Digital Fashion Project

Collaborative Online International Learning in Digital Fashion

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CONTENT

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1. FASHION DATABASE

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LEARNING OUTCOMES

COMMON LEARNING OUTCOME	EFFECTIVE USE OF THE ONLINE PLATFORM DIGITAL FASHION AND THE FASHION DATABASE MODULE
SPECIFIC LEARNING OUTCOMES	• describe the basic steps of fashion design • explain the requirements of fashion and the role of design elements in the design of fashion clothing • describe the importance of a technical drawings • explain in detail the basic design elements • explain the use of the basic design elements in virtual 3D prototyping of clothing

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CONTENT

1.1 INTRODUCTION

The DIGITAL FASHION technology platform enables fashion designers to learn digital fashion design by using knowledge databases integrated into a digital environment (https://digitalfashiondleu.com/).

The knowledge databases are integrated into the platform, **Figure 1.1,** where currently following databases are located:

- *3D human database,*
- *Garments,*
- *Fabric and*
- *Virtual Try On*.

In the following, the *Fashion Database* will be set up on the platform, the purpose of which for the teaching of digital fashion design is presented as below.

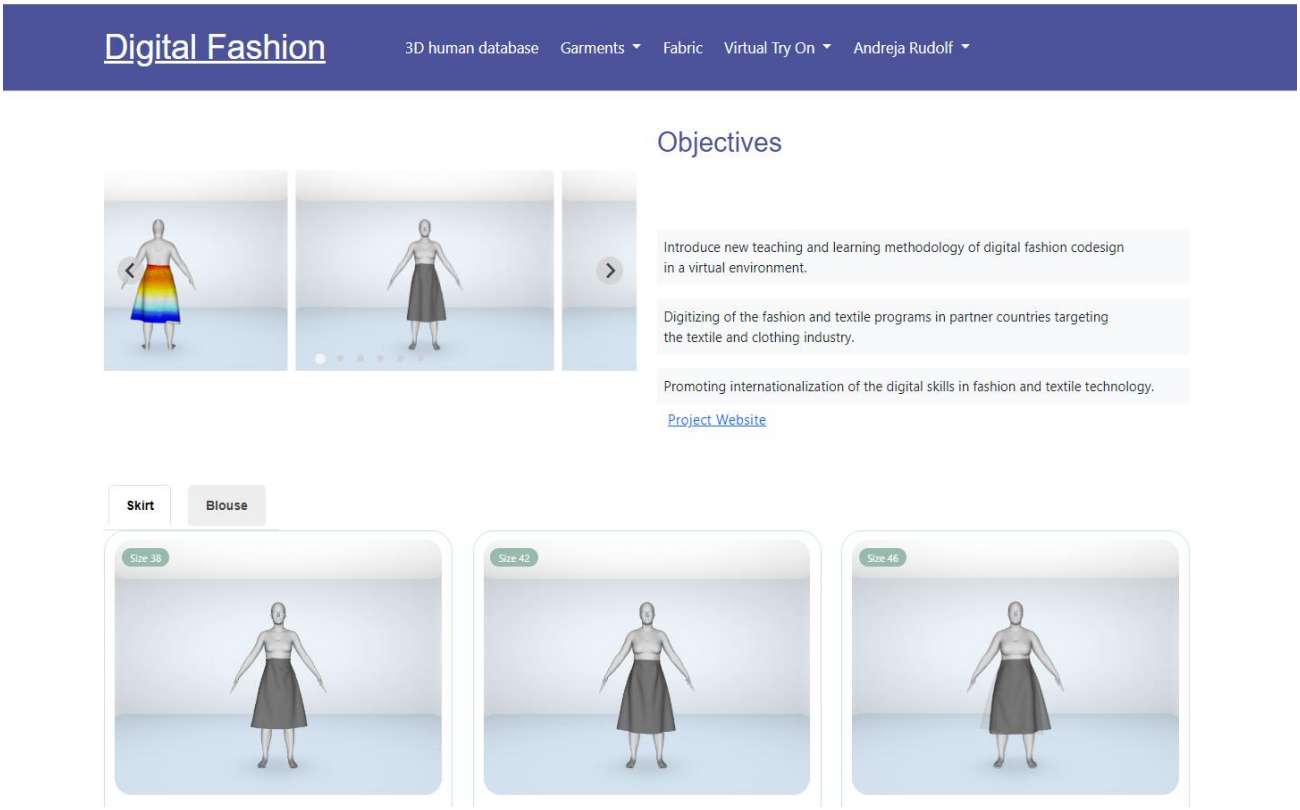
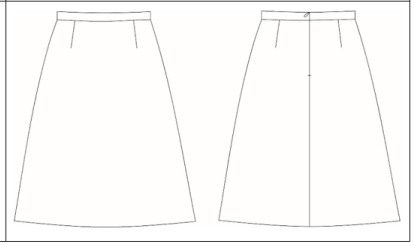
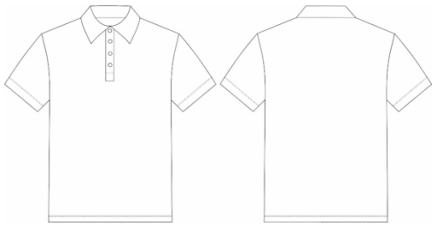


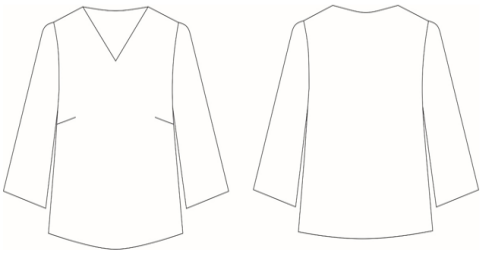
Figure 1.1. The DIGITAL FASHION technology platform.

1.2 FASHION DATABASE

The project partners have collected items of clothing for women and men for a fashion database: shirts for men, trousers for men, blouses for women and skirts for women, for which 48 clothing styles were created, examples of which are shown in **Figure 1.2.**

Item	Description
Garment	**Women skirt**
Style	**CLASSIC A-LINE SKIRT**
Fabric	**100 % Cotton**
Technical drawing	

Item	Description
Garment	**Men shirt**
Style	**Polo T-shirt short sleeves**
Fabric	**100 % Cotton**
Technical drawing	

Item	Description
Garment	**Women blouse**
Style	**SHORT BLOUSE**
Fabric	**100 % Cotton**
Technical drawing	

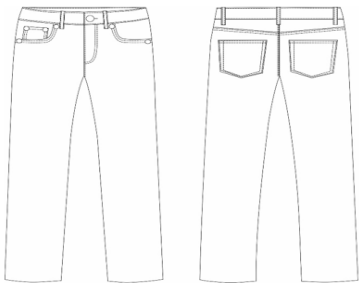
Item	Description
Garment	**Men trousers**
Style	**CLASSIC JEANS TROUSERS**
Fabric	**98 % Cotton 2 % Elastane**
Technical drawing	

Figure 1.2. Examples of garments from a fashion database.

The fashion database contains information about the description of the garment style (men and women), the raw material of the fabric and the technical drawing for the respective garment style. Pattern pieces are designed for each garment and graded into different clothing sizes. On this basis, simulations of virtual 3D prototypes of garments are carried out, allowing digital fashion design students to observe the shape of the garment and the visual appearance of the garment depending on the chosen garment pattern design and textile material (colour, texture, pattern).

1.3 FASHION REQUIREMENTS

A fashion designer uses a combination of textile materials, shapes, colours, textures etc. to create a specific look for a person that must meet visual and aesthetic requirements. During the design process, the fashion designer follows multiple steps that bring the design to life and becoming a reality.

The process of fashion design involves detailed research, inspiration, fashion forecasting, creativity, innovation, etc. There are known basic steps of fashion design that usually include the following, **Figure 1.3:**

- research inspiration,
- creative process,
- production of prototypes,
- evaluation of the collection and
- presentation.

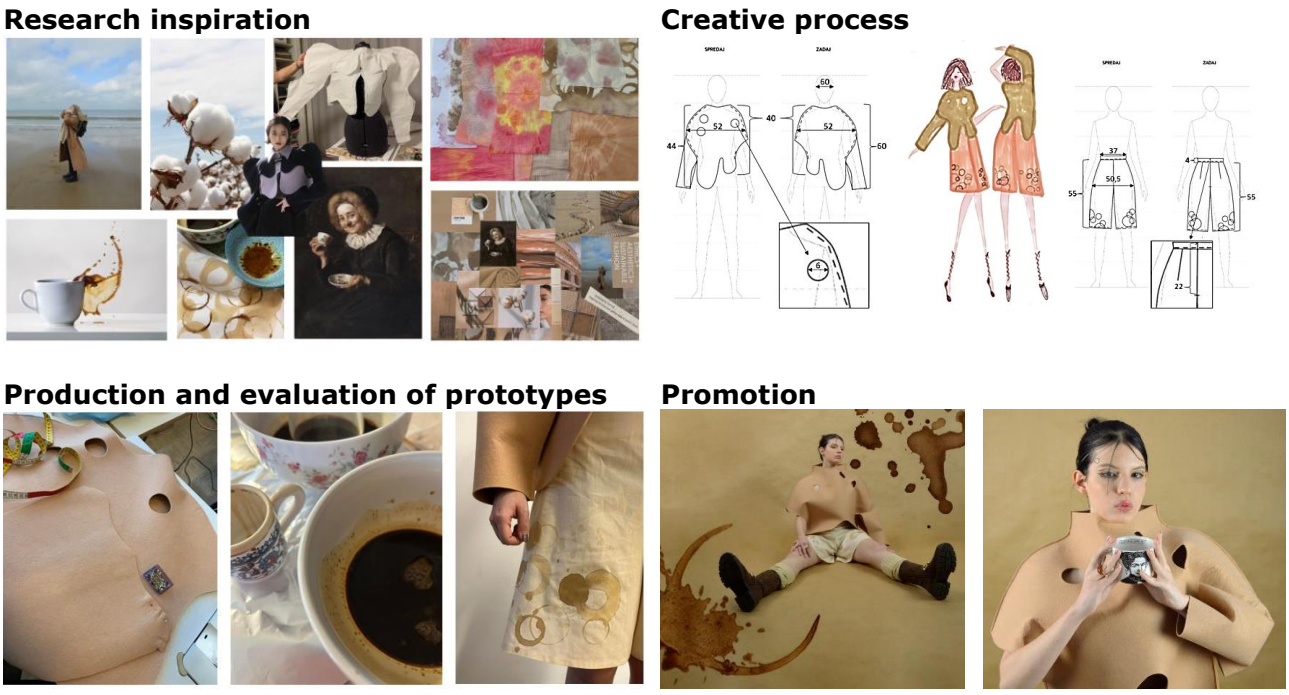


Figure 1.3. Basic steps of fashion design [1].

When starting to create a collection, the fashion designer should have a clear idea of the target customers, generally categorised by gender and age (babies, children, teenagers, adults, elderly people) and type of clothing (classic, casual, formal, sporty, etc.). At the same time, fashion designers are categorised into three basic types: Haute couture designers, prêt-à-porter (ready-to-wear) designers and costume designers.

As part of the creative process, the fashion designer makes fashion drawings or fashion illustrations based on the inspiration board (mood board) and selects the textile materials for the designed clothing collection, both in terms of their properties and in terms of colour, texture and/or pattern.

Fashion designers acquire skills and use their experience to create their own concepts for designing clothing and they take into account basic design principles, which are proportion and scale, balance, harmony, rhythm and emphasis. A design concept is the core idea on which the design of a product is based. It is explained through a collection of sketches, images and a written explanation which guides the designer through the creative process. Design elements serve as the basis for the development and design of all textiles and clothing products, including interior textiles. Throughout history, designers have used design elements in different ways to create aesthetics. In all disciplines, every designer usually uses the elements of design, such as line, shape and form, texture and colour.

Fashion designers need to understand the basic elements and principles of the garment design. To create garments that are visually intriguing and stand out, they must consider four basic design elements [2]:

1. Shape and form,
2. Line,
3. Colour,
4. Texture,

that will be detailed presented in the next sub-chapter 2.2.

The ability to show an understanding of individual garments is essential for fashion designers. Therefore, a fashion designer must be able to transform the fashion drawing into a technical drawing to bring the fashion collection to life.

The technical drawing, also called a flat drawing (abbr. flat) or technical sketch, is a garment drawing that shows the shape of the garment and its elements such as seam lines, neckline, collar, sleeves, darts, hem, etc. and is drawn proportionally to the human body. A technical drawing is a single garment, or a series of garments drawn in the horizontal plane to represent a two-dimensional shape of the three-dimensional garment form, as if they were laid down and viewed from above. Front and back views are common, but side views can also be included depending on the visual information to be conveyed [3].

Technical drawings are not so much about the overall appearance of the garment, as might be the case with a fashion drawing or fashion illustration, but rather about the details and features of the garment. These features can be defined by a series of three important visualisation processes:

1. The first reffers to the understanding of the overall silhouette and proportions of the garment. Technical drawings are therefore drawn with much greater proportional accuracy than corresponding fashion drawings, **Figure 4**, so instead of a nine- or ten-headed body figure, a more realistic eight-headed body figure is used [3].

2. The second requirement for technical drawing is to document the style lines, e.g. drawing in all seams and darts that shape the garment, as well as any additional features such as gathers or pleats, **Figure 1.4**. All style lines can be drawn using linear techniques, which should not rely on shading, colours or tones. It is also important to include the back views of all style lines to demonstrate a complete understanding of the garment. Style lines such as ruffles, added fullness or pleated variations can be drawn in a variety of ways, all of which are achieved through drawing techniques of flat drawings to enhance the understanding of the garment.

3. Detail lines are the third visualisation feature that makes up a technical drawing, e.g. top-stitching and other visual surface applications such as a pocket with lapel, which does not affect the fit of the garment but is an integral part of the final presentation of the garment [3].

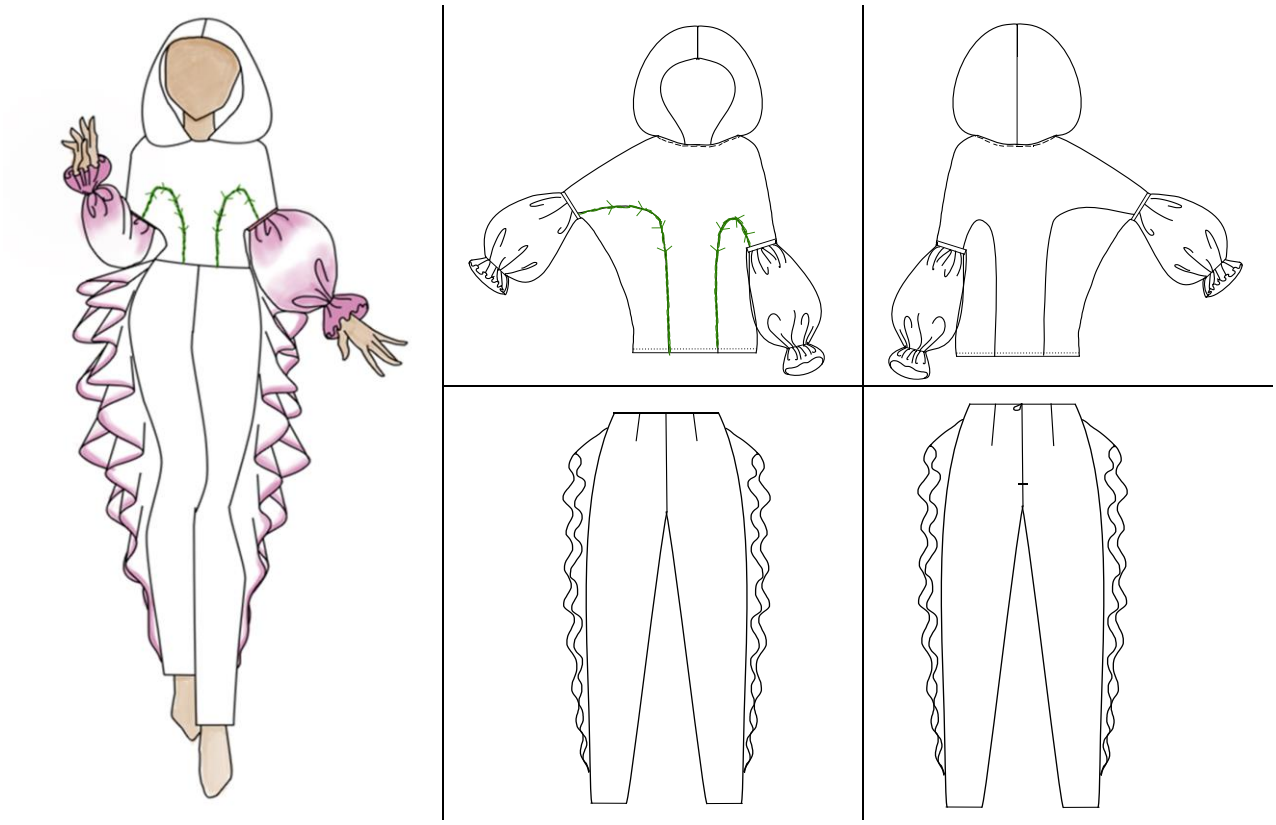


Figure 1.4. Fashion illustration (left), technical drawings or flats (right) [4].

1.4 BASIC DESIGN ELEMENTS

The elements and principles of design are flexible and should be interpreted in the context of current fashion. Design elements are the components that a garment designer utilises when creating garments. A design can be defined as an arrangement of lines, shapes, colours and textures that create a visual image of the garment [5].

1.4.1. LINE

The line is the simplest and most important of the design elements and is integrated into the other elements. All lines have a direction, length and width. The line is the basic requirement for almost designs. It defines the visual dimensions of lengths and widths of garments expressed by different types of lines, **Figure 1.5.** When lines are combined, space is enclosed and shapes and forms are defined [5].

In fashion, the term line expresses the basic shape of the garment, as well as the neckline or armholes and various openings in the garment, etc. The line also refers to the direction of visual interest in a garment created by construction details such as seams, openings, pleats, gathers, tucks, top-stitching and trims [5].

Figure 1.5. Types of lines [5].

Figure 1.6 shows technical drawings of skirts with lines in the form of darts, seams and topstitching as well as a wrap skirt and a skirt with gathers defined with curved lines.

According to the direction, lines may be vertical, horizontal, or diagonal and can also represent a textile pattern, **Figure 1.7**. Depending on the type, there are three types of lines - straight, curved and zigzag lines. Straight lines are in contrast to natural curves and signify consistency, neatness, evenness and strength. They give to the garment a sense of elegance, boldness and strength, stability and dignity. Curved lines are less conservative, formal and powerful than straight lines. Circles and curves make sillouette appear larger than they actually are. Zig-zag lines have sharp points that change direction abruptly due to their points. These types of lines appear jerky, busy and excited. They also emphasise angularity [5].

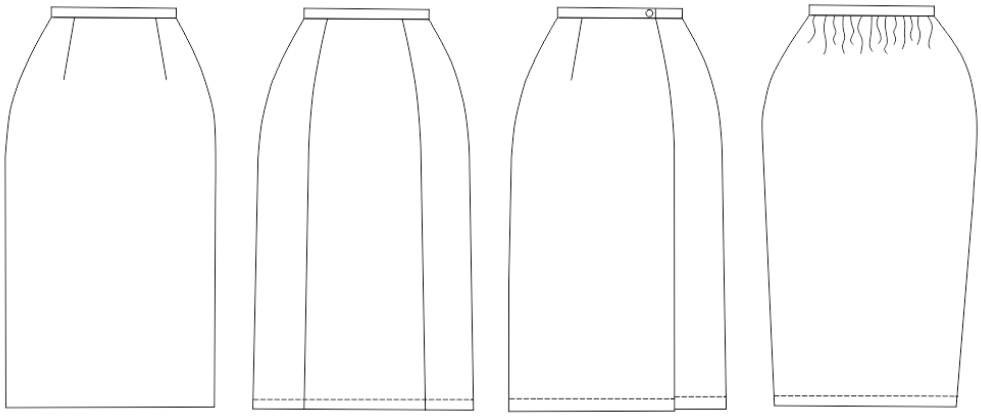


Figure 1.6. Technical drawings of skirts with lines in the form of darts, seams, topstitching, gathers.

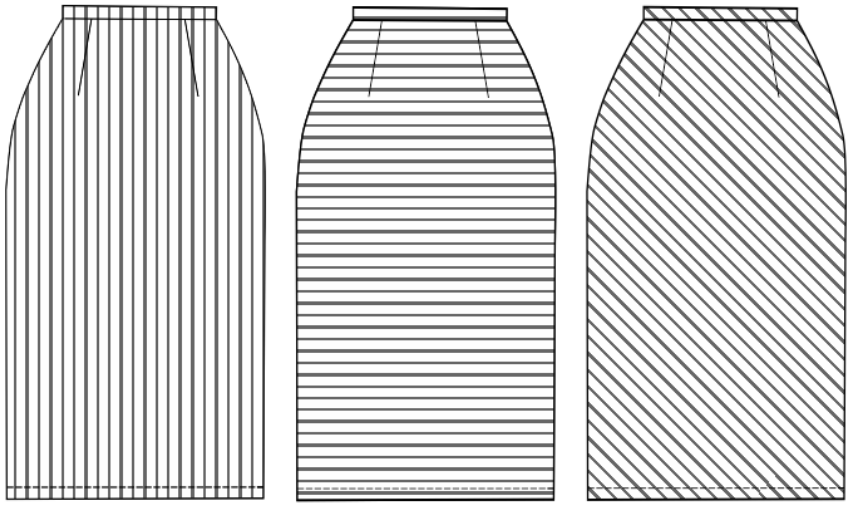


Figure 1.7. Technical drawings of skirts with lines as a fabric pattern.

1.4.2. FORM AND SHAPE

Shape and form define objects in space. Shapes have two dimensions, height and width, and are usually defined by lines. Forms exist in three dimensions, with height, width and depth.

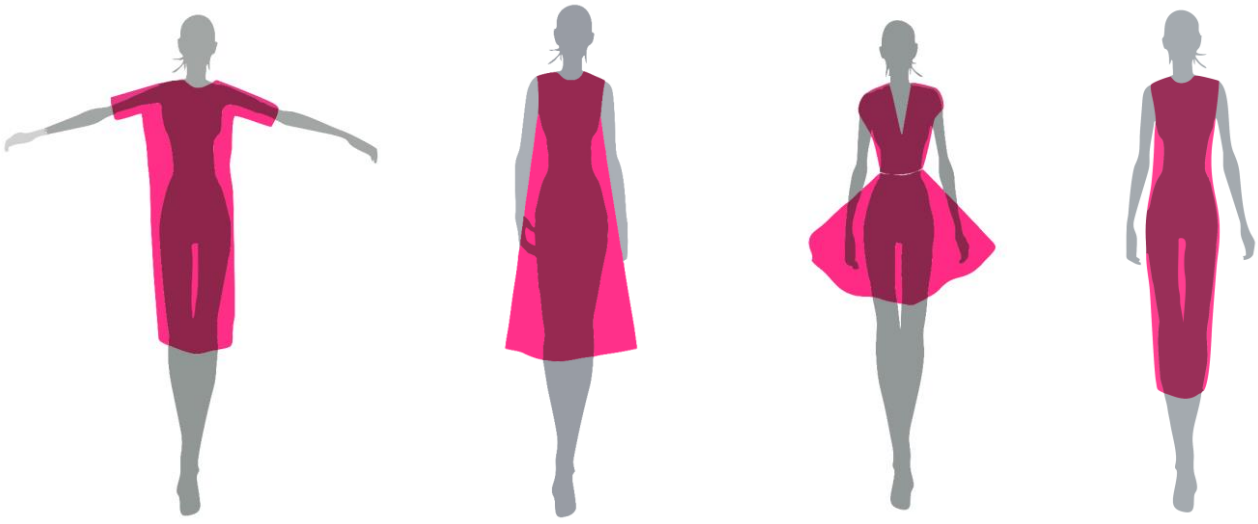
The human body is a form and if we look at it analytically, its different perspectives become visible. The human form changes visually with clothing, especially with changes in fashion [5].

The shape describes the external dimensions or contour of an object. The design of garments often naturally reveals the shape of the human body, sometimes concealing it, but sometimes distorting it. The shape of the garment on the human body unobtrusively conveys a message about the wearer. In every fashion period there has been a particular shape of garment, and today different shapes of garments are in fashion [5].

The design of fashion clothing collections usually comes from researching the basic shapes of clothes, the most common of which are T-line, A-line, X-line, I-line, V-line, H-line, Y-line, O-line, etc., **Figure 1.8**.

The visual effects created by the use of different shapes in clothing can influence the wearer's physical appearance and mood [5]:

- They can increase or decrease the person's height, width and weight, which can be achieved by placing seams, pleats, armholes, necklines and waistlines in the appropriate places on garments.
- Garment styles such as dome-shaped skirts can conceal heavy thighs or short legs, i.e. shapes can be used to conceal undesirable features of the human form.
- Tight-fitting garments can help to emphasise a person's desirable features, but they can also make a person look larger, so they need to be used with care.



