

Iron (soldered) tie železná (letovaná) kravata - hotová vázaná kravata připínající se k obleku.

Jabot druh kravaty v době baroka.

Jumpsuit dámský overal.

Justacorps/Justaucorps pánský dlouhý kabát ke kolenům s dlouhými rukávy, kryje vestu a kalhoty.

Lace krajka.

Lining podšívka.

Mantilla typický dámský španělský přehoz splývající z hlavy až na ramena.

Matrose clothing matrozové oblečení - oblečení s námořnickým motivem, modrobílé pruhy.

Morning dress žaket, pánský denní oblek, pro který je typický kabát se šikmo ustřiženými šosy.

Muff muf - rukávník.

Mull mul - řídká obvazová tkanina.

Negligee negligé, nedbalky - od doby rokoka méně formální společenské oblečení, ve kterém dámy přijímaly své hosty.

Pantaloni barokní úzké kalhoty sahající k lýtku.

Paper curls papírové natáčky.

Parasol slunečník.

Patent leather glazé, bílá rukavičkářská jircha z kůzlečí kůže (jircha - useň vydělávaná ze surových zvířecích kůží minerální cestou, useň - zvířecí kůže zbavená srsti, podkožního vaziva a tuku) [1].

Perforate perforování, děrování.

Petticoat spodnička šatů [5].

Planchette planžeta - tenký pružný, většinou kovový pásek.

Pomade pomáda - vonná mast používaná k úpravě účesů.

Postiche viz Hairpiece.

Punt náprsenka, ozdoba korzetu, která se vyvinula z náprsního šátku, jejím účelem bylo skrýt šněrování, byla vyrobena ze silného kartonu (někdy i želoviny či slonoviny), který byl potažen látkou.

Redingot dlouhý plášť s rukávy, jehož jeden límec se nosil zdvižený, původně určen k cestování.

Ribbon stuha.

Ringlet (lock; curl) lokna, kadeř, prstýnek vlasů.

Robe volante vpředu otevřený plášť s hermelínovým lemem.

Robe à la lévite plášť vpředu zcela otevřený, na prsou sepnutý agrafovou a v pase přepásaný šerpou.

Ropon (Schaube) čuba - renesanční kožešinový kabátek [4].

Ruffle volán.

Shirtfront viz Punt.

Silk hedvábné vlákno.

Spats kamaše.

Steinkirk krajková kravata s dlouhými volnými konci [6].

Strass štras - silně olovnaté sklo používané k výrobě napodobenin drahokamů.

Suede semiš.

Suit jacket sako.

Tailcoat frak.

Taper tapé - rokokový účes, vlasy vpředu zkadeřené, vzadu zcela hladké.

Tassel střepec.

Teddy kombiné.

Top hat cylindr.

Topknot pačesy.

Topmost petticoat (farthingale) obručová spodnička.

Train vlečka šatů.

Trunk (pumpkin; round) hose plundry - kalhoty tvořené nabíranými ne-foremnými pytli dlouhé ke kolenu [2].

Turn-up záložka na kalhotech.

Ulster svrchní vlněný plášť.

Velvet samet.

Waistcoat vesta k obleku.

Waistline břišní pás k obleku.

Wave hair vlnité vlasy.

Wax canvas voskové pláty používané při výrobě krinolín.

Wrap přehoz přes ramena.

Á la Watteau hat dámský plochý klobouk nošený hluboko do čela, vzadu zdobený peřím.

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Contents of enclosed disk

readme.txt	the file with disk contents description
aids	.....	the directory with some aids
result	.....	the directory of example animations
├─ 3D modelling	...	the directory of animations created by 3D modelling
├─ 3D scanning	.....	the directory of animations created by 3D scanning
src	.....	the directory of implemented plug-ins
├─ fabric_materials	.....	the directory of plug-in Fabric Materials
├─ node_arrange2	.....	the directory of plug-in Node Arrange 2
├─ postprocessing_sewing	...	the directory of plug-in Postprocessing of Sewing
├─ texture_combiner	.....	the directory of plug-in Texture Combiner
├─ MH_plugins	.....	the directory of MakeHuman plug-ins for Blender
text	.....	the thesis text directory
├─ thesis.pdf	.....	the thesis text in PDF format
├─ source	.....	the source form of the thesis text in L ^A T _E X format