T-line A-line X-line I-line

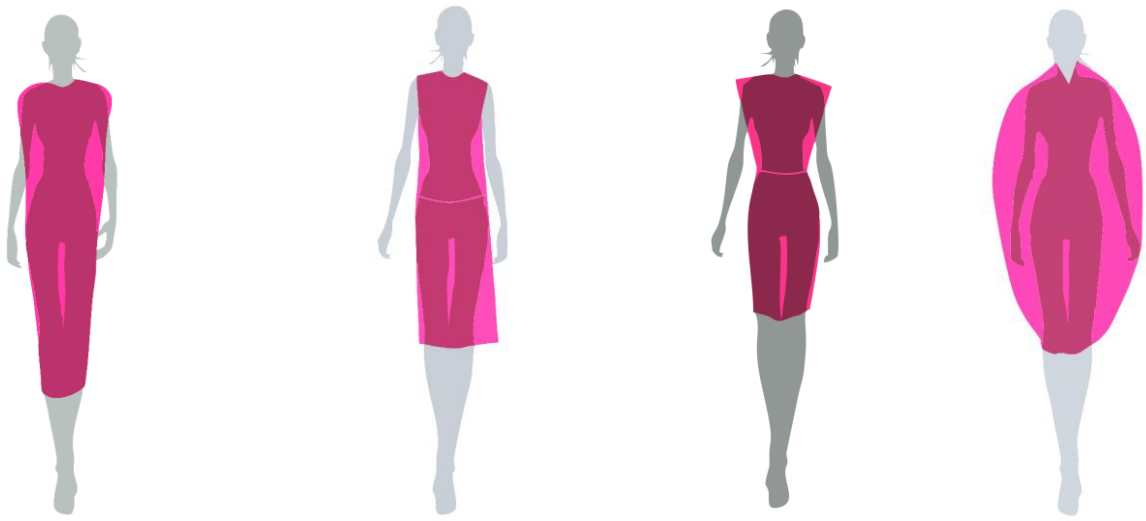


Figure 1.8. Examples of garments shapes [6].

1.4.3. COLOUR

Colour is the visual and essential element in fashion design. Colour has an aesthetic and commercial value. Colour is the first element that the viewer reacts to. Colour adds excitement, mood and evokes emotion to a design and therefore influences the overall look and feelling of a design, i.g. the colour blue is commonly associated with feelings of calm and serenity, while the colour red is associated with passion and energy. Understanding the power of colour is crucial to creating an impressive and impactful fashion collection [5, 7].

To understand how colours interact with each other and how they can be used to evoke emotions and feelings, we use colour theory. Most commonly used in fashion design is the colour wheel, a circle divided into primary, secondary and tertiary colours, **Figure 1.9**. There are only three primary colours: red, blue and yellow, and they cannot be created by mixing other colours. Secondary colours are orange, green and violet. They are created by mixing primary colours (red and yellow make orange, yellow and blue make green, while blue and red make violet). Tertiary colours are created by mixing primary and secondary colours. If all the colours of light are absorbed, this results in a black colour, while all the colours reflected by a surface result in a white colour [7].

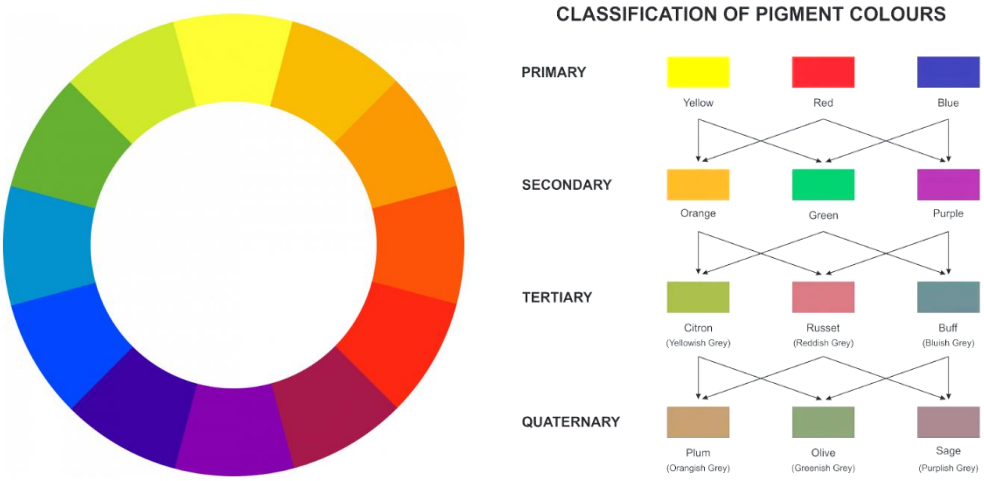


Figure 1.9. Colour wheel and classification of pigment colours [8].

By understanding the relationships between the different colours on the colour wheel, designers can use colour combinations to create a certain mood or feeling in their collection.

Colour has three dimensions, **Figure 1.10** [2]:

1. Hue is the name of the colour: for example, this dress is red.
2. The value indicates how light or dark the colour is (black pigment added are called ''shades'').
3. The intensity indicates how bright or muted the colour is (white pigment added are called ''tints'').

Figure 1.10. Dimensions of colours [9].

In general, light colours are peaceful, dark colours are confident, muted colours are refined and bright colours are energetic. Only rarely a design will require pure colour tones. We often use customised colours by changing the hue, shade (add black), tint (add white), tone (add grey), temperature (**Figure 1.11**), to create a better contrast and convey the right message for the mood, for example [9]:

Bright – energising, powerful, exciting.
Muted – relaxing, non-stimulating, sophisticated.
Light – gentle, soft, pleasant, peaceful.
Dark – serious, intense, professional.

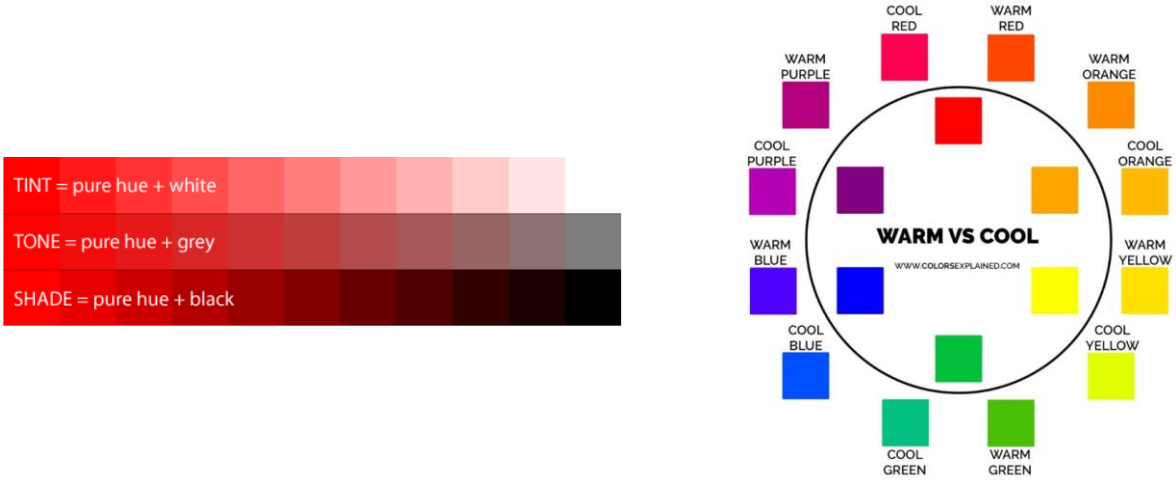


Figure 1.11. Colour hue, shade, tint, tone, temperature [9, 10].

When we design a clothing collection, we can match the colour combinations (analogous, complementary, monochromatic) of the clothing with the colour wheel, which helps us to create a balanced clothing collection. **Analogous colours** lie next to each other on the colour wheel and look most similar. One colour is the dominant colour, while others support it. These colours are the easiest to combine as they are closely related. **Complementary colours** are opposite each other on the colour wheel. They have the strongest contrast and are the most daring combination we can make. The best way to combine complementary colours is by contrasting their brightness, i.e. one colour is darker or lighter or more muted than the other (e.g. a dominant green colour and a red accent colour). **Monochromatic colours** use a single colour with variations of tints, shades and tones of the colour. This scheme is very pleasing to the eye. Because monochromatic colours naturally go well together, they have a calming effect [8, 11]. Of course, we can also use three (triade colours) or more colours, such as black and white and their shades.

When designing a clothing collection, the digitisation of the designs and the creation of the corresponding clothing specifications are two important steps. Once the fashion or technical drawing is finalised, we need to add colour(s) and texture(s) to the creations. For this purpose, we use software such as Adobe Illustrator, CorelDraw, Photoshop, etc., which allows us to choose between RGB, Hex, CMYK, etc. colour palettes.

RGB stands for red-green-blue, i.e. the primary colours in additive colour synthesis. An RGB file consists of composite levels of Red, Green and Blue, each coded in 256 levels from 0 to 255.

Hex colour codes are values that tell the display how much of a colour should be shown. The values are a special code that represents colour values from 0 to 255.

CMYK refers to the four colours used in colour printing: Cyan, Magenta, Yellow and Key (Black).

An example of analogous colour combinations can be found in **Figure 1.12**, where a shade of blue according to the **RGB colour scale** (**87; 192; 255**) and **Hex (# 57C0FF)** is used for the blouse and skirt.

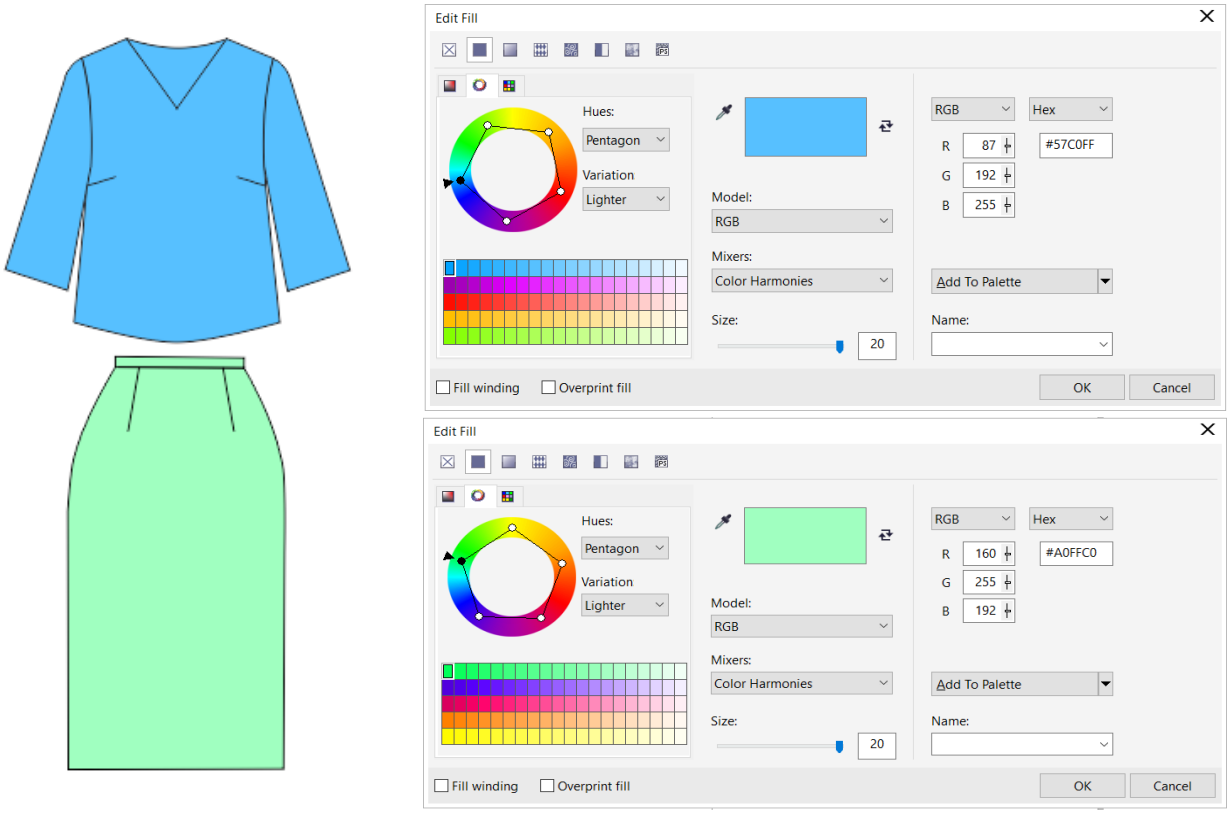
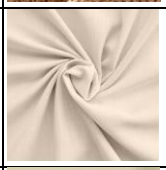


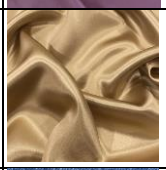
Figure 1.12. Analogous color combinations.

1.4.4. TEXTURE

Texture is the design element that describes the look and feel of a surface that is perceived by both sight and touch. It also means the appearance of the fabric. It is the quality of roughness or smoothness, dullness or lustre, stiffness or softness. Some words used to describe the texture of fabrics are: rough, smooth, dull, shiny, firm, crisp, fluffy, voluminous, etc, **Table 1.1**. Texture is defined also as the tactile quality of a fabric. Hand refers to the tactile aspects of the fabric. Texture has the different physical dimensions of weight, size, volume and shape [5].

Table 1.1: Description and examples of different textures of fabrics.

Texture	Description	Examples	
Coarse	Loose, rough or coarse	Burlap, Sail cloth	 Burlap
Smooth	Free from obstruction	Batiste, Voile	 Voile
Crisp	With a roughened surface that has small folds or ruffles	Linen, Crepe	 Crepe
Nubby **Heavy**	With small knobs or lumps With a high weight in relation to the mass	Tweed, Shantung Fabric, especially wool such as Camel, boiled wool	 Shantung  Boiled wool
Fine	Very thin in fineness or texture	Fine Pina, Fine Cotton, Organza	 Organza
Clingy	To adhere	Tricot, Plain Jersey Knit	 Jersey
Glossy	With a surface luster or brightness	Smooth Plastics, Polished Cotton	

			 Polished Cotton
Shiny	Shiny in appearance	Satin, Vinyl	 Satin
Dull	Lack of shine or lustre	Cotton Denim, Medium Weight Flannel	 Denim

There are two types of textures: (1) structural textures, which are created during the production of textile materials or garments, and (2) visual textures, which are added, for example, by a design printed on the surface of the textile material. During the production of textile materials, various components such as fibres, yarns, fabrics or finishing treatments, determine the fabric texture [5].

Figure 1.13 shows a clothing set consisting of a blouse and a skirt for women. The pattern pieces of the blouse and the pattern pieces of the skirt are shown, the technical drawings of which can be seen in **Figure 1.2**. In addition, the print pattern design and the raw material composition of the fabrics, for the blouse and for the skirt as well, as the virtual prototypes of the blouse and the skirt are presented.

The women's blouse has a slight A-line with slightly flared sleeves that reach above the elbows. Its length extends to the centre of the hips. The blouse has a V-neckline and bust darts at the front. It is made from 100% cotton poplin in a white colour (RGB: 254; 254; 254, Hex: #FEFEFE), which gives the fabric a glossy look. The blouse has an additional visual effect due to a monochrome print pattern in blue (RGB: 0; 0; 191, Hex: #0000BF), situated on the longitudinal centre front and back as well as on the sleeves at the bust level.

The skirt is a classic A-line without darts and with a straight waist. Its length extends to the centre of the sword. The skirt is made of 100% cotton denim fabric of uneven and mottled blue colour, so the shade cannot be determined exactly by RGB; its average value is about (18; 37; 95) and Hex #12255F. The 100% cotton denim fabric is added to the prototype of the simulated skirt model prototype as an image in the form of a *.jpg* file, which enables a visual perception of the texture of this textile.

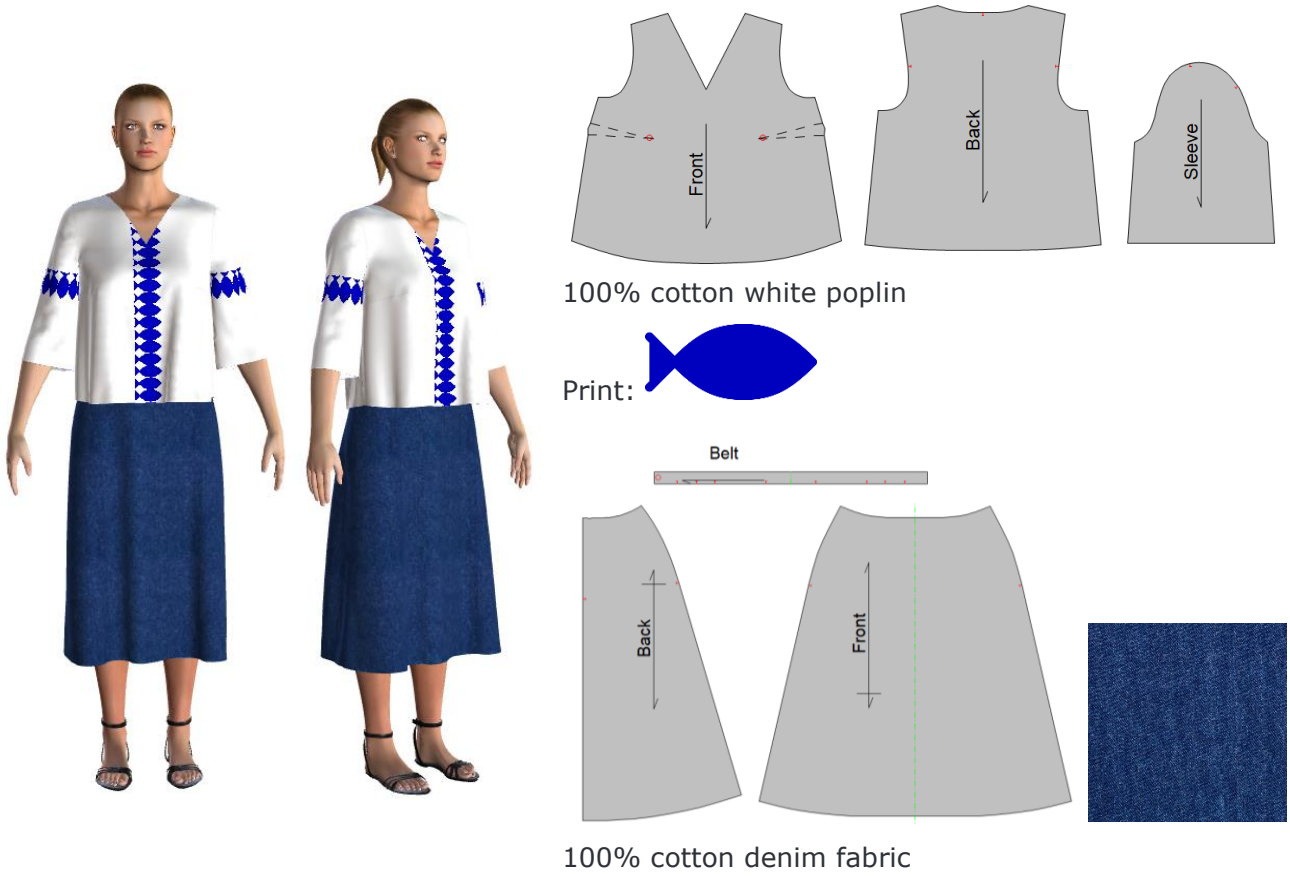


Figure 1.13. Examples of different textures of fabrics on the virtual prototypes of the blouse and skirt.

CONCLUSION

The DIGITAL FASHION technology platform enables fashion designers to learn digitally fashion design by using knowledge databases integrated into a digital environment (https://digitalfashiondleu.com/). This chapter, the Fashion database, is presented from the point of view of the fashion requirements that fashion designers most often use when designing their collections. The ability to demonstrate an understanding of individual garments is essential for fashion designers, and design elements are the basis for the development and design of all textiles and clothing products, including interior textiles. Therefore, this chapter explains the basic elements of fashion design, such as line, shape and form, colour and texture, supported by rich visual representations.

BIBLIOGRAPHY

[1] Maja Vita Onič, Responsible Fashion collection, model Fontaline, subject Production of prototypes, study year 2022-2023, University of Maribor, Slovenia

[2] Elements and Principles of Fashion Design, Available at: https://www.fitnyc.edu/museum/documents/elements-and-principles-of-fashion-design.pdf, [Accessed 2 December 2023].

[3] John Hopkins, Basics Fashion Design 05: Fashion Drawing, AVA Publishing, December 2, 2009.

[4] Tinka Križman, Responsible Fashion collection, model Fontaline, subject Production of prototypes, study year 2022-2023, University of Maribor, Slovenia.

[5] Introduction to Design Elements, Available at: https://gcwgandhinagar.com/econtent/document/1587358837UNIT%203,4,5.pdf, [Accessed 2 December 2023].

[6] F. Volker Feyerabend and F. Ghosh, Shapes and Styles of Fashion, Templates for Fashion Design & Bilingual Work of Reference (German / English), Stiebner Verlag GmbH, January 1, 2008.

[7] Fiona Byrne, The Power Of Colour In Fashion Design, British Academy of Fashion Design, 23 March 2023, Available at: https://www.fashiondesignacademy.co.uk/blog/the-power-of-colour-in-fashion-design, [Accessed 2 December 2023].

[8] Will Fanguy, Adobe, What Is Color Theory? Meaning & Fundamentals, Nov 3, 2020 Available at: https://xd.adobe.com/ideas/process/ui-design/what-is-color-theory/, [Accessed 2 December 2023].

[9] Colors Explained, Graphic Design, Color Theory 101: A Complete Color Guide, Available at: https://www.colorsexplained.com/color-theory/, [Accessed 2 December 2023].

[10] learn. Artspeak, Elements: Color / Hue, value, saturation, Available at: https://learn.leighcotnoir.com/artspeak/elements-color/hue-value-saturation/, [Accessed 2 December 2023].

[11] Robert van Tongeren, Restart Your Style, Matching Clothes, What Colors Go Together? The Best Clothing Combinations, October 3, 2023, Available at: https://restartyourstyle.com/what-colors-go-together/, [Accessed 2 December 2023]

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2. FABRIC DATABASE

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LEARNING OUTCOMES

COMMON LEARNING OUTCOME	UNDERSTANDING FABRIC PROPERTIES, CONSTRUCTION AND REAL VS DIGITAL FABRIC FOR USING FABRICS DATABASE
SPECIFIC LEARNING OUTCOMES	• Know important fabric properties • Interpret fabric properties • Understand real fabrics vs digital twin fabrics • Knowledge of fabric construction • Knowledge of fabric visual properties

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CONTENT

2.1. INTRODUCTION TO THE FABRIC DATABASE

A fabric is a textile material obtained through weaving or knitting technologies, or by different techniques like spreading, felting, stitching, crocheting, or bonding, that may be used in the production of further products, such as clothing or upholstery.

The characteristics of a fabric depend on various factors such as the type of fibres used, the weave or knit pattern and additional treatments or finishes applied. Fabrics can vary in terms of texture, weight, durability, and appearance, making them suitable for different purposes and applications, ranging from clothing and household textiles to industrial uses.

The fabric database of this project consists in a structured and organized collection of types of fabrics, widely used in clothing industry and suitable for the garment models selected in the project. The database includes fabric details such as raw material composition, fabric's specifications (e.g. weight, fabric identity, source and Lectra pairing number, fabric image, colour code), construction description (type of weave/knit, the density of weave/ knit, thickness, elasticity, bending and stiffness properties, visual references as transparency, drapability, feel and touch). The database serves as a valuable resource for designers, in the textile and fashion industries, aiding in the selection and understanding of different fabrics for clothing applications.

The fabric database consists in a total of 49 fabric samples (F1-F49). These fabrics are divided according to the intended garment, i.e. Men shirts, Men trousers, Women blouses, and Women skirts. The fabric parameters include the fabric image, colour according to Pantone or RGB code, precise material composition, type of weave/knit, yarn density in the weave/knit, fabric weight, thickness, see-through (yes or no), and the touch feeling (rough or smooth) among other fabric properties.

2.2. FABRIC PROPERTIES

It is important to explore and understand the visual and mechanical properties of textile materials for an informed selection of fabric to achieve a specific look, texture, lines, and drape of the final product. By comprehending the properties of textile materials, designers can create aesthetically pleasing and functional products that meet consumers' needs and expectations. By understanding the visual and mechanical properties of textile materials, designers can make informed decisions during the creative process. They can select appropriate fabrics, colours, patterns, and textures that align with the intended design concept and functionality. The visual properties are influenced by the material composition, mechanical properties, finishes, and colour.

2.2.1. MATERIAL /FABRIC COMPOSITION

Textile materials are made of yarns/fibers that, based on their origin, are classified in natural and man-made fibres. The classification of fabric composition helps in understanding their characteristics and applications.

The fabrics in the database are described by their exact fibrous composition, for example, 100% cotton means the material is purely from cotton or 60% viscose, 37% cotton, and 3% elastan, which means the material is a blend of the three in the defined compositions. The fibrous composition of fabric plays a significant role in determining some properties and performance characteristics, like strength and durability, comfort and breathability, wrinkle resistance, thermal properties, colour retention properties, and environmental impacts.

Natural fibers: are generally considered more environmentally friendly as they are biodegradable. However, the environmental impact depends on factors such as cultivation practices and processing methods.

Synthetic man-made fibers: Often derived from petrochemicals, synthetic fibers may have a higher environmental impact. However, recycling initiatives for synthetic fabrics are increasing. Advances in textile technology continue to introduce new materials and fabric blends, providing a wide range of options to meet various needs.

2.2.2. MATERIAL /FABRIC WEIGHT

Fabric weight plays a significant role in the garment construction process, influencing the overall fit, drape, and style. It is determined by various factors, such as fiber type, yarn thickness and finishing techniques. Measuring fabric weight is realized using the ***GSM (grams per square meter***) test. Standard fabric weight classifications help in identifying different fabric properties. Choosing the right fabric weight for specific garments requires to take into consideration factors such as: functionality, durability, and desired aesthetic look. Different fabric weights enable the creation of diverse garments, from delicate and lightweight summer dresses to sturdy and robust outerwear (figure 2.1).

Heavy weight 315.8 GSM Light weight 103.3GSM

Figure 2.1. Example heavy and light fabric from the database

2.2.3. DRAPABILITY

Is the ability of a fabric to hang gracefully and fluidly when used in garments or interior decor. It affects the overall aesthetics and functionality of the final product. It is the how well a fabric can fall, fold, and drape when draped over a surface or when used in garments. It is the quality that transforms fabric from a mere piece of cloth into a stunning and elegant material that enhances the beauty and functionality of various items. Fabrics with good drapability provide comfort, enhance movement, and create visually appealing silhouettes. The right choice of drapable fabric can elevate the design and create a striking impression.

Measurement of Drapability

Measuring drapability involves assessing various characteristics, such as fabric stiffness, flexibility, and the way it hangs. To evaluate the drapability of a fabric could be a very subjective process, even with the same sample exposed to different experiments, as they may not always generate exactly the same shape. Since the evaluation can vary by reason of the evaluator subjectivity and because it is a time-consuming and costly process, a standardized method of drapability measurement is required.

The most common method include the Kawabata Evaluation System (KES), which measures bending, shear, and compression properties, and the Fabric Drape Index (FDI), which quantifies the overall drapability on a scale. These tests help designers and manufacturers make informed fabric choices for their intended applications.

In this project the draping image was taken using a Cusick Drape Tester, i.e. orthogonal projections of the drapes of textiles were taken using a digital camera. In addition, the drape coefficients (DC) and the number of nodes were calculated using Drape Analyser software.

2.2.4. LECTRA PAIRING NUMBER

Lectra pairing number represents the corresponding Lectra digital number of the fabric that is the most closes to the fabric in question. For example, the Lectra pairing number for F34 is 100 and for F27 is 30.

2.2.5. FABRIC IDENTITY/SOURCE

The fabrics are identified by F1- F49 or the identification from the source, i.e. CITEVE_F04 is a fabric from CITEVE with a serial number F04. These number/letters are used to trace the origin of the fabric, from the total of the 49 fabrics, registered into the database, characterized by different material composition, fabric construction or finishing treatments.

2.2.6. FABRIC IMAGE

Fabric image refers to the visual perception and representation of the fabric. It encompasses the overall appearance, texture, and design of the fabric. It is essential for designers and manufacturers to create fabrics that not only look aesthetically pleasing but also convey the desired image. Example of fabric images and the sizes used in the database is given in figure 2.2:

Figure 2.2. Example of fabric images and the sizes used in the database: F4

Several factors can impact the fabric's image. These include the fabric's quality, colour, pattern, texture, and finish. Additionally, the way a fabric drapes, wrinkles and maintains its appearance can also contribute to its overall image. Understanding and managing these factors is crucial in creating the desired perception.

2.2.7. FABRIC COLOR (CODE)

Fabric colour code typically refers to a system or set of codes used to identify and communicate specific colours within the textile industry. These codes help ensure consistency and accuracy in colour matching during the manufacturing and design processes. There are several colour coding systems used, and the most common one is the Pantone Matching System (PMS).

Fabric colour in the database is descripted according to the Pantone Code or Berger Whiteness Index. Colour is an integral part of the fabric selection process. The choice of fabric colour is more than a matter of aesthetics. It also reflects expressions, emotions, personality, culture, and or identity.

2.2.8. CONSTRUCTION (KNITTED OR WOVEN)

The fabrics are described according to their construction: knitted, woven, and according to the type of weave/knit. The following terminologies have been used in the database to describe the fabrics further:

Construction description

Woven fabrics

Structure – woven fabrics are textile materials, obtained by weaving process, characterized by interlacing at right angles of at least two systems of threads - a longitudinal system (the warp) and a transverse system (the weft), as shown in figure 2.3.

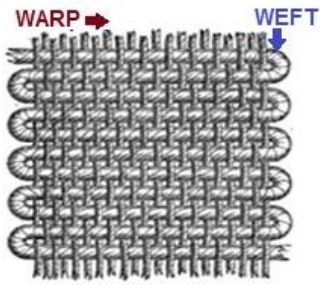


Figure 2.3. The structure of the woven fabric

Properties - the fabrics have specific properties - good positional stability, low elasticity, good resistance to mechanical stress.

Knitted fabric

Structure- Knitted fabrics are textile materials, obtained by knitting process, characterized by interloping one thread or a system of threads.

Knits are divided into two large categories.

- **weft knits** (one or more threads evolve along the transverse direction of the knit)- figure 2.4.

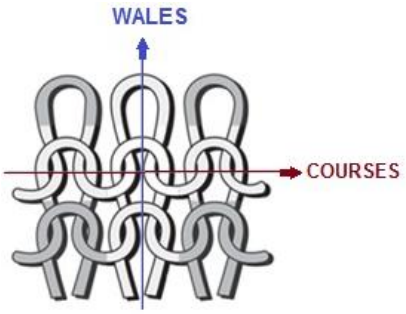


Figure 2.4. The structure of the weft knit

- **warp knits** (one or more thread systems evolve along the longitudinal direction of the knit)- figure 2.5.

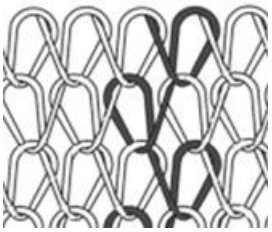


Figure 2.5. The structure of the warp knit

Properties- compared to woven materials, knitwears show greater elasticity, high capacity to recover from wrinkling, reduced stiffness, high air permeability.

Types of weaves/knits

Plain weave is the most basic of fabric weaving, the lengthwise and crosswise threads, evaluate in right angles, one to each other, criss-cross, which is in the simplest pattern: canvas. But in others, the threads may be woven in other multiple ways – artistically and decoratively, such as: twill, satin, velvet, jacquard, or by inserting special threads to create special materials – ripstop.

The knits are classified in two major categories: *simple*- jersey, where a single thread is used and results an uniform face, or with a complex patteoven in rn obtained through various knitting processes, such as rib, ajour, mesh.

The density of weave (warps/cm)

Represents the number of warp threads per 1 cm of woven fabric. In general, the higher the warp density, the thinner the woven fabric is. The number of warps per cm varies on the pattern to be woven and the thickness of the thread. Thinner threads require more threads per cm than thick ones and thus result in a higher number of warps per cm.

The density of weave (wefts/cm)

Represents the number of weft threads per 1 cm of woven fabric. In general, the higher the weft density, the thinner the woven fabric is.

The density of knit (wales/cm)

Represents the number of vertical columns measured per centimetre and the density of knit wales represents the number of wales per 1 cm of knitted fabric.

The density of knit (courses/cm)

Represents the total number of horizontal rows measured per centimetre. The course is a horizontal row of loops formed by all the adjacent needles during one evolution. Course length is obtained by multiplying loop length with the number of needles involved in the production of the course.

Elasticity

Elasticity of a fabric refers to its ability to stretch and then return to its original shape and size. Elasticity is influenced by factors like type of fibers, the fabric's weave or knit pattern and the presence of elastic materials, like spandex or elastane. To determine if a material is elastic or not, a stretching force is applied to it. The elasticity is tested in both directions of the material. The elasticity of the material is important in the development of products with a good fit on the body, or even for its compression, both in the fashion industry and in the medical industry.

Thickness

The thickness is the distance, in mm, between the two faces of the fabric, measured under a certain pressure. To determine the thickness, a micrometer device is used. The thickness of the material is influenced by factors such as: the thickness of the threads and fibers, the fabric structure, the applied finishing treatments. The thickness parameter, is also strongly correlated with the fabric stiffness, hence it has a large impact to the drapability of the fabric.

Drapability (stiffness/flexural)

Drape - is the property of the fabric to form mobile folds under the action of its own weight. In this project, when the drapability was measured, using Cusick Drape Tester, the resulted draped image of the analized material was larger for the area supported by the disk, compared to the unsupported area of the material.

See through (yes/no)

Transparency - is the property of the fabric to allow the passage of a ray of light without changing the character of that ray. The opposite of transparency is opacity. The transparency of a textile material is influenced by the thickness of the thread used, the density of the fabric/knitting.

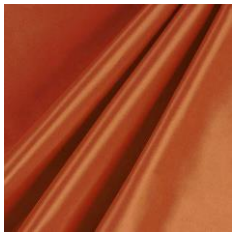
Feel/touch (smooth, rough,..)

It is a sensation when the material touches the skin, it can be quantified in slippery, stiff, smooth, soft, little rough.

Bending and stiffness properties

The bending of fabrics refers to the way that fabric flexes as a response to movement or external forces. The bending behaviour is expressed in terms of bending rigidity (also known as flexural rigidity), which provides important information about the ease with which the fabric bends. The fabric's flexural rigidity basically depends on the constituent fibres and yarns from which the fabric is manufactured, the fabric construction and most importantly the nature of the chemical treatment given to the fabric.

Examples of woven fabrics:



Taffeta is a crisp, smooth, plain woven fabric made from silk, nylon, cuprammonium rayons, acetate, or polyester. Modern taffeta was first woven in Italy and France and until the 1950s in Japan. Taffeta can vary in weight from light to medium and in levels of sheerness, depending on the type of fiber used and the tightness of the weave. Taffeta is frequently used for evening gowns, corsets, linings, blouse.

Twill is a type of textile weave with a pattern of diagonal parallel ribs. Twill is popular because it is very durable and hides stains well, and it is used for jeans, chinos, furniture coverings, bags, and more. Therefore, twill is commonly associated with British culture even though this type of fabric has been woven in other cultures for much longer. Twill fabric can be made in many different colours, thread counts, and styles, and this fabric is renowned for its excellent draping ability, which is derived from its unique weaving pattern

Canvas is an extremely durable plain-woven fabric. Modern canvas is usually made of cotton or linen. The word "canvas" is derived from the 13th century Anglo-French canevaz and the Old French canvas. Canvas fabric is used for trousers, skirts, jackets

Velvet is a type of woven tufted fabric in which the cut threads are evenly distributed, with a short, dense pile, giving it a distinctive soft feel. By extension, the word velvety means "smooth like velvet". In the past, velvet was typically made from silk. Today, velvet can be made from linen, cotton, wool and synthetic fibres. The first recorded mention of velvet fabric is from the 14th century, and scholars of the past mostly believed that this textile was originally produced in East Asia. Velvet is much more prevalent in womenswear

Ripstop fabrics are woven fabrics, often made of nylon, using a reinforcing technique that makes them more resistant to tearing and ripping. During weaving, stronger (and often thicker) reinforcement yarns are interwoven at regular intervals in a crosshatch pattern. Ripstop reinforcements are incorporated into heavier fabrics requiring extreme durability, such as army uniforms, outdoor and sports clothing

Examples of knitted fabrics:

Jersey, the generic name for the knitted fabrics predominantly used in the clothing manufacturing, has the origin in Jersey, an island country, which firstly produced it. The Jersey area was a major knitted products exporter since the medieval times. The jersey fabric was initial obtained from 100% wool, but later, other raw materials were added in it's fibrous composition, like cotton or synthetic fibers.

The most common available jersey structures are interlock and jacquard, jersey being considered to be an excellent fabric for draped garments, like dresses or women's tops.

Fabric database contains representative weaves and knits (table 2.1 and table 2.2):

Table 2.1. Examples of knitted fabrics in the database

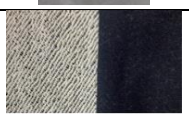
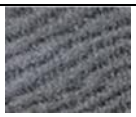
Code	Image	Composition (%)	Weight (gm^{-2})	Thickness (mm)
F3		100% cotton	145.8	0.48
F4		100 % cotton	210.2	0.467
F5		100 % cotton	163,86	0,674
F15		55% Polyester, 45% Polyacrylonitrile	315,8	1,86
F45		78% polyamide, 22 elastane	238	0,536

Table 2.2. Example of woven fabrics in the database

Code	Image	Composition (%)	Weight (gm^{-2})	Thickness (mm)
F1		100% cotton	200	0,38
F2		97% cotton, 3% elastane	115	0,22
F6		55% cotton + 45% cellofibre	103,3	0,228
F7		100% cotton	114,52	0,462
F8		100% cotton	138,54	0,292
F9		68% polyester, 29% viscose, 3% elastane	345	0,65

The fabrics presented in table 3 were selected according to their properties to develop the designed garment from the database:

Table 2.3. Summary and the properties of the collected fabrics

Garment	Styles	Materials Composition	Fabric Structures	Fabric weight (GSM)	Thickness (mm)	Finishes
Man Shirt	20	Cotton, polyester, Viscose, wool, and in various percentage composition	Knitted/Woven	75 - 200	0.2 - 0.6	Stripped, checked, and plain colours light fabrics. Easy iron and easy care
Man Trouser	24	Cotton, polyester, Viscose, wool, and in various percentage compositions some with Elastane	Knitted/Woven	206 - 447	0.3 - 1.8	Mostly plain dyed in dark colors, visual and feel effect brought by fabric construction
Woman Blouse	21	Cotton, polyester, Viscose, wool, Tencel, lyocell, and in various percentage composition	Knitted/Woven	60 - 145	0.1 - 0.3	Mostly Plain fabrics in different shades of white. Additional bright-coloured printed fabrics, easy iron, easy care
Woman Skirt	28	Cotton, polyester, Viscose, wool lyocell, denim* and in various percentage composition	Knitted/Woven	114 - 404	0.3 - 1.6	Fabrics with multiple visual effects, single coloured, multiple coloured

2.2.9. VISUAL PROPERTIES OF TEXTILE MATERIALS

These properties depend on the visual perception of fabric and are normally influenced by the fabric parameters discussed in the previous sections: (material composition, construction, colour, drape among others). The visual properties consist of:

Colour

Colour is a fundamental visual property of textiles, influencing their attractiveness and emotional appeal. In Fashion, the colour themes change with seasons. Textile materials

come in a vast array of colours, allowing designers to create visually captivating products that resonate with consumers. The colours can be plain/even, printed/ stripped etc. the colour is mainly described by RGB/pantone colour coded.
The materials can be in the same colour on the entire surface (figure 2.6), printed with a pattern created by the designer (figure 2.7) or woven from threads of different colours (figure 2.8).

Figure 2.6. One color fabric

Figure 2.7. Printed fabric

Figure 2.8. Fabric of different colored threads

Pattern

Patterns add personality and interest to textile materials, whether through intricate designs, geometric motifs, or bold prints. Patterns can evoke various emotions and set the tone for a product or space.

Texture

Texture refers to the tactile quality of a textile material's surface. It can range from smooth and soft to rough and coarse, enhancing the overall sensory experience and creating a unique aesthetic appeal. For example, in Figure 2.9 the material is made of two different threads, obtaining the effect of loops name "boucle". In Figure 2.10 is a multi-layered fabric with dense piles that are soft to the touch.

Figure 2.9. Boucle fabric

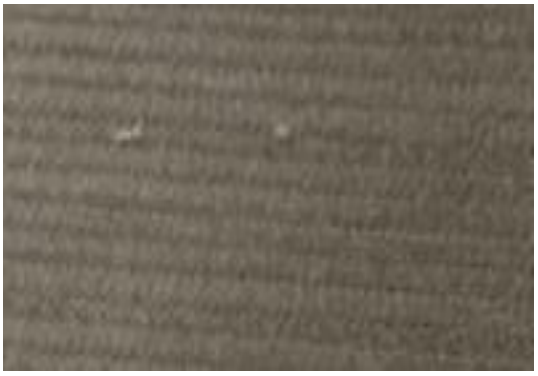


Figure 2.10. Velvet fabric

Luster

Lustre describes the sheen or shine of a textile material. It can vary from subtle to high-gloss, adding depth, richness, and glamour to the fabric, for example satin (figure 2.11).

Figure 2.11 Satin fabric

Transparent/see-through: a fabric property that allows the passage of light through a beam. These fabrics are made using thin thread and/or with low-density knit, for example ajour, a specific type of decorative openwork or cut-out pattern in fabrics (figure 2.12).

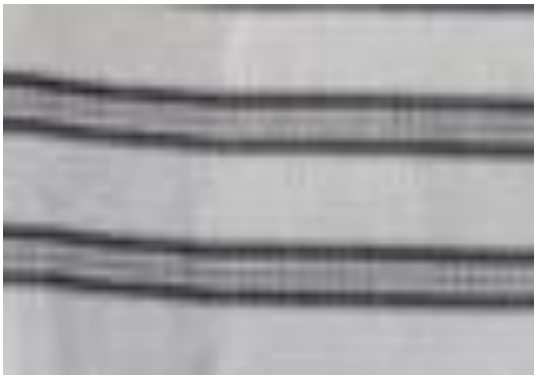


Figure 2.12 Ajour fabric

2.3. REAL FABRICS (PHYSICAL FABRICS) DATABASE

Physical (real) fabrics are the actual fabrics that we work with in the real world, while digital fabrics are the virtual fabrics that enable online product development.

2.3.1. PROJECT OWN FABRICS, (FABRIC INFORMATION AND SPECIFICATIONS)

The fabric database consists total of 49 fabric samples (F1-F49). The fabric parameters defined are fabric image, colour according to Pantone or RGB code, precise material composition, type of weave/knit, yarn density in the weave/knit, fabric weight, thickness, see through (yes or no), and the touch feeling (rough or smooth). Table 2.4 shows an example of fabric specifications for F9 used in Men trousers.

Table 2.4.F9 Fabric technical specification

Item	Description
Fabric code	TC2222/D8
Used in which garment /style	Men trouser – style 2 Casual garment
Image	
Colour (according to Pantone Code/RGB code)	Grey
Material exact composition	68% Polyester, 29% Viscose, 3% Elastane
Construction description: weave/knitted/other	Weave
Type of weave/ knit	Taffeta
The density of weave/ knit (warps/Wales cm or courses/cm)	
Elasticity	Warp: >=14; Weft: >=12: EN 14704-1:2005
Weight (GSM)	345 g/m^2: ISO 3801-1977
Thickness	0,65 mm: ISO 5084-1996
Drapability (stiffness/flexural)	
See through (yes/no)	No
Feel/touch (smooth, rough,…)	smooth

2.3.2. SWATCH BOOKS AND DESCRIPTION OF FABRIC COLLECTION/ LECTRA DATABASE)

A swatch book is a collection of small real fabric samples that showcase the appearance of the fabrics with different textures, colours, patterns, and material composition to provide a tangible and visual guide to a wide range of fabrics.

A swatch book can give inspiration on the (real) fabric choices or can be used to search for the physical parameters of the real fabrics that are necessary to identify their digital twin. They provide the designers with a hands-on experience of the fabrics so they can

feel the texture, weight, and drape of each material, helping them choose the right fabric for a particular garment.

The pink swatch book is the main one used by the designers and students, teachers, to identify random fabrics. The book is specifically designed to provide an extensive collection of fabric swatches (151) to serve as a practical resource for designers, students, and professionals who work with fabrics in the context of fashion design.

Textile manufacturers often release seasonal swatch books that showcase the latest fabric trends, colours, and patterns. This helps designers stay updated with current fashion and design trends.

2.4. DIGITAL (VIRTUAL) FABRICS AND TRANSITION FROM PHYSICAL FABRIC TO DIGITAL FABRICS

Digital fabrics are digital twins of real (physical) fabrics.

To identify the most relevant digital twin fabric, the software behind the platform predicts the most relevant digital fabric closest to the fabric parameters defined by the users of the platform, (fabric composition, weight, thickness, structure, drapability are the minimum fabric parameters required for this identification).

Measuring drapability involves assessing various characteristics, such as fabric stiffness, flexibility, and the way it hangs. In this project the draping image was taken using a Cusick Drape Tester, i.e. orthogonal projections of the drapes of textiles were taken using a digital camera. In addition, the drape coefficients (DC) and the number of nodes were calculated using Drape Analyser software

To identify the most relevant digital fabric, the drape image of real fabric is compared with the drape images of digital fabrics. The drape image (**see *Figure 2.13*)** is taken with a resolution of 1296x1025 pixels). The support diameter of the drape plate is 18 cm while the fabric sample has a diameter of 30 cm.

Table 2.4 shows the drape images of some fabrics used in woman skirt.

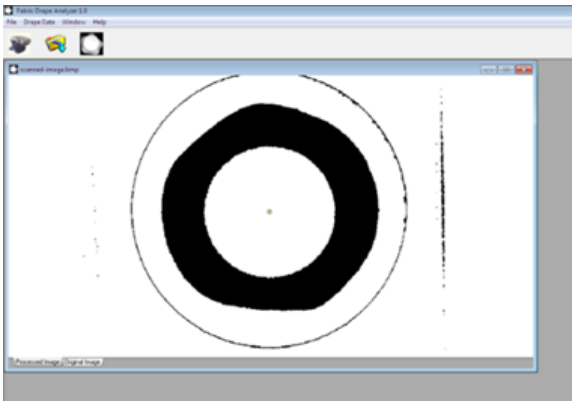
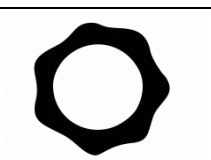


Figure 2.13. Fabric drape image (support diameter is 18 cm and fabric sample diameters is 30cm)

Table 2.4. Drape images of fabrics used in Women's skirt

	Women skirt				
Fabric ID	***Orthogonal projections of the draped fabrics***	**Drape ratio**	**Node number**	**Digital Fashion project Fabric database No.**	**Lectra fabric match No.**
CITEVE_F01		0.629	7	**F26**	**30**
MARIBOR_F05		0.647	7	**F27**	**30**
INCDTP_F11		0.628	7	**F29**	**30**
TUIASI_F08		0.378	7	**F32**	**30**
HOGENT F2		0.791	12	**F34**	**100**

2.5. IMPORTANCE OF FABRIC SELECTION IN THE DESIGN PROCESS

The material for clothing is chosen depending on the design, functionality and destination of the product. A designer must take into account, in addition, the visual and physical-mechanical properties of the materials. Thickness and mass/ weight and drape of the fabric influence the arrangement of a garment on the body.

For the virtual simulation, a base fabric is used that covers the usual material types presented.

Within the project database:

- You can search for fabrics by materials, composition, structure, or
- Based on your requirements, design a garment

For example, light fabric will be chosen for underwear, made of natural fibers or mixed materials composition, (with anti-bacterial properties) and with elasticity in the structure, while for summer garments, such as dresses, blouses, or shirts, are composed of natural fibres or mixed material composition, to improve the appearance and drape on the body.

Trousers and Jackets can be made of thicker synthetic or mixed materials, they will generally be lined inside with other textile materials.

A special category is swimwear and fitness products, which require materials/fabrics with special properties of elasticity, hygroscopicity, and breathability. In this regard, special materials/fabrics have been developed and are on the market.

Winter clothing products as the last layer on the body can be of natural origin, such as natural or artificial leather, fur, or synthetic materials that do not allow heat loss and have several layers of materials in their composition.

Evening dresses or costumes, elegant or those for special occasions, are made of precious materials, which have a good drape, such as silk, velvet, sequins, lace, and veil, the main characteristic being the aesthetic appeal.

CONCLUSIONS

The fabric database developed in the Digital Fashion project framework comprises a total of 49 real fabric samples (labeled F1-F49), categorized based on their intended garment use, namely Men's shirts, Men's trousers, Women's blouses, and Women's skirts. Their important fabric parameters related to the garment feel, comfort, and fitting are described and the criteria for selecting a digital twin fabric (from the Lectra database) of the real fabric are outlined.

The module aims to develop specific competencies related to fabric knowledge, fabric construction, and the properties of both real and digital fabrics.

The module aims to equip learners/ designers with the necessary knowledge to work effectively with fabrics in both real and digital environments. Learners should be proficient in assessing information related to various fabrics, especially in the digital environment and are also expected to be able to identify and know the essential fabrics that they use in the digital platform.

The study underscores the importance of understanding the properties of both digital and real fabrics towards garment development.

BIBLIOGRAPHY

[1] Sinclair R. (Eds.). (2014). Textiles and Fashion Materials, Design and Technology.Cambridge, United Kingdom: Woodhead Publishing

[2] Amanda Johnston, Clive Hallet. (2014) *Fabric for Fashion, The Swatch Book* (Second Edition), London, United Kingdom: Laurence King, Pages 1-88.

[3] Odhiambo S. et al. (2024) *Library of Knowledge for virtual training in Fashion design.*Communications in development and Assembly of Textile Products. Dresden, Germany.

I. R. Radulescu, S. Olaru, M. Jomir, S. Odhiambo and X. Zeng. (2023) *E-Learning Platform for Digital Customization of Garments*. *46th International Spring Seminar on Electronics Technology (ISSE)*, Timisoara, Romania, Pages 1-4.

[4] Kyosev Y. (2022), Material Description for Textile draping Simulation: Data structure, Open Data Exchange Formats and System for Automatic Analysis of Experimental Series. *Textile Research Journal*;92(9-10):1519-1536.

[5] www.fibre2fashion.com, fibre to Fashion [online] accessed 22 January [2024]

[6] https://glamobserver.com/what-are-textiles-a-guide-to-fashion-fabrics/[online] accessed 22 January [2024]

[7] www.journalname.com, Journal Name [online], Available at: www.journalname.com, [Accessed 18 October 2023]

[8] A.G.I.R., Societatea inginerilor textilişti, *Manualul inginerului textilist*, Editura AGIR, Bucureşti, 2003

[9] Matusiak M, Influence of the Structural Parameters of Woven Fabrics on their Drapeability, Fibres & Textiles in Eastern Europe, 2017, DOI: 10.5604/12303666.1227883

[10] Buyukaslan E., Jevšnik S., Kalaoglu F., Drape of Virtual Garments on Body Models: Impact of Mechanical Properties of the Fabrics, Conference paper, 2015, DOI: 10.15221/15.127.

[11] Ionescu I. et. al, Digital Fashion – A Must in Our Days, International Symposium "Technical Textiles - Present and Future", 2024, DOI: 10.2478/9788367405355-026

Digital Fashion Project

Collaborative Online International Learning in Digital Fashion

3. GARMENT DATABASE

3.1. DESIGN CASES

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LEARNING OUTCOMES

COMMON LEARNING OUTCOME	THE ELABORATION AND USE OF SPECIFICATIONS SHEET FOR THE GARMENTS MODELS
SPECIFIC LEARNING OUTCOMES	• To know the elements of the specifications sheets (technical drawing, description) • To identify the elements of the garments • To be able to select a model from the garments database

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CONTENT

3.1. DESIGN CASES

3.1.1. TECHNICAL (SPECIFICATIONS) SHEET FOR GARMENTS

To transform a designer sketch in garments hanging on a shop rack, it is necessary to elaborate technical documentation. All the processes developed in a clothing company are based on the documents from the technical documentation. These constitute the informational flow of the company.

WHAT IS A GARMENT TECHNICAL SHEET?

The garment technical sheet contains a range of information relating to the identity of the product, i.e. product type, model, technical sketch of the model, brief description of the product elements. In addition, there may be information relating to the customer, season for which the product is made, size range, packaging details, color positions, specific finish, etc.

The technical sheet is the basic technical document for the brief characterization of a clothing product and is found, in different forms, in most clothing companies. Depending on their specifics and the type of product, a number of elements can be listed which are found in most products of the same type, or the fiche is completed with different information.

First, everything starts with the designer sketch. From this it will be draw a technical sketch of the product. This will be completed with general information about the garment and all these data will be put in the **Garment Technical Sheet**.

DEVELOPMENT OF A TECHNICAL SHEET FOR CLOTHING MODELS

Developing a technical sheet for clothing models is an important process in the development and production of garments. Here are several essential elements you can include in the technical sheet:

1. **General Information:**
- Product Name: The specific name of the clothing model.
- Product Reference: A unique code or reference for product identification.
- Season: The season for which the product is intended (spring/summer, fall/winter).
- Color: Color palette available for the product.
- **Sizes and Dimensions.** (Size Charts: Available sizes for the product and details on how to measure correctly)
- **Composition and Materials** (Description of the raw materials and accessories used for the garment.)

2. **Design and Style:**

- Fit Type: Description of the cutting style (regular, slim fit, oversized, etc.).
- Design Details: Specific design elements, such as pockets, pleats, decorative stitching, etc.

3. **Care Instructions**
4. **Packaging and Labeling:**

- **Special Technologies or Unique Features:** Waterproofness, Breathability, Insulation: If the product has special features, these should be specified here.

A well-prepared technical specifications sheet ensures a smooth transition from design to production, helping to maintain consistency and quality in the manufacturing of garments. It serves as a reference guide for everyone involved in the production chain.

Technical Sketch and the description of that can include:

- **Detailed Illustration**: The technical sketch is a detailed, to scale illustration of the garment that provides a visual reference for the production team. It typically includes front and back views and may also include side views or close-ups of specific details.
- **Annotations:** Key features of the garment are annotated on the sketch, indicating important details such as seams, stitches, darts, pleats, pockets, and any embellishments. These annotations help clarify how different elements of the garment should be constructed.
- **Proportions and Dimensions:** The sketch should accurately represent the proportions and dimensions of the garment, helping the production team understand how the final product should look.
- **Color Details:** While the technical sketch is often in black and white, color details may be indicated through shading, notes, or a separate color reference chart.
- **Silhouette:** Describes the overall shape or outline of the garment. For example, it could be described as fitted, loose, A-line, etc.
- **Neckline:** Specifies the type of neckline the garment has. This might include variations like crew neck, V-neck, scoop neck, boat neck, etc.
- **Sleeve Length and Type:** Clearly defines the length and style of sleeves. Options include short sleeves, long sleeves, cap sleeves, raglan or sleeveless.
- **Fit:** Describes how the garment is intended to fit on the body, such as regular fit, slim fit, loose fit, or oversized.
- **Hemline:** Specifies the shape and length of the garment's hem. This can include details like straight, rounded, asymmetrical, or high-low hemlines.
- **Materials:** Provides information about the primary fabric, lining material, and any additional materials used for trims or embellishments.

- **Construction Details:** Describes key construction elements such as seams, stitching techniques, and closure types (zippers, buttons, snaps).
- **Measurements and Sizing:** Includes a size chart with measurements for each size offered, as well as specific garment measurements for key areas like bust, waist, hip, length, and sleeve length.

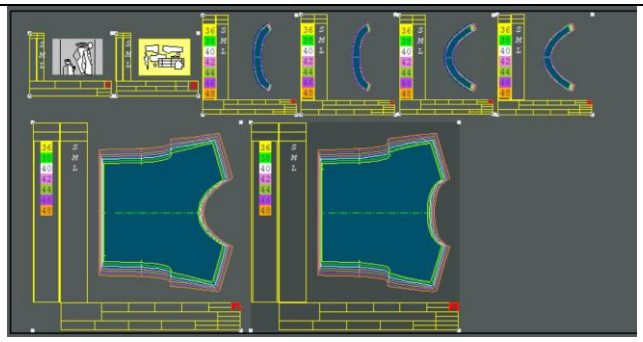
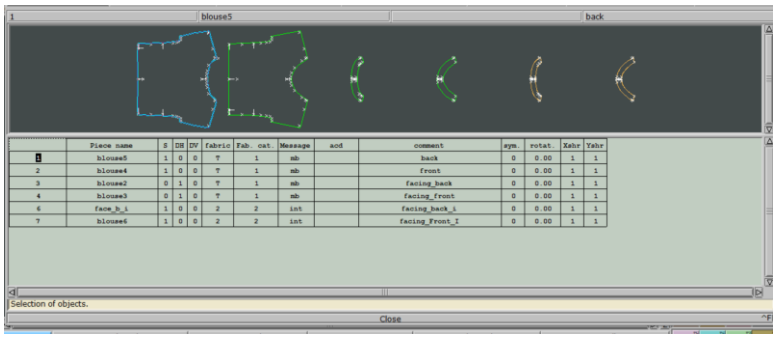
The technical sheet is then used by the manufacturer to create the pattern for the garment, grade it for different sizes, and lastly construct a sample.

Figure 3.1. Technical file of a garment

In the DigitalFashion platform the technical sheet of the garments contains information about garment, style, fabric, sketchand patterns, as presented in table 3.1.

Table 3.1. Technical sheet in Digital Fashion platform

Item	Description
Garment	**Woman blouse**

Style	**KIMONO SLEEVE -short**
Fabric	**100% Cotton**
Technical drawing	 Front  Back
Digital pattern(Lectra/DXF) with grading in different sizes	
	
Pattern pieces	This information will be in the above file: 

3.1.1. ANALYSE AND DESCRIPTION OF THE MODELS FROM THE DATABASE

The structural analysis of the product aims to identify the elements of the product providing information on the complexity of the product, the type of elements and their positioning in the product. Any garment can be broken down into one or more elements. An elements database can be structured and using it will facilitate the constructive and technological design of a particular model in order to digitize the design process.

Product elements can be defined as that part of the product that is characterized by:

- its own dominant function (to protect, to store, to fix, etc.);

- is interchangeable - implies that a given element with its own function, shape and appearance can also be used in another product model without the need to change the manufacturing technology.

A product can be considered to be structured from a number of elements defined by their own dominant function and capable of being changed and translated from one model to another. The garment 'rests' on the basic element(s) (e.g. front). Some elements of the product are absolutely necessary, constituting the 'skeleton' of the product, other elements may or may not be included in the product and may or may not be identical or different from one model to another (e.g. collars, waistband etc.). In a particular type of clothing product, the types of elements are presented in figure 2. Some of the elements are made from one or more cut pieces, some are integrated in the cut pieces of another element (as hems are).

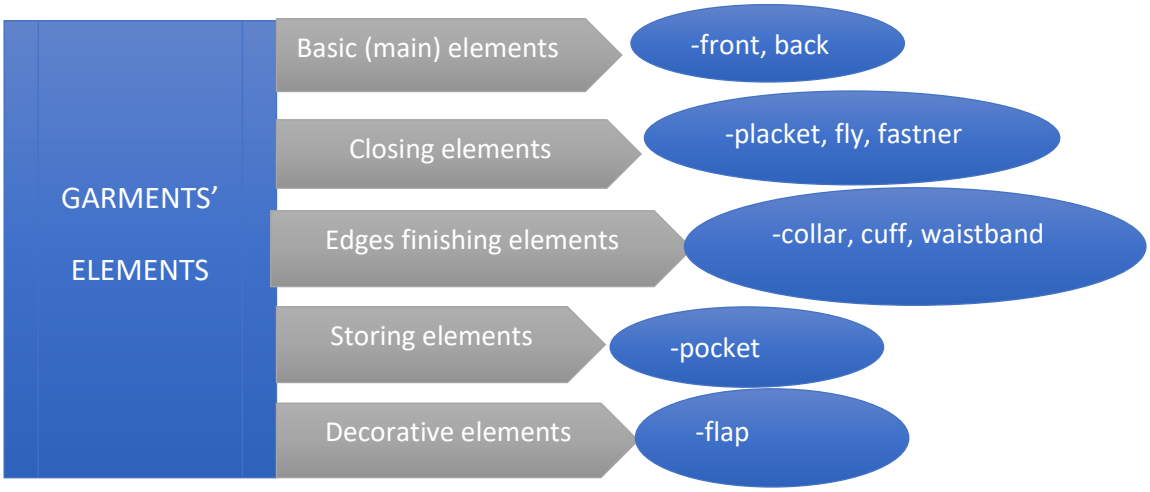


Figure 3.2. Garment's Elements

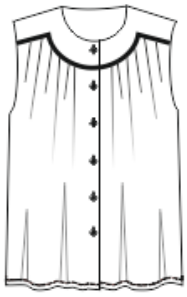
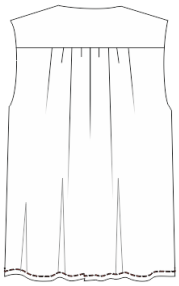
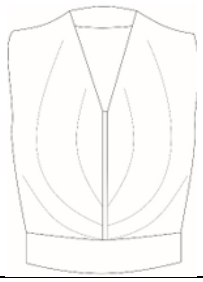
BASIC (MAIN) ELEMENTS

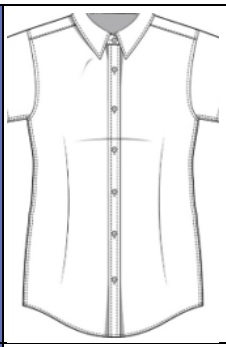
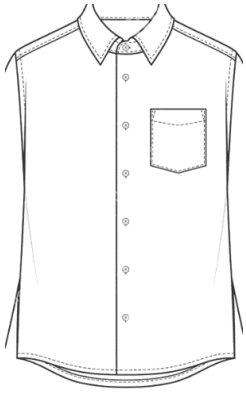
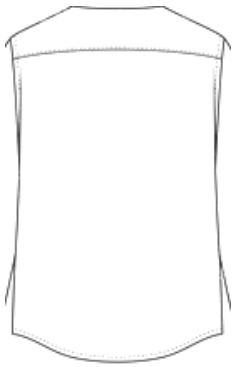
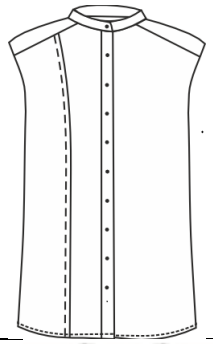
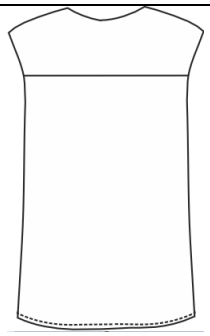
For the four garment types, namely blouse, skirt, shirt and trousers, the main elements are: front, back, sleeve.
The shape of the main elements depends of:

- Garments shape – can be body conforming fit, using darts, seams, stretch material to flare silhouette, oversized using material gathering for example
- Length: from waist line to hip or dress length
- Sleeves: varies in length (short or long) or sleeveless, sleeve cap smooth, gathered or pleated
- Armhole: can be classic or raglan or kimono, with extended shoulder line.
- Neckline: rounded, close to the neck, V or heart shape.

These elements are made from one or more parts. On front or back there can be yoke, side panel etc. On front or sleeve there can be also closing elements, pockets etc. For decorative reasons there are specific elements that can be applied on basic elements, such as embroideries, prints, applied laces or ruffles, decorative stitches.
The blouses and shirts of the garment database have the following shapes and short description for the front and back (table 3.2).

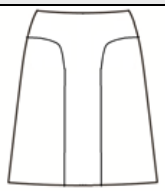
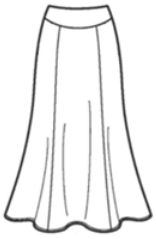
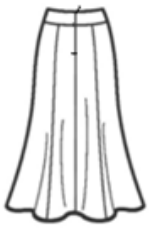
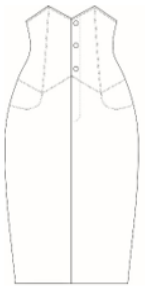
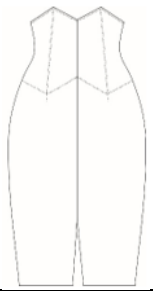
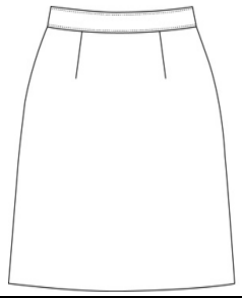
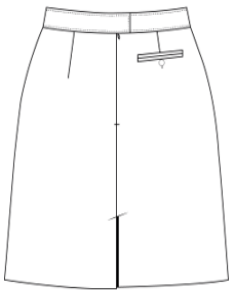
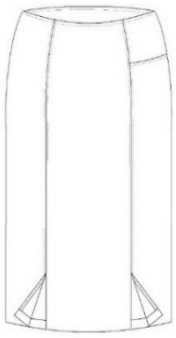
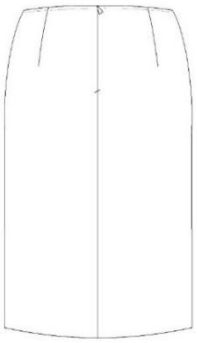
Table 3.2. Shapes of basic elements for blouses and shirts

Garment type	Shape / short description	
	Front	**Back**
Blouse	 One panel, hip length, Kimono, straight silhouette, one panel for rounded boat shape neckline	 Hip length, Kimono, no fit, one panel for rounded boat shape neckline
	 2 symmetric panels, hip length, flare, with yoke on shoulder and round neckline with buttons closing element. Piping between the yoke and the front panel.	 Yoke on the shoulders, back panel gathered on the middle
	 One panel, chest darts, V neckline, slightly flare at the bottom, hip length	 One panel, round neckline, slightly flare at the bottom
	 2 panels, central zipper, V neckline, waist line length, gathered ruffled shape.	 2 panels with central back seam

		2 symmetric panels, waist darts and round neckline, hip length, slightly rounded in front. The back yoke is extended on front		Upper yoke, central back with waist darts, hip length, rounded on central back
Shirt		2symmetric panels with buttons closing element, waist darts and round on front. Hip length, slightly rounded on the sides, side vent.		Upper yoke, central back, hip length, rounded on central back, longer than the front
		2 asymmetrical front, with side panel on the right front. Hip length, straight.		Upper yoke, central back, hip length, straight.
		Front one panel, straight silhouette, from knit fabric. Round neckline, hip length, straight.		Back one panel, Front one panel, straight silhouette, from knit fabric. Round neckline, hip length, straight

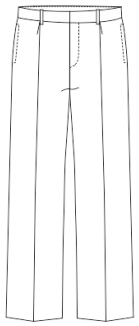
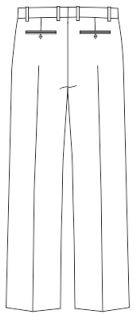
The skirt of the garment database have the following shapes and short description for the back (table 3.3).

Table 3.3 Shapes of basic elements for skirts

Shape / Short description	
Front	**Back**
 One central panel and two side panels, slightly flared at the bottom.	 2 symmetrical panels, with central back seam, waist darts
 Hip yoke, three panels, flared at the bottom. Ankle length.	 Hip yoke, four panels, flared at the bottom. Ankle length. Zip on central back seam.
 Straight shape, with central front seam, high waist, yoke at waist line, with two corners, side pockets, knee line length. Zip fly on central seam and three buttons closure on the yoke.	 Straight shape, with central back seam, high waist, yoke at waist line, with two corners up and bottom, knee line length.central vent.
 One front panel with waist darts, slightly flared at the bottom, above knee length.	 2 back panels with waist darts, slightly flared at the bottom, above knee length. Zip closure, central vent, one pipped pocket on right back.
 Straight silhouette, two side panels, assymetric, vents at the bottom of decorative seams, length bellow knees, Inseam pocket on right panel.	 2 back panels with waist darts, invizible zip on central seam.

Men trousers are basically of two types: formal (casual) or blue jeans. The shape of the trousers are as shown in table 3.4. They can have different lengths.

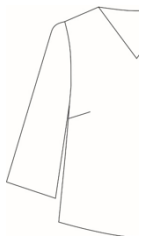
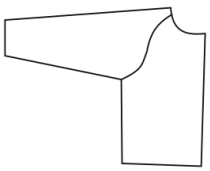
Table 3.4 Shapes of basic elements for trousers

			
Classic straight silhouette	**Back one dart**	**Front blue jeans type**	**Back blue Jeans type**

SLEEVES

The most important feature of a sleeve design consists in the armscye shape. The set-in sleeves are placed on the natural position of the body (table 3.5). If the shoulder line is extended, and or the armscye is lowered, the sleeve (as in men shirts), the sleeve is a looser fitted one. In some cases the sleeve is cut together with the front or back, in the kimono style. If the sleeve is reaching the neckline, being part of the front and the back of the garment, it is a raglan style.

Table 3.5 Sleeves types

Set-in sleeve (classic)	Loose fit sleeve	Kimono sleeve	Raglan sleeve
			

Another important feature of the sleeve is its length. Usually we have short or long sleeves.

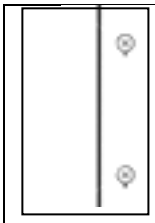
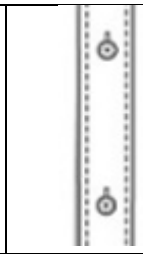
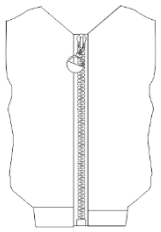
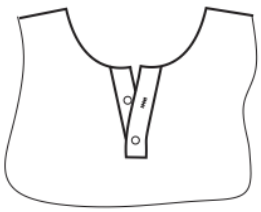
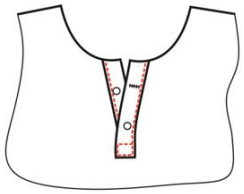
CLOSING ELEMENTS

Closing elements are a very important part of a garment design and they are very different depending on the garment type and model. Their main function is to get a garment on and off the body, to allow the body movement and sometimes they contribute to the garment aesthetic. The closing elements are not necessary when the garments are made of stretch or knit fabrics or on garments models with large silhouettes. The closing elements are different from the following points of view:

1. Clothing accessory (buttons, zipper, hooks and eye, snaps, hook and loop tape etc.)
2. Visibility of the elements- sometimes the closing elements are visible on the garment, as in a button fastener on a shirt, sometimes the clothing element is hidden, as the zipper fly on trousers or invisible zipper on back seam on a skirt.
3. Position on the garment. Closures for shirt and blouses are usually placed on center front, from top to bottom (regular shirts) or with limited length (as in Polo shirt placket). Sometimes the closure element is placed on the back. Women's closure elements are overlapped right over left, men's are overlapped left over right.

The blouses and shirts are usually closed with buttons, on front from top to bottom (table 3.6).

Table 3.6. Closing elements for blouses or shirts

				
Buttons closure elements		**Zipper close**	**Polo shirts placket**	

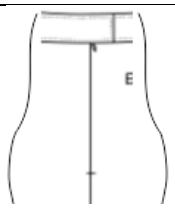
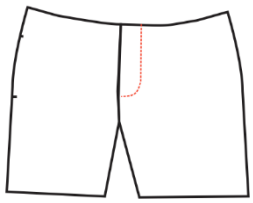
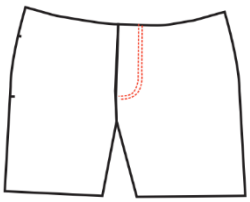
The design of the closure is important only for the upper part, the one with the buttonholes, as the other part, the one with the buttons is hidden. Depending on the way that the fabric is folded and the topstitching, the design of the element may vary, as shown in table 5. Sometimes the closing element is a zipper inserted in the central front seam.

The closure element placed on a limited part of the main element is frequently found on Polo shirts. The number of the buttons or snaps may vary from 2 to 4 and sometimes, the overlap is depending to the wearer gender and it may have additional topstitching of various forms.

Closing elements for garments with waist support, skirt and trousers

Most of the time both the skirts and the trousers are closed with a short zipper. The skirts are closed with an hidden zipper placed in the central back seam (table 3.7). Additional closing element may be buttons or hooks and eyes placed on the waistband. On other models the closing element can be placed on central front and it is composed from a zipper fly, as in men trousers, and an additional button closing placed on the waistband.

Table 3.7. Closing elements for skirts or trousers

			
Hidden zipper	**Buttons and zipper**	**Men trousers fly with 1 or 2 J stitch**	

For men trousers the usual closing element is a zipper fly. The front parts are overlapped and one topstitch or two, in J form are sewed.

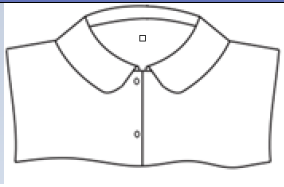
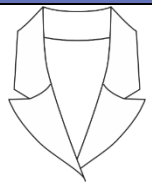
EDGE FINISHING ELEMENTS

Edge finishing elements at the upper part of the garments

The **neckline** of a blouses or shirt is usually finished simply with a facing, ribbed band or bias binding or, for aesthetic reasons, with a collar. The neck line can be round, V shape, scooped or heart shape. Collars are elements that are attached permanently on the upper edge of front and/or back of a blouse or shirt.

The collars design may be very different, but essentially there can be identify four types: stand collars, flat collars, lapel (tailored) collar, shawl collars (table 8).

Table 8 Collar types

Stand collar	Flat collar	Lapel collar	Shawl collar
			

Stand collars are used mainly for men shirts, but very often we can find them on blouses/ dresses, the only difference consists in the stand overlapping, right above left for women products, the same as for closing elements. The stand collar has a part that fits close to the neck, the band and a rolled part. Some collars, also called mandarin collars, consists only in this band. The corners of the mandarin collar can be rounded or not. The two parts of the stand collars can be cut form one piece or separately, for a better fit near the neck.
The size and the shape of the collars varies very much, depending on the design. The corners of the collar can be regular, spread, round, with buttons down.

The flat collars have the neckline curves with similar shape of the neckline of the garment. Sometimes, depending on the design, the collars may be slightly raised on the neck.These types of collars can have different shapes and width and they can be near the shoulder line. Example of flat collars are either so called Peter Pan or Polo collar, where the collar is knitted.

The lapel or tailored collars are partial roll collars the front the collar lies flat on the garment. The base of the collar is inserted into the lapel. These types of collars vary according with the position of the breakpoint, the shape and width of the collar and lapel.
Shawl collars are designed as an extension of the front. They are similar to tailored collars, but they have no gorge line.

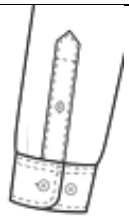
The bottom part of the blouses and shirts is finished with a simple hem or with a waistband (similar with the ones from skirts or trousers).

Sleeves bottom edge finishing

The bottom sleeve may be finished with a simple hem, usually for women blouse or with a cuff – more frequently at men shirt. Hems may be blind hemmed, double rolled and topstitched or simple folded and topstitched with a cover stitch when the garment is made of knitted fabric. Sometimes, with aesthetic role, especially at short sleeves, the hems are folded on the front part of the garment.

The cuffs are with functional role or only aesthetic. For easing the dressing process, the cuffs are in need of a vent placed on the sleeve, slightly back. The cuffs may have different width and shapes (table 3.9).

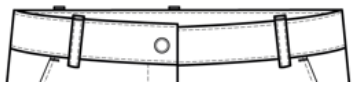
Table 3.9 . Cuffs shape

		
Narrow cuff, circular, no closing element (piping cuff)	**Normal shirt cuff, round corners, 2 buttons, vent with tape in V shape, one button, decorative topstitch**	**Wide cuff, 1 button, tape vent straight, topstitched**

Edge finishing elements of the skirts and trousers

For the skirt and trousers the upper part is finished with a waist band or simply by using a facing (table 3.10). The shape of the waist band may be straight, with or without extension, narrow or wide or with different shapes. For inserting a belt, the waistband can have attached belt loops.

Table 3.10 Upper edge finishing of skirts and trousers

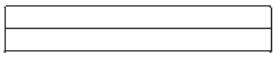
Facing finishing	Waistband with belt loops	Waistband with extension
		

The bottom part of the skirts and trousers can be blind hemmed, rolled and topstitched.

STORAGE ELEMENTS

The pockets are the basic storage elements, they can be found on almost all garments types, usually on front. These consists of an extra cut piece fabric to the outside or inside the garment to form a bag with an opening on top or side. There are four types of pockets (table 3.11): patch pockets, side pockets, inseam pockets and piped (welt) pockets.

Table 3.11 Pockets types

Patch pocket	Side pocket	Inseam pocket	Piped pocked
			

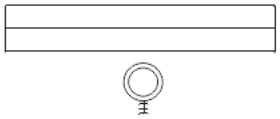
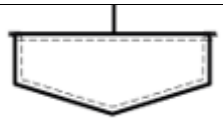
Patch pockets are outside pockets, usually placed on the left front of a shirt or on blue jeans back. The pockets can have different shapes and sizes,with folds, pleats, tucks, decorative stitches. Patch pockets can be made three dimensional by adding a pleat of fabric on the perimeter of the pocket or on the lateral sides. They are specific for cargo pants. The pockets are applied on the main element with one or two stitches, with threads that are on the same or different color as the basic textile material. Sometimes, either for aesthetic reasons or in order to ensure the content of the pocket, on top of it, a flap is placed.

Side pockets are made on garments like skirts or trousers, placed on their upper part – on hip-, up to the waist line. The opening line is cut on the front pattern, the pocket bag is inside the garment and only the opening line is visible and it is usually topstitched. The shape of the opening line can be in a straight or curved line. At jeans, on the right pocket facing is placed a coin pocket – patch type.

Inseam pockets are designed into an existing seam of the garment, like the side seams or between the front and the waistband. In this way, the visibility of the pocket is minimum.

Piped (welt) pockets, as shown in table 3.12, also known as cut pockets can be done anywhere on the surface of the main elements. On the opening of the pocket can be sew one or two piped elements. For a more special look, the opening can be doubled with a zipper or a flap, or adding a button and a button hole for aesthetic reasons or for ensuring the pocket content.

Table 3.12 Piped pockets

			
One side welt	**Double welt**	**Double welt with button**	**Flap and one side welt**

Double welt pocket is usually about 0.5 cm wide, in case there is only one welt the wide is usually about one cm wide. Sometimes, the upper welt is replaced with a flap.

CONCLUSIONS

The combination of a detailed technical sketch and a comprehensive description ensures that the design intent is accurately communicated to the production team, minimizing errors, and ensuring consistency in the final product.

Any garment can be broken down into one or more elements. An elements database can be structured and using it will facilitate the constructive and technological design of a particular model in order to digitize the design process.

BIBLIOGRAPHY

[1] What is a Garment Spec Sheet and How to Add one in a Tech Pack [Internet]. Available from: https://techpacker.com/blog/design/what-is-a-garment-spec-sheet/

[2] Tech Pack in Garment Industry: Benefits & How to Make - Textile Learner [Internet]. Available from: https://textilelearner.net/tech-pack-in-garment-industry/

[3] Specification Sheet in Garments Industry [Internet]. Available from: https://www.textileindustry.net/garments-specification-sheet/

[4] Understanding of Technical File of a Garment for beginner [Internet]. Available from: https://textilefocus.com/understanding-of-technical-file-of-a-garment-for-beginner/

[5] Tech Pack and It's Content – Online Textile Academy [Internet]. Available from: https://www.onlinetextileacademy.com/tech-pack-content-garment-manufacturing/

[6] Technical Drawing: Specs and Flats - Textile Learner [Internet]. Available from: https://textilelearner.net/technical-drawing-specs-and-flats/

[7] Fashion Flat Sketches Basics [Internet]. Available from: https://techpacker.com/blog/design/what-you-need-to-know-about-fashion-flat-sketches/

[8] Keisler, Sandra, J., Garner, Myrna J., Beyond Design, The Synergy of Apparel Product Development, Third Edition, Fairchild Book, New York, 2012

[9] Papaghiuc V. –Variante tehnologice de confecţionare a produselor de îmbrăcăminte, Ed. Performantica Iaşi, 2008

[10] Papaghiuc V., Ionescu I., Florea A.- Proiectarea sistemelor de fabricatie pentru produse de imbracaminte, Ed. Performantica Iasi, 2004

Digital Fashion Project

Collaborative Online International Learning in Digital Fashion

3. GARMENT DATABASE

3.1. 2D GARMENT DESIGN

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LEARNING OUTCOMES

COMMON LEARNING OUTCOME	THE USE OF DIGITAL TOOLS TO DESIGN THE BASIC 2D SHAPES OF THE SELECTED PRODUCT CATEGORIES
SPECIFIC LEARNING OUTCOMES	• Interpret measurements and pattern requirements from technical drawings and specifications sheets; • Design the shape of basic blocks; • Modify patterns to create design features

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CONTENT

3.2. 2D GARMENT DESIGN

3.2.1. MEASUREMENTS AND PATTERN REQUIREMENTS

Pattern-making is a bridge between fashion design and production. A model sketch can be transformed into a garment via a pattern that interprets the style of the fashion line in the form of garments. The shape of the patterns needed for the new model must be well-dimensioned and have precise contours, as they influence the quality of the garment.The appearance of the garment model (fit and balance) determines its final acceptance or rejection.

A pattern maker usually designs a pattern on the basis of a flat sketch with measurements. The shape of these main pieces (basic pattern, blocks or slopes) is then altered according to the details of the model and the customer's body shape. The following methods are known in the field of pattern making: drafting, draping and flat pattern making. The flat pattern method is the most commonly used and the shape of the patterns is developed with the help of special programs (CAD software such as Lectra, including Gerber or Gemini, Optitex, etc.). The pattern-making software allows the input of individual customer measurements for an interactive pattern design process. The digital garment pieces are used to create the virtual 3D prototype of the selected model to check whether the chosen design process corresponds to the desired shape and size of the garment.

Female – Garments for Full Body

Size	38	42	46
Bust girth	88	96	104
Range bust girth	86 - 90	94 - 98	102 - 107
Body height	166	166	166
Body height	88	96	104
Waist girth	70	77	87
High hip girth	76.5	84.5	97.5
Hip girth	95.5	101	107

Figure 3.3. Measurement human bodies for different sizes

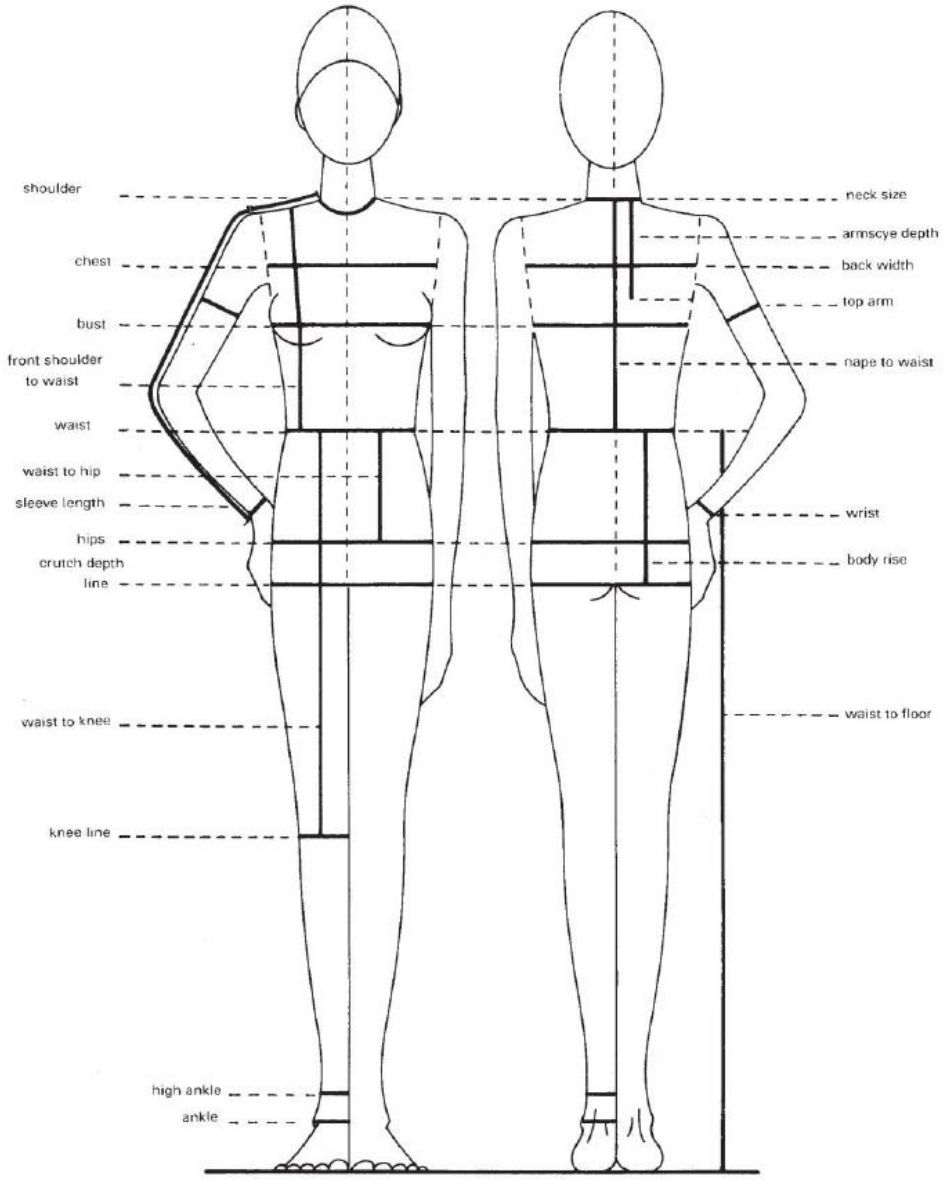


Figure 3.4. Body measurements

The following body measurements (key measurements) are usually used in a pattern algorithm (figure 3.3, 3.4):

- body height→ the distance between the crown of the head to the sole of the feet (vertical, straight).
- bust circumference→ Bust for women, chest for men. Bust circumference: Horizontal girth measured at bust point level. Chest circumference: Horizontal girth of torso measured at axilla (or armpit). Source: ISO 8559-1:2017;

- waist circumference→ ISO 8559-1: Horizontal girth of the body measured at the waist level. Waist level: midway between the lowest rib point and the highest point of the hip bone at the side of the body. The narrowest part is not necessary the waist;
- hips circumference→ ISO 8559-1: Horizontal girth of the body measured at the hip level. Hip level: level of the greatest projection at the back of the body (buttocks).

In addition to the information about the garment and the body measurements, the designer uses constructive allowances to ensure the comfort and freedom of movement of the customer. The values of these allowances are determined by the model silhouette, the human body shape, the number of textile materials required for production and their physical properties.
The process of 2D pattern-making of the basic blocks is a geometric algorithm based on mathematical relationships and a specific sequence for drawing baselines and contour lines. This process includes the following steps:

- Select the required measurements;
- Development of pattern block;
- Pattern alterations according to model details;
- Validate the design solution by creating and analysing the physical/virtual prototype;
- Grading → to obtain the shape of the garment model for all required sizes of the model technical specification sheet;
- Development of the production patterns. The production patterns are templates to cut out fabric that matches the required specifications to sew a garment.

3.2.2. DEVELOPMENT OF A DESIGN SCENARIO

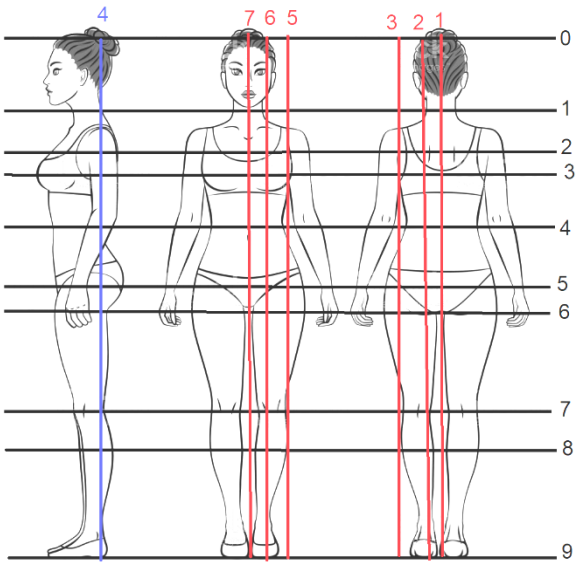
The fundamental problem in the production of clothing is to find the best solutions to adapt the structure of textile materials, structures with regular geometric shapes, and certain physical-mechanical properties to the shape of the human body.

Designing the geometry of unrolled surfaces (pattern construction) is a complex problem based on correct knowledge and analysis of the shape of the human body, stylistic details of the model, understanding the influence of the properties of textile materials on the structure of the product and the role of manufacturing technology.

The flat pattern-making method is based on a geometric algorithm with specific mathematic relations and drawing base and contour line sequences.

This method has a closed algorithm because, based on the sequence proposed by each author, a unique solution is obtained for the shape of the patterns for a given type of product, an approximate shape of the components of the product structure.

In constructing the patterns of any product, the planned representation of its components begins with the imaginary intersection of the body with a series of planes (planes in which the dimensions of the body are taken) orientated vertically or transversely and drawn through different anthropometric points (see fig. 3.5). The traces of these intersecting planes with the surface of the body are considered horizontal and vertical lines; they form a network of baselines in which the shapes and patterns of a product type are drawn.



Horizontal planes through different anthropometric points or levels:

0- vertex
1- through cervical point
2- at the scapula level
3- at the nipple level
4- at the waist level
5- at the hip level
6- through gluteal furrow point
7- at the knee level
8- at the calf protrusion point
9- product hemline

Vertical planes

1- through the spine
2- through neck posterior base point
3- through posterior axillae point
4- through the shoulder point
5- through the front axillae point
6- through the front neck base point
7- through suprasternal point

Figure 3.5 Main anthropometric planes

The network of baselines resulting from the intersection of these horizontal and vertical lines forms the graphic support into which the flat shapes of the components of a product

type are drawn. Specific baseline networks are developed for the two product categories – with shoulder support and with waist support.

Each author proposes a particular structure for the initial data, indicating graphically how the body dimensions are measured, his point of view on solving the construction and a particular way of numbering the points placed on the outline of the patterns. There are also differences in the approach to the construction phases.

The construction of the basic patterns for both product categories is carried out for half of the product in the following sequences:

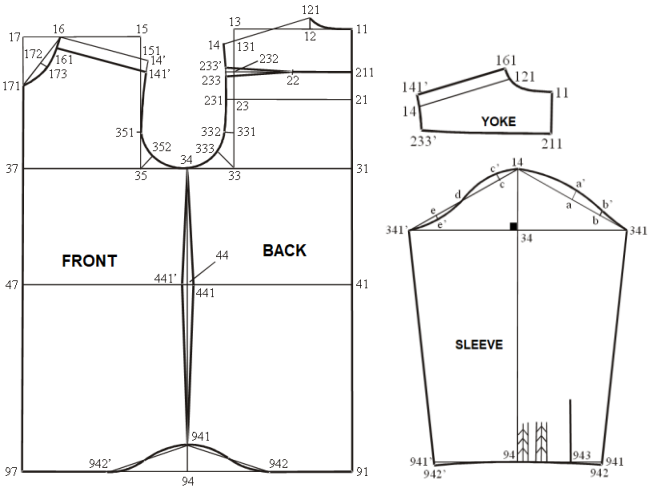
- drawing the starting point- a right angle. This point may belong to the back or front main element according to the adopted design variant;
- drawing the horizontal lines of the basic network;
- define the final position of the middle line in the back pattern (for pattern with support on shoulders):
- drawing vertical lines of the basic network;
- drawing the supper contour lines;
- drawing the lines of the side seams and hemline;
- verifiy the width and length of the patterns

For patterns designed for garments with support on shoulders, the sleeve pattern is drafted after the shape of the back and front patterns has been finalised. This is the logical way because in the design algorithm of the sleeve, the designer has to measure either the length of different contour lines or the distances between some points.

To start a pattern, the designer must calculate the values of the constructive segments to design the pattern network and then determine the position of the main points of the outline contour of the pattern with different geometric constructions.

Table 3.13 Basic block for men's shirt

Category	**Symbol**	**Category**	**Symbol**	**Category**	**Symbol**
Body measurements		**Product dimensions**		**Constructive allowances**	
Body height	I_c	Garment length	L_{pr}	Bust allowance	Ab
Bust circumference	P_b	Sleeve length	L_m		
Neck circumference	P_g	Sleeve width on the hemline	L_{mt}		
		Length of the sleeve cuff	L_{man}		

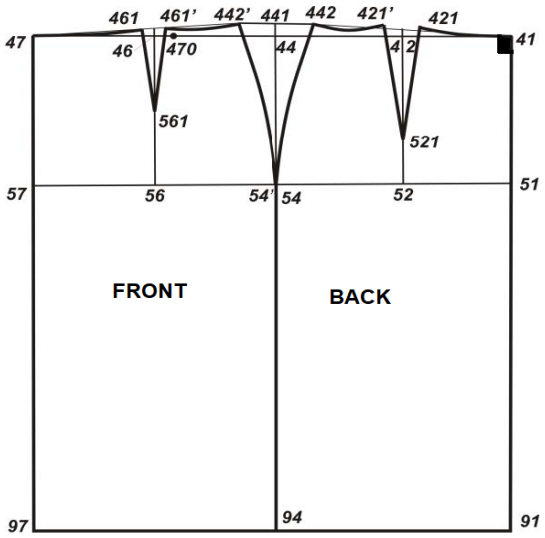


Mathematical relations of the network (selection):
(11 31)= P_b/10+15cm
(11 41)= I_c/4 +1,5cm
(11 91)= L_{pr}
(31 33)= (0,19*P_b+1cm) + 0,25*A_b
(33 35)=(0,22*P_b-1cm)+0,5*A_b
(35 37)=0,2*P_b+0.25*A_b
(17 37)= (11 31)-1cm

Figure 3.6. The patterns of the men's shirt

Table 3.14 Basic block for skirt

Category	Symbol	Category	Symbol	Category	Symbol
Body measurements		**Product dimensions**		**Constructive allowances**	
Body height	I_c	Garment length	L_{pr}	Hip allowance	A_s
Waist circumference	P_t			Waist allowance	A_t
Hip circumference	P_s				



Mathematical relations (selection):
(41 51)= I_c/10 +(2÷3)cm
(41 91)= L_{pr}
(51 57)= P_s/2+A_s
(51 54)= (51 57)/2-1cm
(54’ 57)=(51 57)/2+1 cm
(41 470)= P_t/2+A_t
(47 470)= total adjustment on the waist level:- front dart=0,2*(47 470);
-back dart= 0,3* (47 470);
-lateral adjustment=0,5*(47 470)
The lengths of the front and back darts are determined by their depth and the distance between the waist and hip lines (41 51).

Figure 3.7. The patterns of the woman's skirt

3.2.3. DRAFTING DIGITAL PATTERNS USING THE FUNCTIONS OF LECTRA/ MODARIS

Lectra's CAD programme for digital product development is called Modaris. It makes it easy for pattern makers to organise, store, access and use important digital materials for the production of clothing. By automating low-value operations, users have more time to develop novel and captivating patterns instead of spending it on time-consuming pattern optimisation and quality control.

Modaris has been developed in several iterations, but the latest, Modaris Expert, offers a higher level of efficiency and focuses on the essentials: improving patterns to produce items with flawless fit and quality. The need for manual pattern alterations is reduced when pattern components are synchronised. Sophisticated fitting tools are used to ensure that the pattern fits correctly before fitting, making the process safe for all users, including beginners.

After launching the software, the user will see the following screen, regardless of the version of Modaris they are using (see fig.3.8.).

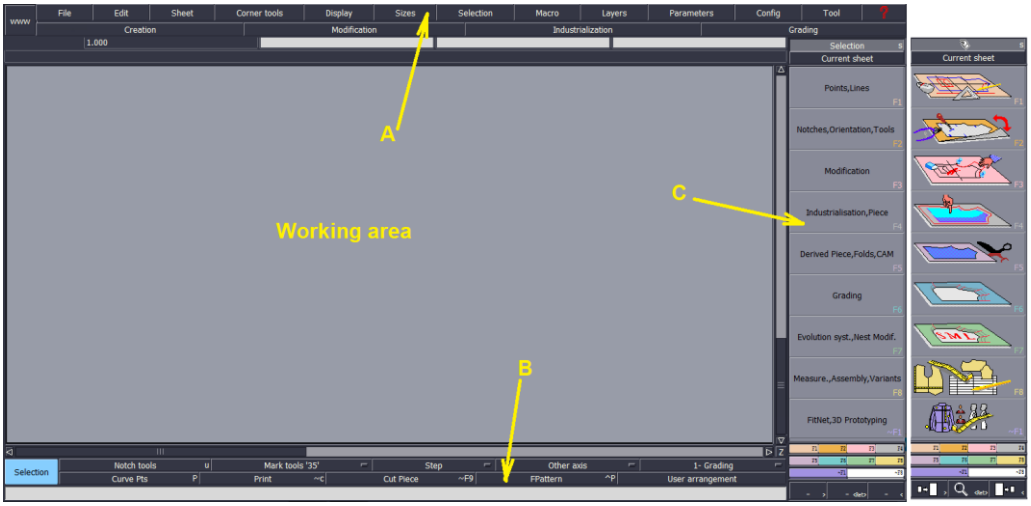


Figure 3.8. Modaris display

The main sections of the Modaris display are:

A→top menu (upper menu); main headings of the program (File, Edit) and others specific to Modaris;

B→Bottom menu with Modaris simple choice buttons;

C→ coloured coded specific function menu headings. These are the toolboxes specific to Modaris.

Working area→ is the space where worksheets are created to design the shape of the product parts.

Many functions in Modaris work clockwise, so it is important for every user to work out the product design process in this way.
The designer who creates a digital pattern in Modaris must be aware of:

- the steps of the design process;
- know the values of the different lines and how to position the most important points on the contour of the part.

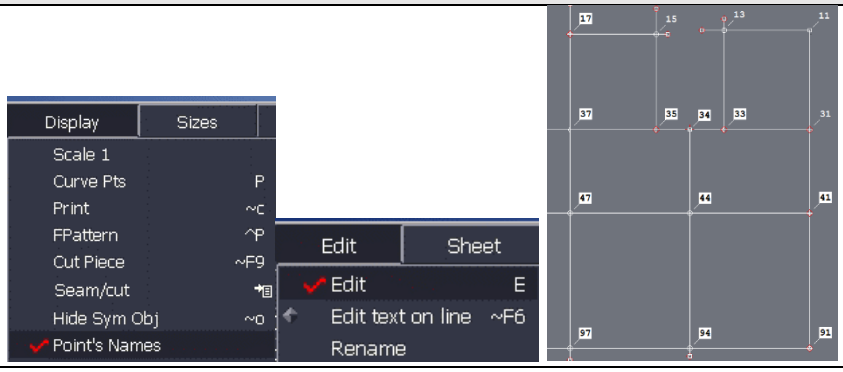
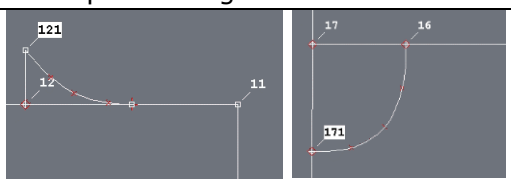
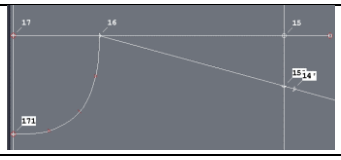
To create a digital pattern in Modaris Lectra, the designer uses the following commands (functions): ***F1*** (Points, Lines); ***F2*** (Notches, Orientations, Tools); ***F3*** (Line modification, Point modification and Pins); ***F4*** (Piece); ***F5*** (Derived pieces and Folds); ***F8*** (Measurements, Dynamic measurements, Assembly).

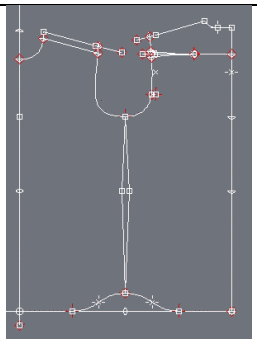
Digital pattern development of men's shirt

The main stages for designing the patterns are described in table 3.15

Table 3.15 Patterns design stages

No.crt.	Design stage / Function/ Screenshot of working stage
1.	Launch Modaris program. Create a new model/ Enter.
	 . Press *Enter* from the keyboard.
2.	Sheet/ New sheet (Fig. 6)
3.	File/ Access Path/ Select OK button.
4.	File/ Save as (save the file with the desired name and in the selected folder). Select the button *Save*.
5.	Parameters/ Length units/ Select cm.
6.	F1/Lines/Straight→ draw straight lines (horizontal or vertical). The line length is previously calculated; F1/Points/Developed →position points on a line. F1/Line/ Division → split a line into equal parts; F1/Lines/ Straight → draw vertical line / horizontal line; F1/Points/ Intersection → declare the intersection points; Display/Display Point's Names/ Point Names → visualise the point's names; Edit/ Edit→ write point id;

No.crt.	Design stage / Function/ Screenshot of working stage
	
7.	F1/Points/ Developed→ position points on vertical or horizontal lines; F1/Lines/ Straight → draw straight lines; Display/Display Point's Names/ Point Names → visualise the point's names; Edit/Edit → write point id.
8.	F1/Lines/ Bezier → draw curves lines (by pressing the Shift key) for the neckline (back and front); Activate Curve Pts → visualise the curve points; F3/ Point modification/ Reshape→ change the curve line's shape as needed;
	
9.	F1/Points/Developed → establish the back slant; F1/Lines/Straight → draw straight lines; F1/Points/ Ali3Pts → align three points; F1/Points/Developed → establish the length of the back shoulder; F8/Measurements/ Length → measure the length of the back shoulder
10.	F1/Points/Developed → establish the front slant; F1/Lines/Straight → draw straight lines; F1/Points/ Ali3Pts → align three points; F1/Points/Developed → establish the length of the front shoulder (equal to the back)
	

No.crt.	Design stage / Function/ Screenshot of working stage
11.	F1/Points /Division → split a line into equal parts; F1/Lines/ Straight → draw straight lines (horizontal): Edit/ Edit → write point id; F1/Points /Division → split a line into equal parts; F1/Lines/ Straight → draw straight lines (horizontal): F1/Lines/Straight → draw the bisecting line; F1/Points/ Developed → position points; F1/Lines/ Bezier → draw curves lines (by pressing the Shift key) for the armhole; Activate Curve Pts → visualise the curve points; F3/ Point modification/ Reshape→ change the curve line's shape as needed;
12.	F1/Points/ Developed → position points: F1/Lines/Straight → draw straight lines; Edit/ Edit → write point id; F1/Lines/ Bezier → draw curves lines (by pressing the Shift key) for the hemline; Activate Curve Pts → visualise the curve point; F3/ Point modification/ Reshape→ change the shape of the curve line as it is needed Final patterns: back and front.
	
13.	Sheet/ Copy → copy the worksheet; F3/Deletion → delete the unnecessary lines; F4/Cut → extract the patterns (the command is applied if the piece contour is closed). With the right button of the mouse, the new pieces are extracted. Press the key" **j** "to reposition the pieces on the display.
14.	F2/ Orientation/ Xsym/ Y Sym → reposition the yoke front piece for connecting with the back yoke; F8/ Assembly/Assemble → connect the pieces; Sheet/ Copy → copy the working sheet; F4/ Cut → extract the new piece; Activate Curve Pts → visualise the curve points; F3/ Point modification/ Reshape→ change the shape of the curve line as it is needed;

No.crt.	Design stage / Function/ Screenshot of working stage
	

The shape of the patterns for women's skirts is obtained by applying the same procedure.

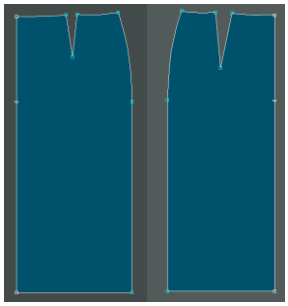


Figure 3.9 Woman skirt (basic block)

Grading digital patterns (basic blocks)

Grading is the process of enlarging or reducing the shape of the pieces of the reference size of the model using exact and specified rules to determine the shape and size of the pieces of a particular model over the whole dimensional range in which it is created.

Computerised grading systems work in two ways:

1. the pattern for each size is computed independently using the information in the size tables;
2. the grading increments are uploaded to the computer, and the different sizes are automatically created using the same procedures as for human sorting.

On the computer monitor, the designer can see the generated pattern nest true to scale to assess it and correct it visually if necessary.

The patternmaker may select the following grading solutions:

- Data from a table of grading rules;
- The measurement model table (garment specification sheet or measurement chart) for all the order sizes.

In Modaris- Lectra, the designer will use the following commands (functions): ***F7*** (Evolution system and Nest modification) and ***F6*** (Grading Control, Grading Modification and Grading rules)

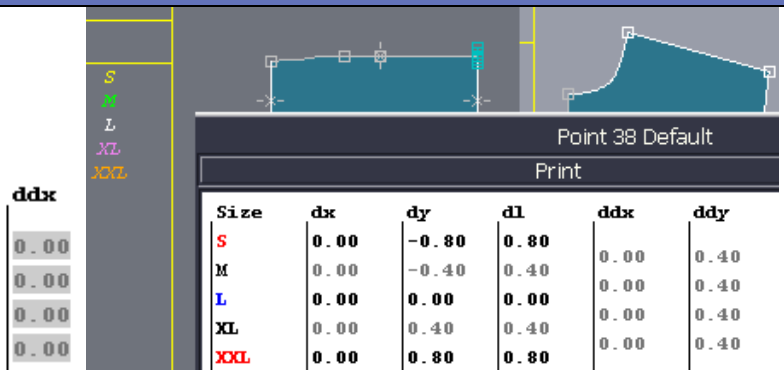
For grading, the following steps have to be followed (table 3.16):

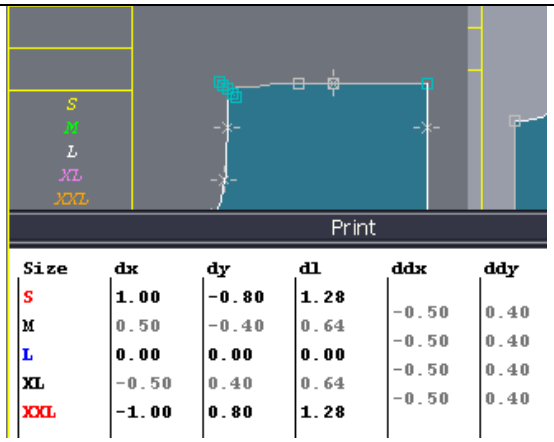
1. Create the size range. The model size range can be numeric alphanumeric.

The size range is made in the Notepad application and saved in the same folder where the model file was saved.

2. Open the model file (which contains either the patterns of the main elements or model pieces patterns);
3. F7/ Evolution System/Imp. EVT → the user selects the file with the size range (from the folder) and then selects the *Open* button.
4. In the upper menu, *Display*, select the *Title block* option to visualise the imported size range. Each size is coloured; the contour line of the piece has the same colour as the size id.
5. F6/ Grading control/ Control → select the point of the contour line, select Control and write values (with algebraic sign) for grading the selected point. If the pattern is graded with constant increments values, the user fills the columns "ddx" and "ddy" with values (the user selects the needed column with the left button of the mouse; this way, the required value is automatically written for all the sizes). The base size is not graded.

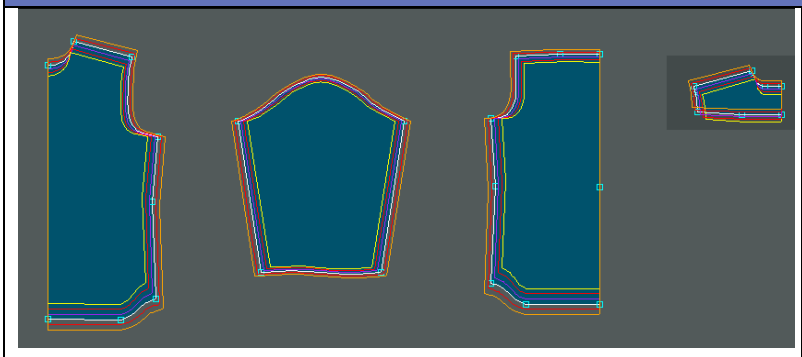
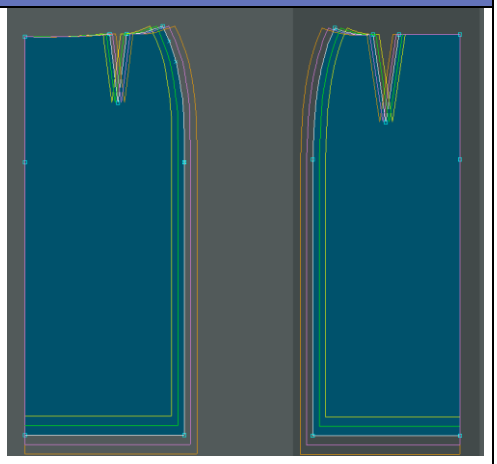
Table 3.16 Stages of shirt grading

Grading men's shirt (selection)	
Grading point 121	

Grading point 233	 Size dx dy dl ddx ddy S 1.00 -0.80 1.28 -0.50 0.40 M 0.50 -0.40 0.64 -0.50 0.40 L 0.00 0.00 0.00 -0.50 0.40 XL -0.50 0.40 0.64 -0.50 0.40 XXL -1.00 0.80 1.28

Step by step, each point of the contour line is graded. When the process is complete, the user selects *Close,* and the session ends.
All graded patterns are displayed if the designer selects the combination F9-F12-F9 on the keyboard. If the designer selects F10, the visualisation of the graded patterns is deactivated. The final shapes of the graded patterns are presented in table 3.17.

Table 3.17 Shirt and skirt grading

Graded patterns	
	
Men shirt	**Woman skirt**

3.2.4. PATTERNS ADAPTATION

Creating patterns for a model means that you get all the model components and elements as they unfold. Designing the model patterns, validating them through the actual implementation of the prototype, and evaluating how closely the model form matches the designer's concepts are the main goals of this activity.
The model is analysed in two steps: the first step emphasises the external form of the model by identifying the silhouette and the type of cut. The second step is to thoroughly examine the constructive features and individualisation of the model, focusing on all the components and landmarks that make up its structure.
In order to achieve the correct fit of a garment, the pattern usually needs to be adjusted or altered. However, alterations to the fit are limited to seam allowances and existing darts once the fabric has been cut. By making the necessary adjustments to the pattern, fit issues should be resolved before the garment is cut.
Basic techniques for altering patterns are:

- All similar pieces must be altered to match the alterations to the main piece.
- Additions or extensions must be made by attaching an extension strip to the edge in question.
- Modified patterns must have the same character as the original pattern piece.
- Correct the movement on the altered pattern so that the altered line has the same character as the original line.
- The altered pattern must be as flat as the original pattern piece.

Dart manipulation is one of the most important techniques for pattern design. Fashion designers must determine the position of the dart before manipulating the pattern and know how to manipulate the dart. The manipulation of darts usually starts with a simple sloper, which they then transform into their fashionable designs. Darts become princess seams, gathers, tucks or cowls. New cutting lines are added or shifted; necklines are redesigned.
There are three techniques for manipulating darts in flat patterns. These are suitable for manipulating darts at any point. The slash and spread or pivot methods are most commonly used to transfer darts to the bust, neck, armhole or wherever is necessary.

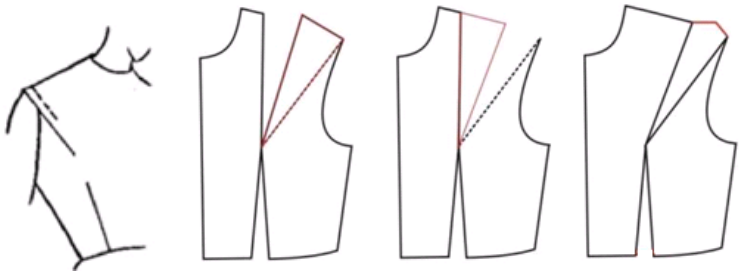


Figure 3.10. Dart manipulation

Cut lines (figure 3.11) are very stylish, especially in women's clothing. The model's size and the human body's shape determine the shape of these lines. For the design, it is necessary to determine the position of the start and end points as well as their shape. The material properties and the manufacturing technology influence the shape of these cutting lines. The surface of the garment is divided by these lines. The shape and geometry of the new piece must be checked, especially at the cutting lines.

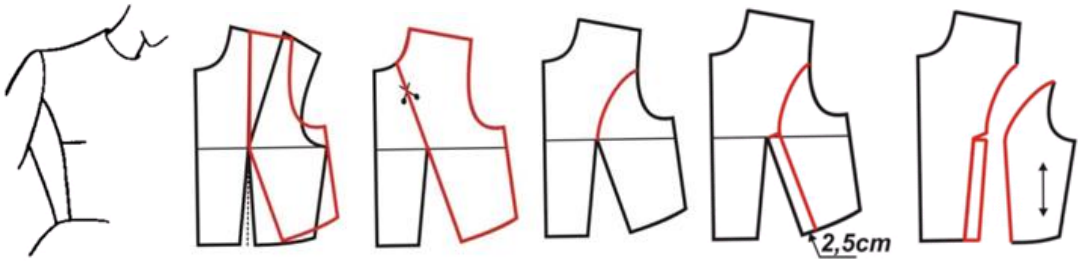


Figure. 3.11 Cut lines

Collars are used to finish the upper contour lines for garments with shoulder support. For a stand collar of a man shirt the collar pattern is presented in figure 3.12.

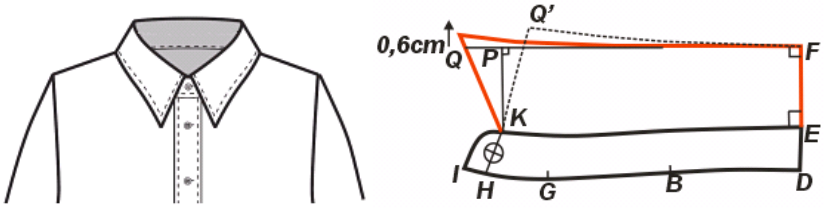
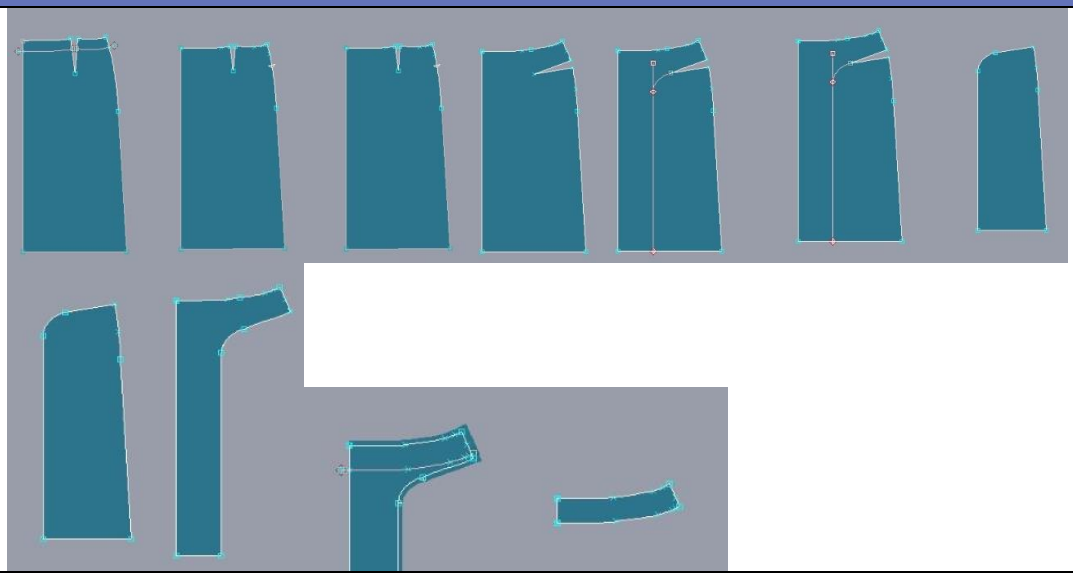


Figure 3.12 Stand collar pattern

The images in table 3.18 present the main stages of pattern alterations for designing the model components.

Table 3.18. Patterns alterations

Model	Back pattern alterations
	
Model Front	Front pattern alterations
	

Production patterns are defined as patterns with technological allowances. The values of these allowances are determined by taking into account the following data: material properties (thickness, shrinkage, drapability, etc.), pattern shape and structure, and manufacturing technology (figure 3.13).

Depending on the purpose, a garment can have two or four layers; two layers mean base material and interlining (fusible material), and four layers mean base material, interlining (fusible material), insulating layer (non-woven material) and lining.

Regardless of the category, a production pattern must contain the following information:

- the model to which the respective pattern corresponds;
- the name of the piece and the number of times it appears in the finished product;
- the material from which the piece is cut (base material, lining, interlining) and its characteristics (single-coloured material, material with checks, stripes or other designs);
- the size;
- the grain, which is referred to as the nominal direction and the allowed tolerances;
- the seam values, the hem values and the correct shape of the corners;
- the depth of the uncut darts, tucks and pleats (and the direction of the bend of the material);
- the position of some control marks (balance marks or notches) required for joining to other parts or product elements;
- the areas where the modelling is carried out by wet-thermal treatment;
- construction lines: this includes buttonholes, pocket placements, etc.

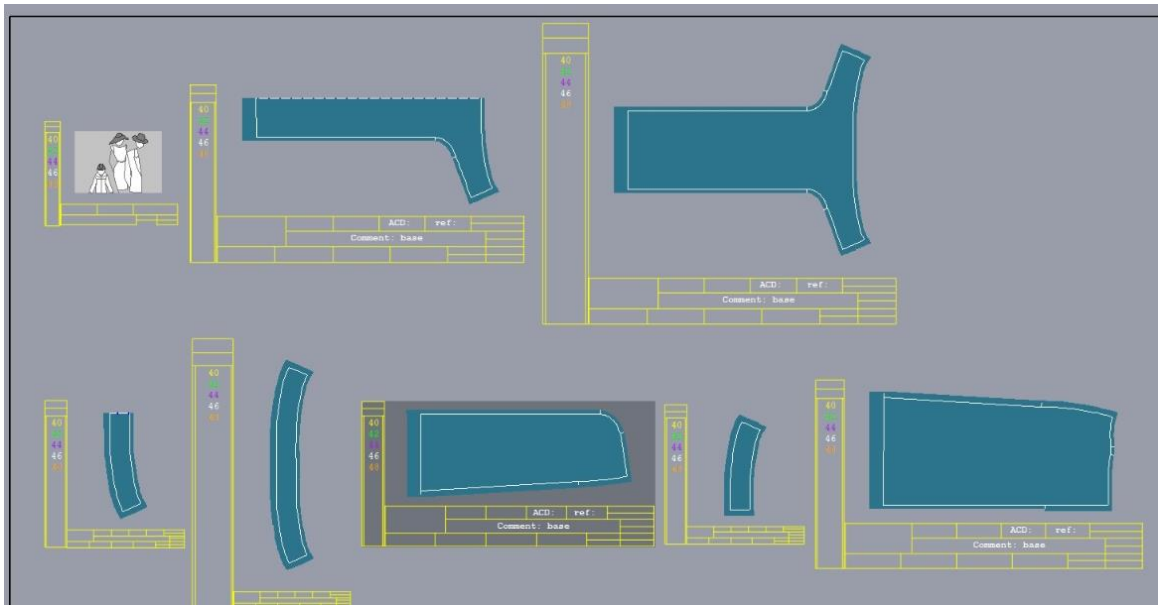


Figure 3.13 Production patterns for skirt

CONCLUSIONS

A pattern maker usually designs a pattern on the basis of a flat sketch with measurements. The shape of these main pieces (basic pattern, blocks or slopes) is then altered according to the details of the model and the customer's body shape. The flat pattern method was used in the learning module for a shirt and a skirt.

The next step was developping the digital patterns for shirt and skirt using the Lectra CAD software. For patterns of different sizes the grading process made on Modaris was required.

Designing the model patterns requires pattern adaptations first by evaluating the modell silhouette, than there may be necessary dart manipulations, design of cutting lines and eventually supplementary elements as collars.

The final step presented in the learning module consists in the construction of the production patterns as patterns with technological allowances.

BIBLIOGRAPHY

[1] https://www.fibre2fashion.com/industry-article/5658/basics-of-pattern-making
[2] https://www.bommestudio.com/blog/what-is-a-tech-pack
[3] https://eurotexintl.com/polo-shirt-measurement/
[4] W. Aldrich, *Metric Pattern cutting for women's wear*, 5-th Edition, Blackwell Publishing, ISBN -13: 978-1-4051-7567-8
[5] Human Solutions – Utilisation instructions XFIT Army ScanDB
[6] M. Avadanei, *Structura si proiectarea confectiilor textile*, Iasi, Ed. Performantica 2022, ISBN 978-606-685-901-1
[7] E. Filipescu, M. Avadanei, *Structura si proiectarea confectiilor textile*, Iasi, Ed. Performantica 2007, ISBN 978-973-730-412-4
[8] https://www.lectra.com/en
[9] https://www.google.com/imgres?imgurl=https%3A%2F%2Flookaside.fbsbx.com%2Flookaside%2Fcrawler%2Fmedia%2F%3Fmedia_id%3D768107743837907&tbnid=XIXZJpX1gBGRRM&vet=12ahUKEwjkhabSv--EAxX_q_0HHQwICxUQMygAegQIARAw..i&imgrefurl=https%3A%2F%2Fidpoftanuvas.com%2F%3Fu%3Dwhat-is-collar-different-parts-of-collar-types-of-bb-dgvOXvtp&docid=BvRCJi9t95-dIM&w=1440&h=1440&itg=1&q=collars%20constructive%20elements&hl=en&ved=2ahUKEwjkhabSv--EAxX_q_0HHQwICxUQMygAegQIARAw

Digital Fashion Project

Collaborative Online International Learning in Digital Fashion

3. GARMENT DATABASE

3.3. 3D GARMENT DESIGN

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LEARNING OUTCOMES

COMMON LEARNING OUTCOME	THE USE OF DIGITAL TOOLS TO CREATE A VIRTUAL 3D PROTOTYPE
SPECIFIC LEARNING OUTCOMES	• Access and prepare the digital workspace; • Select the appropriate avatar • Select the materials; • Proceed with the 3D garment simulation; • Make adjustments or improvements as needed; • Create the final shape of the required product, arrange and save it.

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CONTENT

3.3. 3D GARMENT DESIGN

3.3.1. INTRODUCTION TO 3D GARMENT DESIGN

In the dynamic landscape of fashion and apparel, the integration of technology has revolutionized the traditional methods of garment design. One of the most innovative advancements in this realm is 3D garment design. Unlike conventional flat pattern drafting or physical prototyping, 3D garment design utilizes digital tools and software to create, visualize, and simulate clothing in three-dimensional space.

This transformative approach to garment design offers a plethora of advantages, ranging from enhanced creativity and efficiency to sustainability and cost-effectiveness. By leveraging specialized software platforms, designers can meticulously craft intricate garments with precision and realism, exploring diverse styles, silhouettes, and textures in a virtual environment.

Moreover, 3D garment design transcends the limitations of traditional methods by enabling rapid prototyping and iteration. Designers can swiftly modify designs, adjust fit, and experiment with various elements, significantly reducing the time and resources typically required in the iterative design process. This accelerated workflow not only expedites the product development cycle but also fosters innovation and experimentation.

Furthermore, 3D garment design facilitates seamless collaboration among multidisciplinary teams, including designers, patternmakers, and manufacturers, transcending geographical barriers. Through digital sharing and visualization, stakeholders can efficiently communicate ideas, address concerns, and streamline decision-making processes, thereby enhancing overall productivity and cohesion.

Beyond its immediate applications in design and development, 3D garment design plays a pivotal role in driving sustainability within the fashion industry. By minimizing physical prototyping and sample production, it reduces material waste and carbon footprint, aligning with the growing imperative for eco-conscious practices and circular fashion initiatives.

In summary, 3D garment design represents a paradigm shift in the fashion and apparel industry, offering a potent blend of creativity, efficiency, and sustainability. As technology continues to evolve and innovate, its potential to reshape the way we

conceptualize, create, and experience clothing is boundless, ushering in a new era of design possibilities and opportunities.

Lectra Modaris 3D prototyping offers a streamlined workflow that integrates digital design, pattern development, and virtual prototyping into a cohesive process. This chapter gives an overview of the typical workflow.

3.3.2. PATTERN CREATION AND GRADING

The process begins with creating digital patterns using Lectra Modaris software. Designers or patternmakers can either draft new patterns from scratch or digitize existing patterns. These patterns serve as the foundation for the 3D garment.

The patterns of a blouse model are used as an example, with 1 front panel, 2 symmetrical back panels, cuffs and collar.

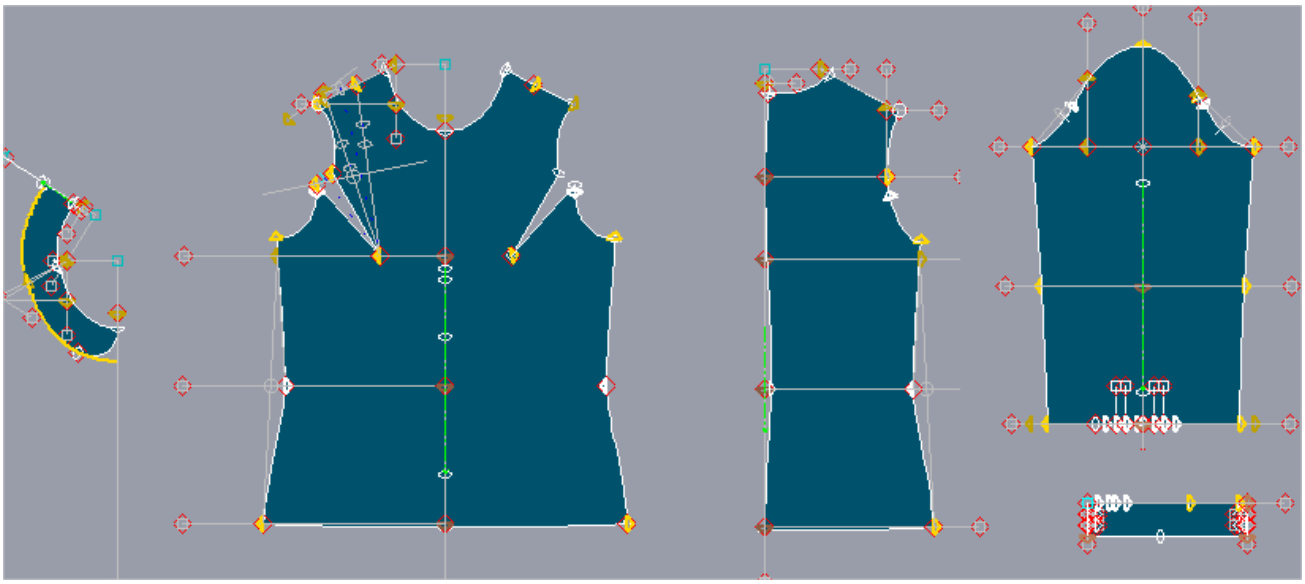


Figure 3.14. Flat pattern of a blouse

Once the basic patterns are created, designers can manipulate and modify them as needed. This includes adjusting measurements, adding design details, such as pockets or seams, and refining the overall shape and fit of the garment.

The patterns are made for one size (basic size) and need to be graded to obtain smaller and larger sizes. In this example, the base size is 40 and it is graded to 3 smaller sizes (38, 36 and 34) and to 2 larger sizes (42 and 44).

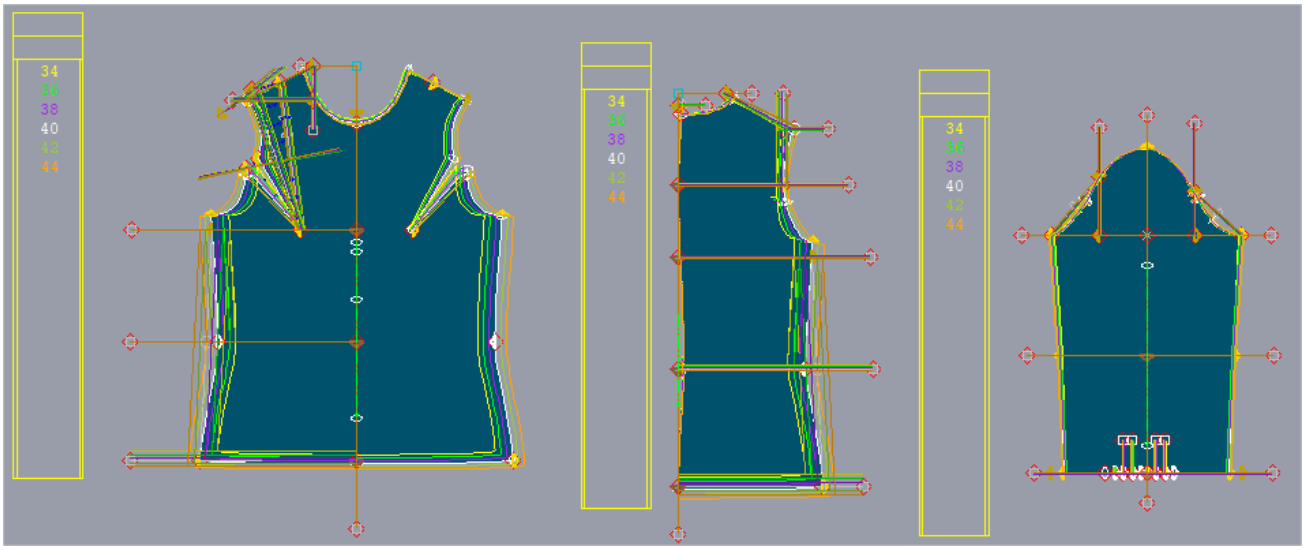
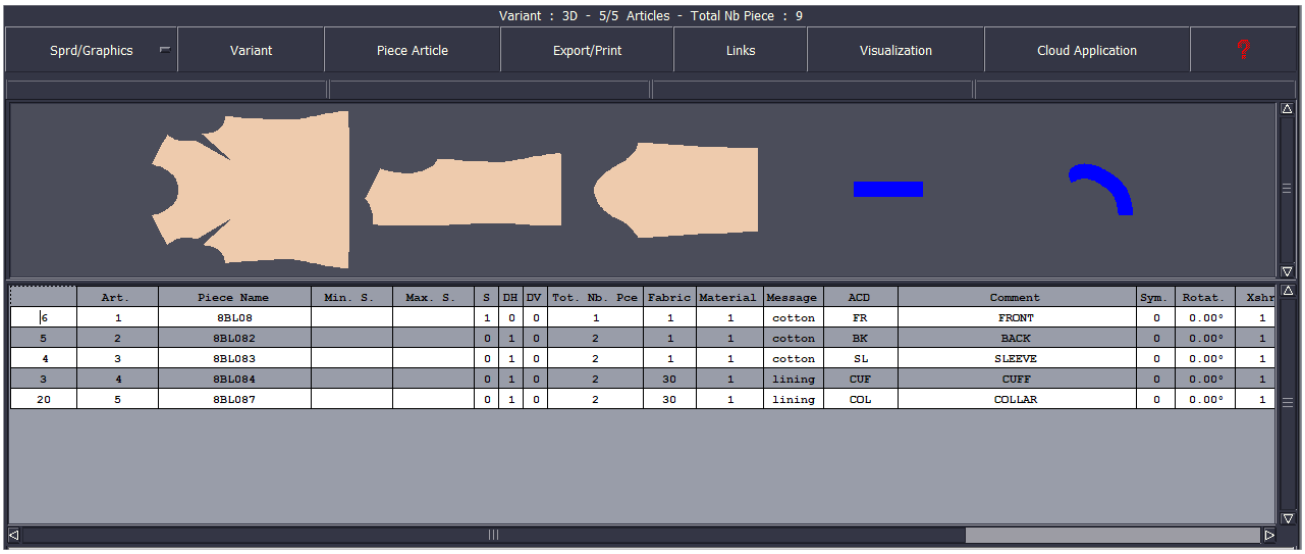


Figure 3.15. Graded pattern of a blouse

The next step is the creation of a variant. A variant is a collection of pattern parts where it is possible to indicate for each panel how many parts are effectively needed, to assign the parts to a fabric code, add comments, and indicate symmetry and rotation.
Such a variant can be used for several purposes. First, they are used to create a cutting plan with MarkerManager and make the marker in the MarlerMaking programme. The variant of the model is then used to indicate in which direction the pieces/parts will lie, how many parts there are of each pattern and whether any pieces/parts need to be mirrored, etc.
The second use is for creating a virtual prototype. Via the variant, using the 'Create Piece to Stitch' function, you can place parts in the 'Desk of Stitches' for stitching.



	Art.	Piece Name	Min. S.	Max. S.	S	DH	DV	Tot. Nb. Pce	Fabric	Material	Message	ACD	Comment	Sym.	Rotat.	Xshr
6	1	8BL08			1	0	0	1	1	1	cotton	FR	FRONT	0	0.00°	1
5	2	8BL082			0	1	0	2	1	1	cotton	BK	BACK	0	0.00°	1
4	3	8BL083			0	1	0	2	1	1	cotton	SL	SLEEVE	0	0.00°	1
3	4	8BL084			0	1	0	2	30	1	lining	CUF	CUFF	0	0.00°	1
20	5	8BL087			0	1	0	2	30	1	lining	COL	COLLAR	0	0.00°	1

Figure 3.16 Creation of a variant with the needed pattern pieces

3.3.3. VIRTUAL STITCHING OF THE PATTERN

The following step is to prepare the pattern (model parts/ pieces) for use in the virtual fitting room. Therefor the parts/pieces need to be virtually stitched in the 'Desk of Stitches', an extra module within Modaris.

This window contains a lot of functions to stitch your patterns parts/pieces together and prepare them for prototype simulation. Only the most important functions are discussed here:

- Phase: This function allows the user to add a 'phase' in the stitching process. This can be seen as a step, for example stitching front panel to back panel. Using these 'phases', one can divide the virtual stitching process into different actions so that, especially in the case of complex pieces, the overview is maintained. However, it is also possible to stitch the entire garment in one phase sheet.
- Edit: The 'Edit' collection includes all functions to move, rotate, select parts, etc.
- Stitch: These tools can be used to indicate which seams are to be stitched together and which points need to face each other. The 'slip-on points' designates certain points on the pattern that must correspond to morphological points on the virtual avatar. For example, the neck, wrists, ankles, etc. This is necessary for the software to know where the garment should go on the avatar. Depending on the garment, 3-5 slip-on points are usually enough.

The most simple process is to stitch 2 parts together. This is done by (1) left-clicking on the start point of the seam and then (2) right-clicking on the end point of the seam. For the pattern part to be stitched to this, repeat (3 & 4) the same process at the right seam. Once this is done, (5) just left-click anywhere in the worksheet and the two pattern parts are stitched.

It is also possible to stitch a seam consisting of several parts in one go. For example, to stitch the sleeve into the armhole. The seam of the sleeve is one part so this is done the same as before (1 & 2). However, the armhole is split between two pattern pieces: the front and back. To stitch this in one 'move' start on one of the two pattern pieces. With the left mouse button, one click on the underarm point of the front pattern piece (3), but instead of right-clicking on the shoulder arm point, click left (4). Thus it is possible to left-click again on the shoulder arm point of the back pattern piece (5) and finally right-click on the underarm point of the same pattern piece (6). This way, the software registers this as one stitching movement. Finally (7) click again randomly in the worksheet.

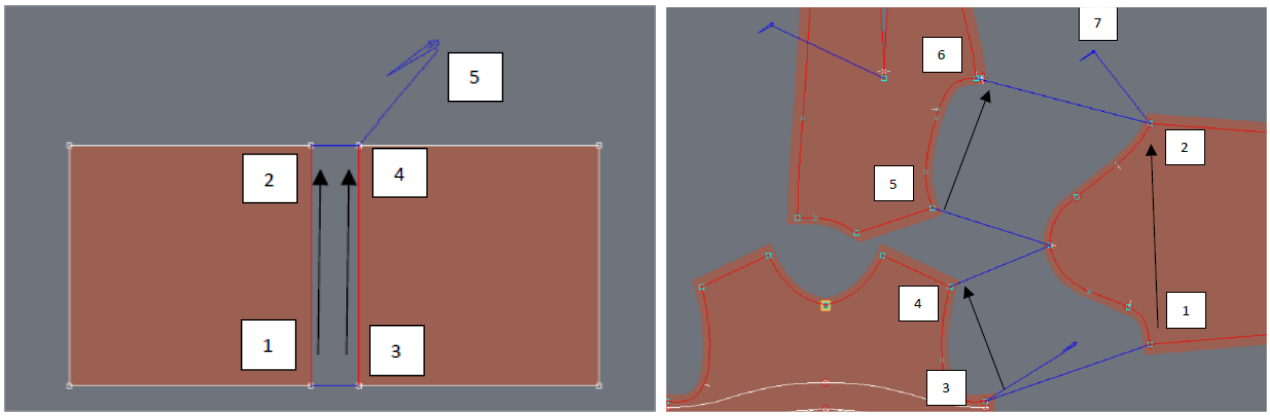


Figure 3.17 Example of how to virtually stitch 2 parts (left) and 3 parts (right) together

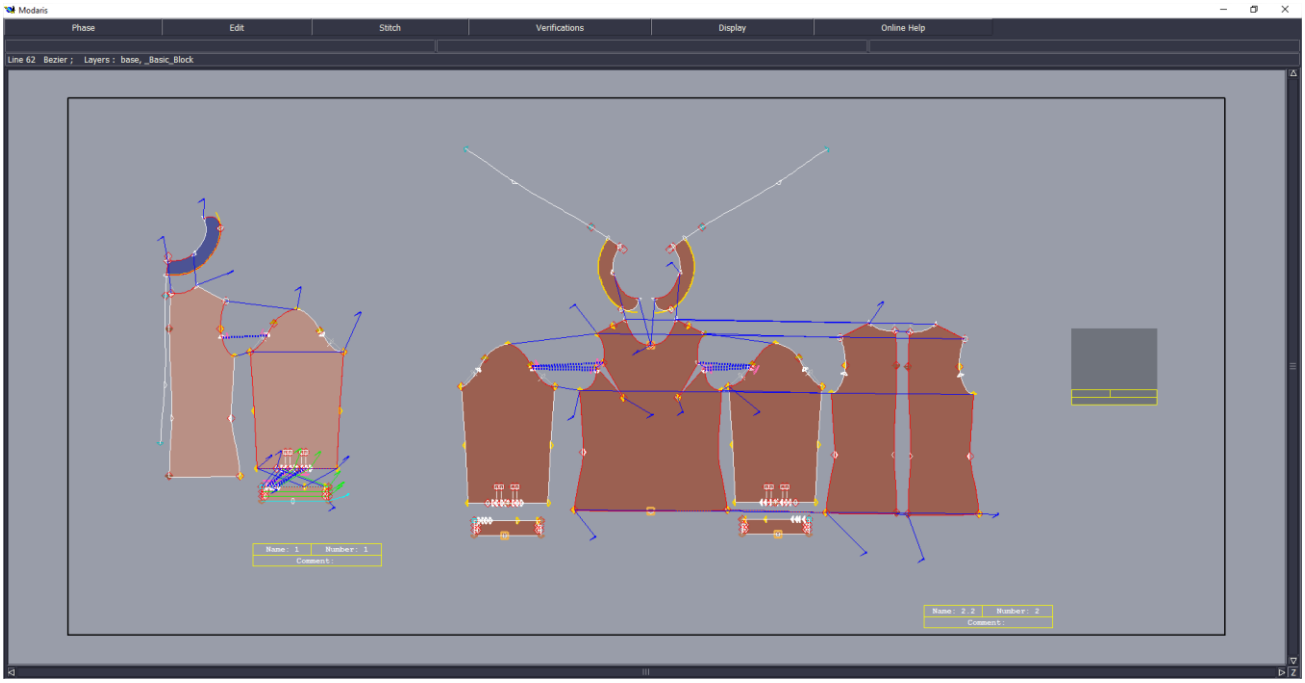


Figure 3.18 Virtually stitched pattern(parts/pieces) in the desk of stitches

3.3.4. INTEGRATION WITH 3D AVATAR

Once all the preparatory work has been done in Modaris, one can move on to Modaris 3D Prototyping to effectively simulate the virtual prototype. The 3D avatar serves as a virtual representation of the human body and allows designers to visualize how the garment will drape and fit in three dimensions.

In this software, there are different parametric avatars available of men, women and children. The term "parametric" refers to the ability to adjust the mannequin's proportions, dimensions, and other physical attributes using specific parameters or

controls. This allows designers to create and customize virtual human models that closely match specific body types, sizes, and demographics. It is also possible to import 3D-point clouds of bodies which are created using a 3D body scanner or with other 3D software, but these are usually not parametric.

Figure 3.19 Some examples of parametric avatars in Lectra Modaris 3D, and an imported avatar below right

After selecting the avatar in the right size and possibly adjusting the body measurements and selecting the pattern in the right size, the morphological points should be marked. These morphological points on the avatar should match with the slip-on points marked on the pattern. With the anthropometric line function, it allows you to draw, adjust and measure lines on the mannequin.

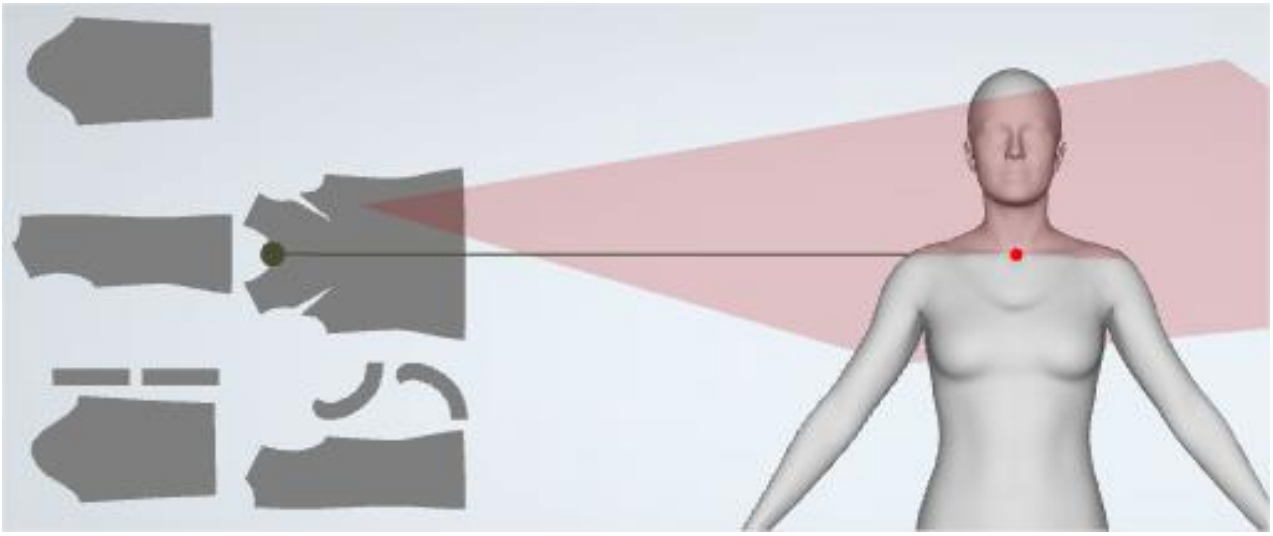


Figure 3.20 Example of a slip-on point on the pattern and the corresponding morphological point on the avatar

3.3.5. FABRIC AND MATERIAL SELECTION

The next step is the selection of the fabric with the preferred 'mechanical properties'. In the software there are 4 built-in libraries available: The Swatch Book Pink, The Swatch Book Yellow, Lectra and Carvico. There is also a possibility to add custom made databases, for example the Digital Fashion fabric database. The Swatch Book Pink database is based on a physical hard copy swatch book with 125 swatches of the most recognized and widely used varieties of fabric. In this book you can see and feel their aesthetic appeal, structure, feel and weight. Natural fabrics such as cottons, silks, wools and linens are included, but also artificial and synthetic fabrics like nylons, polyesters, microfibres, metallics and soya fabrics, and fabrics made from alternative plant fibres like bamboo and hemp.

Figure 3.21. The Swatch Book Pink

In the digital library you can choose a digital fabric which correspondents the most with the desired physical fabric, by filtering on:

- generic name: jacquard, jersey, denim, satin, herringbone, microfibre, …
- category: knit, weave, non woven, bonded fabric
- structure: broken twill, 1x1 rib, interlock, plain weave, …
- weight: gram per square meter (g/m²)
- composition: cotton, silk, wool, linen, polyester, …
- advanced criteria: thickness, stretch and flexibility.

It is also possible to modify the properties of a fabric and save it as a new fabric.

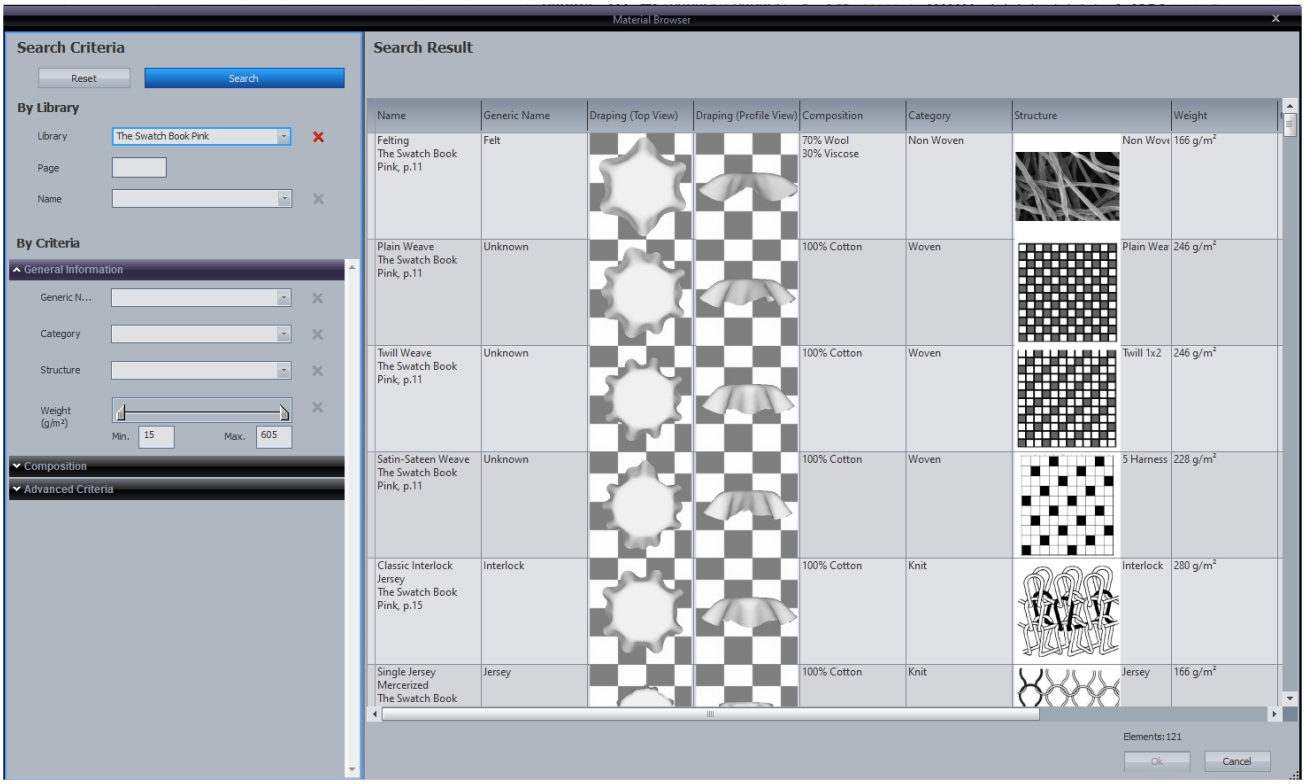


Figure 3.22 The digital fabric libraries in Lectra Modaris 3D Prototyping

There is also a seams-function, which allows you to give seams a specific finish, which is then also visible on the simulation.

3.3.6. VIRTUAL PROTOTYPING AND SIMULATION

The most essential function is the assembly and simulation of the pattern (pieces/parts) on the avatar. When selecting a file, the Modaris pattern software opens automatically and shows the model pattern in a separate window. The simulation software and pattern software are interactive, which means that when an iteration is done on the pattern, the changes will immediately be visible on the simulation and vice versa.

With the assembly-function the garment is virtually assembled and placed on the avatar. With the simulate function you can update the simulation. Once the prototype has been assembled and simulated, the fabric is still very stiff. With fall/relaxation-function, the fabric will start to behave as in reality and you can see the fall of the garment.

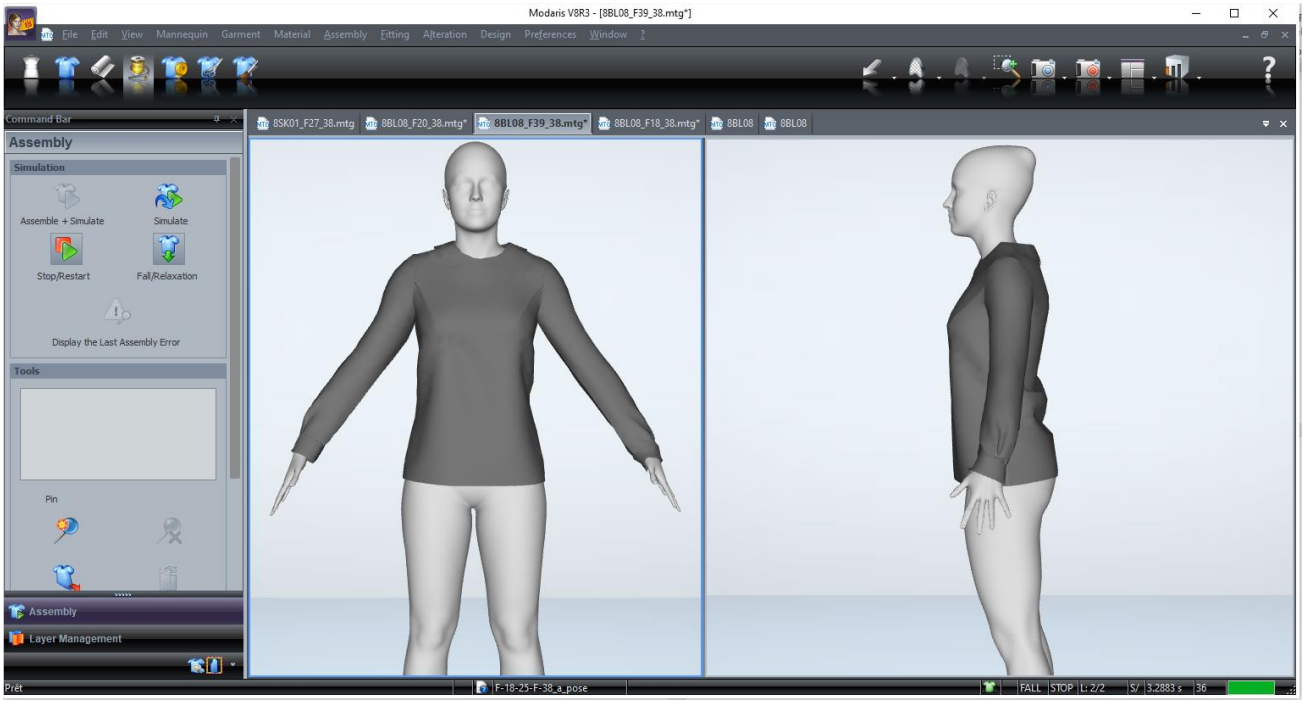


Figure 3.23 3D simulation of a garment on an avatar

The pin-function allows you to pin certain parts of the prototype. Sometimes the simulation does not immediately fits correctly after 'assembly + simulate', but with the 'pull fabric' function one can pull the fabric so that the garment sits better on the doll.

In Layer Management you can mount a next layer, for example a jacket above the blouse. And in Collision Management you can find the Erase tool and a number of parameters. Sometimes it happens that the fabric of the garment overlaps somewhere and the part that should be at the bottom comes through the top piece of fabric in certain places. It can also happen that parts of the mannequin come through the garment. This can be solved with the erase tool.

Figure 3.24 Example of collision

3.3.7. ADJUSTMENTS AND ITERATIONS

During the virtual prototyping stage, you can make real-time adjustments to the garment based on feedback and observations from the simulation. This iterative process allows for fine-tuning of the design, fit, and construction details before moving on to physical prototyping.

There are a variety of functions to check the fit of the prototype.

- With the Ease-function you can see whether the garment is too tight or deformed anywhere.
- 'Mesh Deform.' is the only one that focuses not on the garment, but on the mesh.
- Upright/Balance: The tools found here make it possible to display the warp and weft direction of the fabric. The deviation of the weft direction can also be displayed. Finally, this collection contains a function to view the height difference between two points.
- Proportions: Under this tab, one can use different ways to color the garment. For example, one can give each pattern part a different color. In this way, it can be easier to see the proportions of the individual parts in relation to the whole garment.
- Lines/Measurements: These functions are exactly the same as in 'Anthropometric Line' on the avatar section. The only difference is that they are applied to the prototype instead of the mannequin.

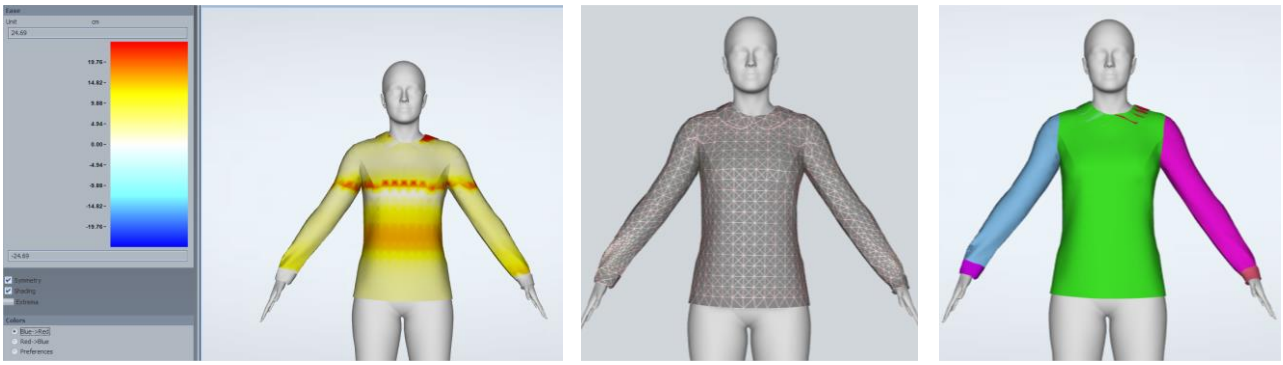


Figure 3.25. From left to right: Ease, mesh distortion and proportions

Furthermore there are more functions to modificate the prototype like open and close seams, create darts and cut the fabric.

3.3.8. VISUALIZATION AND PRESENTATION

Once the virtual prototype meets the desired specifications, you can generate high-quality visualizations and renderings of the garment. These visualizations can be used for presentations, marketing materials, and communication with stakeholders.

There are many possibilities to create visual effects:

- Material Visual Effects: Here you can give the fabric of the garment a certain appearance. This can be a solid color, but a motif is also possible.
- Logo Visual Effects: These functions allow you to place a logo on the prototype.
- Seam Visual Effects: This tab contains a lot of stitching that can be added to the simulation.
- Accessories: These functions let the user place accessories on the garment: buttons, zips, etc.
- Stages: Here it is possible to change the background.
- Postures: The parametric mannequins can stand in different postures.

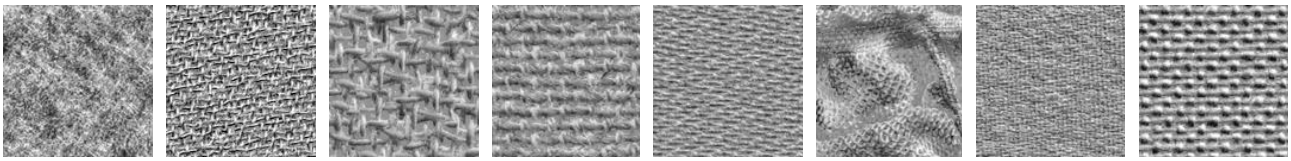


Figure3.26 Some examples of material visual effects

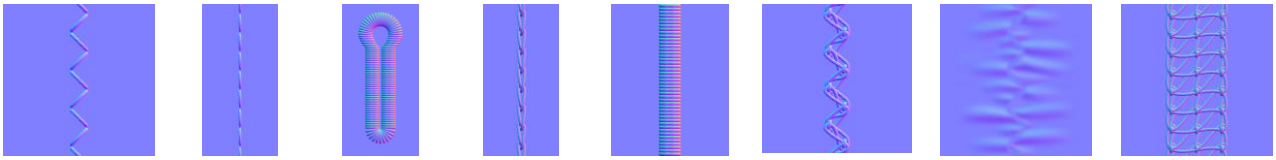


Figure 3.27 Some examples of seam visual effects

When the design is ready, the file can be saved as a mtg-file for later modifications, but it can also be exported as an image (jpeg, tif, bmp, png), a movie with turntable (wmv, mp4) or as a 3D RGB point cloud (obj).

Figure 3.28 Left: parametric mannequin in walking posture, with different visual effects. Right: exported 3D-file (OBJ).

3.3.9. EXPORT FOR PRODUCTION

Finally, once the design is approved, the digital patterns and specifications can be exported from Lectra Modaris for production. The exported files contain all the necessary information for manufacturing the garment, including model pattern pieces, grading, and construction details.

CONCLUSION

In conclusion, the integration of 3D garment design technology marks a transformative shift in the fashion and apparel industry. This innovative approach revolutionizes traditional methods, offering enhanced creativity, efficiency, and sustainability. By enabling rapid prototyping, seamless collaboration, and reduced environmental impact, 3D garment design paves the way for a new era of design possibilities. As technologies like Lectra Modaris 3D prototyping streamline workflows and enhance digital capabilities, the potential for further innovation and advancement in garment design is limitless.

BIBLIOGRAPHY

[1] Baert, R. (2023). *To 3D or not to 3D: The qualities of good 3D software in the fashion industry.*

Digital Fashion Project

Collaborative Online International Learning in Digital Fashion

4. GARMENT E-SHOPPING

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein. Project N° 2021-1-RO01-KA220-HED-000031150

Co-funded by the European Union

LEARNING OUTCOMES

COMMON LEARNING OUTCOME	LEARNERS WILL DEMONSTRATE A PROFICIENT UNDERSTANDING OF PERSONALIZED 3D GARMENT FITTING TECHNOLOGIES, CUSTOMER JOURNEY OPTIMIZATION STRATEGIES, AND THE IMPACT OF DIGITAL CONSUMER BEHAVIOR ON E-GARMENT AND E-SHOPPING INDUSTRIES.
SPECIFIC LEARNING OUTCOMES	• Learners will be able to demonstrate proficiency in using advanced technologies such as 3D scanning and virtual fitting rooms to enhance the online shopping experience. • Learners will be capable of identifying key touch points and designing seamless experiences that foster customer engagement and loyalty, ultimately driving conversions and revenue growth. • Learners will be able to leverage consumer insights to tailor marketing strategies, product offerings, and customer interactions, thereby maximizing customer satisfaction and retention in an increasingly competitive digital marketplace.

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CONTENT

4.1. INTRODUCTION

In the dynamic landscape of modern commerce, the convergence of fashion and e-shopping has reshaped the way consumers explore, select, and acquire garments. The traditional shopping experience has been supplemented, and in some cases, supplanted by the convenience and accessibility offered by online platforms. Garment e-shopping has become a universal and transformative force, seamlessly merging the spaces of fashion and technology.

E-shopping for garments presents a paradigm shift, liberating consumers from the constraints of physical storefronts and geographical boundaries. The digital marketplace offers an expansive array of clothing options, spanning diverse styles, brands, and price points. Whether seeking the latest fashion trends, niche designer pieces, or timeless classics, consumers can navigate an extensive virtual wardrobe with a few clicks or taps.

The allure of garment e-shopping lies not only in its vast inventory but also in the personalized and interactive experiences it affords. The Digital Fashion Project aims to have an important role in producing valuable information to be explored by all those who want to explore these themes. Advanced technologies, such as artificial intelligence, chatbots, and augmented reality, collaborate to enhance the customer journey. Virtual fitting rooms allow shoppers to visualize how garments will look and fit, addressing established concerns associated with online apparel purchases.

Moreover, the integration of fashion knowledge bases ensures that recommendations are not just algorithmically driven but reflect a nuanced understanding of individual preferences, ultimately creating a more engaging and tailored shopping experience.

The report is composed of the following sections:

- Personalized 3D garment fitting;
- Virtual salesperson;
- Prediction of the market evolution.

4.2. PERSONALIZED 3D GARMENT FITTING

The fusion of technology and fashion is giving rise to pioneering innovations, with one such forefront being Personalized 3D Garment Fitting. This revolutionary approach transcends traditional garment sizing constraints by harnessing the power of 3D technology to tailor clothing precisely to an individual's unique body dimensions. Unlike generic sizing charts, Personalized 3D Garment Fitting seeks to revolutionize the fashion industry by offering consumers a bespoke and highly accurate fit, enhancing comfort and style. This transformative technology not only caters to diverse body types but also mitigates the challenges of online shopping, providing an immersive and personalized

experience. As we delve into the intricacies of this innovation, we unveil a future where fashion transcends the limitations of standardization, embracing a new era of individualized style and fit that seamlessly merges cutting-edge technology with the artistry of apparel creation.

The Digital Fashion Project developed a platform that aims to have a word in the challenges of e-commerce. It has four main functions: garment design, fabric design, digital design learning, and garment e-shopping, as shown below:

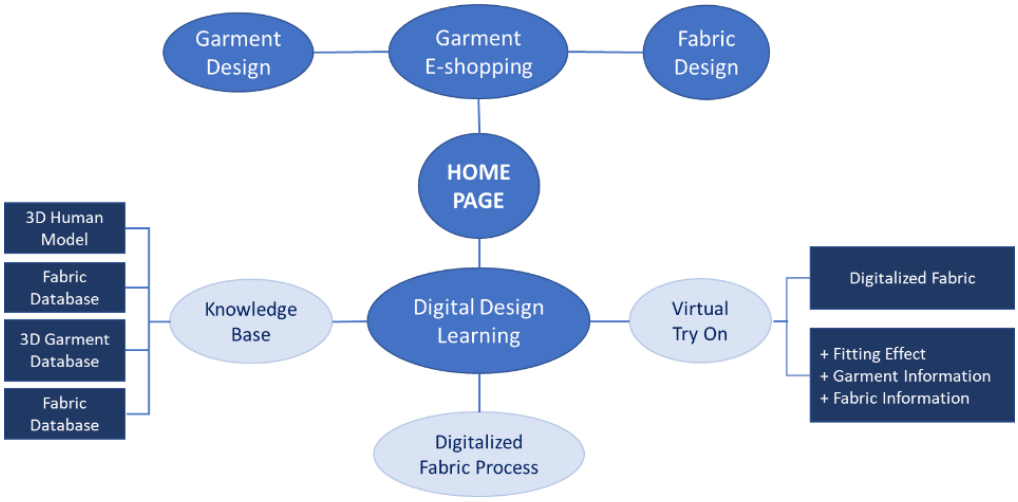

Figure 4.1 General structure of Digital Fashion Platform
Source: http://digitalfashionproject.eu/?page_id=2474

In the dynamic intersection of technology and fashion, implementing Personalized 3D Garment Fitting involves a comprehensive strategy to revolutionize the traditional approach to sizing and enhance the overall shopping experience. Commencing with thorough market research, businesses must understand consumer preferences and demographics to tailor their strategy effectively. Technological integration forms the backbone, with investments in advanced 3D scanning and modelling technologies seamlessly incorporated into design and manufacturing processes.

The strategy joints on data-driven personalization, where robust systems collect and analyse customer data, empowering businesses to provide tailored recommendations and customization options. The development of an intuitive online interface or mobile application allows customers to input measurements and personalize garment styles. This interface, seamlessly integrated with 3D modelling software, facilitates a realistic virtual try-on experience, where customers can visualize how personalized garments will look on their unique body shapes.

Figure 4.2 Initial 3D garment fitting effect of a customized jacket
Source: http://digitalfashionproject.eu/?page_id=2474

As shown below, by using software like Modaris 3D Fit, we can easily simulate the garment fitting effects for a specific body morphology. Aligning production processes with personalized orders and implementing stringent quality control measures ensure that the end product meets the highest standards in fit, comfort, and durability. Marketing campaigns emphasize the benefits of Personalized 3D Garment Fitting, and ongoing education efforts inform customers about the technology and improved shopping experience. The evaluation of garment fitting effects and garment comfort performed by the designer or consumer is extremely important for validating the proposed design solution. This step enables interactions between the virtual product and the consumer. In the environment of Modaris 3D Fit, the user can visualize the appearance of the virtual garment to evaluate the fitting effects and use the "Colorization of ease map" and "Clothing transparency map" to visualize and evaluate both the fitting and comfort effects.

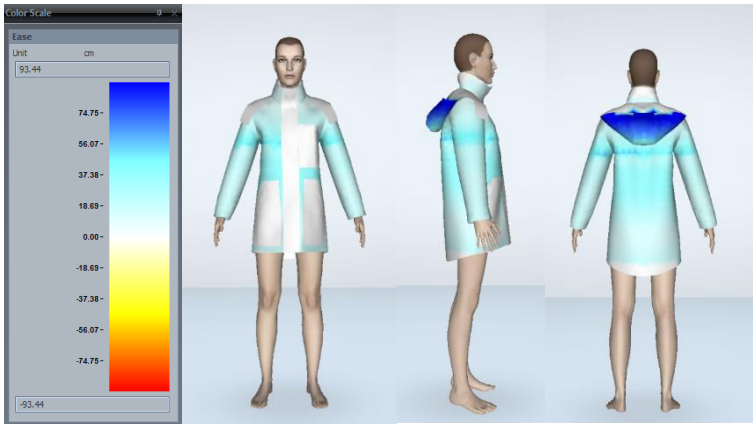

Figure 4.3 Coloration map of the jacket design with the Fabric n°124
Source: http://digitalfashionproject.eu/?page_id=2474

Establishing a continuous feedback loop, fostering partnerships, and prioritizing scalability and accessibility round out the strategy. By staying informed about technological advancements and fostering innovation, businesses can not only meet but exceed the expectations of diverse consumers, ushering in a new era where fashion is as unique as the individuals it adorns.

The Digital Fashion Project Platform also promotes an intelligent engine for garment pattern selection for specific fashion requirements. The current four databases have been designed to be connected to the processes of digital human modelling based on 3D body scanning, digitalized fabrics, patterns and 3D try-on simulations as we can see in the example image below:

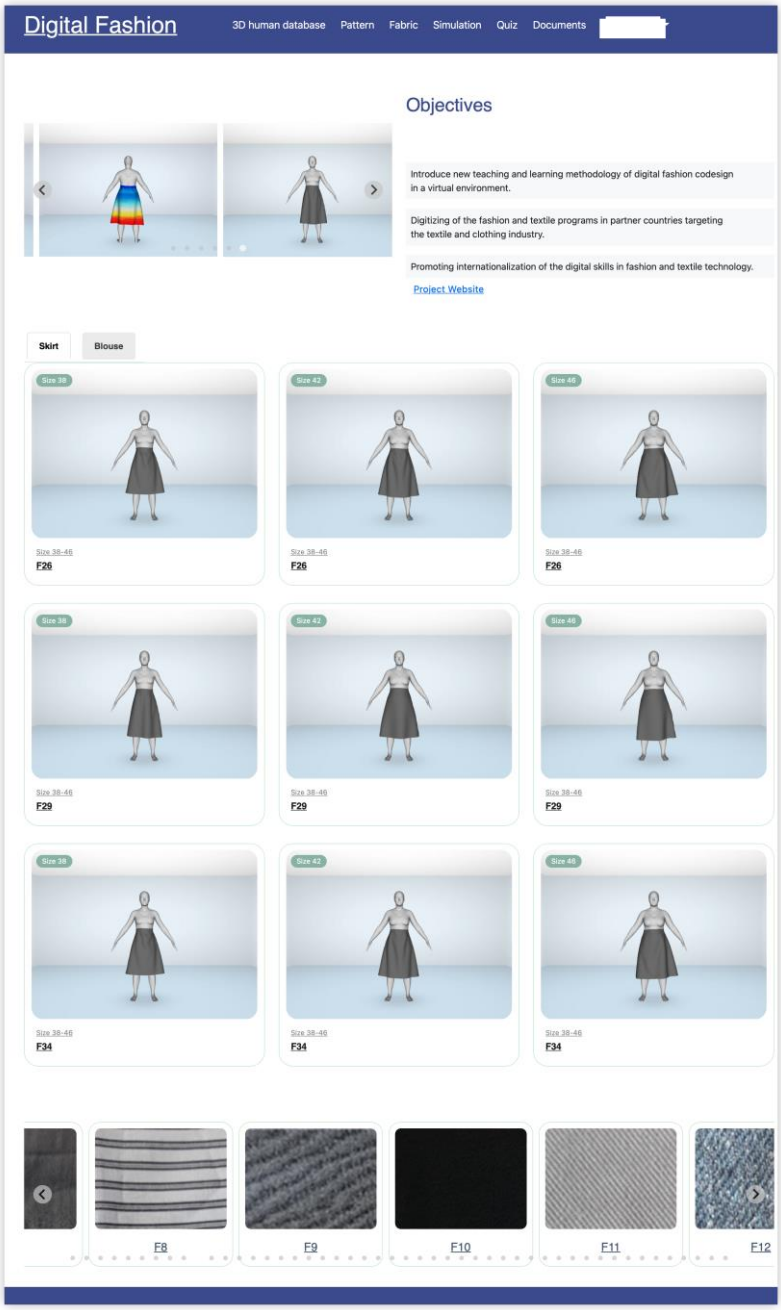

Figure 4.4 Digital Learning Page
Source: https://www.digitalfashiondleu.com

Provided by the University of HOGENT, including 3D and 2D avatar images of young ladies aged from 18 to 25 years old with different sizes 38, 42 and 46, and avatar's

measurement details. As shown below the platform shows the 2D images of the 3D human body from three views (i.e. front, side, and back) and a QR code allowing the user to scan by his/her mobile phone to access the most relevant 3D human avatar.

Figure 4.5 3D Avatar by scanning QR code
Source: http://digitalfashionproject.eu/?page_id=2474

4.3. VIRTUAL SALESPERSON

In the ever-evolving landscape of e-commerce, the integration of advanced technologies has revolutionized the way customers explore and purchase garments online. One significant enhancement is the use of a fashion knowledge base coupled with interactive systems and fitting demonstration platforms, allowing for personalized and informed recommendations.

The core of this innovative approach lies in the seamless interaction between the customer, the e-commerce system, and a fitting demonstration platform. The fashion knowledge base serves as a reservoir of extensive information on various clothing items, styles, trends, and customer preferences. It encompasses a rich tapestry of data, including sizes, fabrics, colours, and even the latest fashion trends curated from diverse sources.

The interaction begins when a customer engages with the e-commerce platform. Through intuitive interfaces and chatbots powered by natural language processing, the system initiates a dialogue with the customer. These interactions go beyond mere transactional exchanges; they delve into understanding the customer's preferences, style inclinations, and even occasions for which they seek garments.

The fashion knowledge base plays a pivotal role in this conversation. It allows the system to tap into a vast repository of information, ensuring that recommendations are not just generic but tailored to the individual's tastes. For instance, if a customer expresses a

penchant for a specific colour, fabric, or particular fashion trend, the system uses this knowledge to refine its suggestions.

A key element in this personalized recommendation process is the fitting demonstration platform. Here, technology transcends mere suggestion and steps into the realm of visual representation. Customers can virtually try on garments, thanks to augmented reality or virtual fitting rooms. This addresses a significant concern in online garment shopping – the uncertainty about how a piece of clothing will fit and look.

Through a combination of 3D modelling and AR, the fitting demonstration platform provides customers with a lifelike representation of how a garment will appear on them. This not only enhances the overall customer experience but also mitigates the likelihood of returns due to size or style mismatch.

The synergy between the customer, the system, and the fitting demonstration platform creates a dynamic feedback loop. As customers interact with the virtual fitting room and provide feedback on the suggested garments, the system refines its understanding of their preferences. This continuous learning process ensures that recommendations become increasingly accurate and aligned with the customer's evolving style.

Moreover, this interactive approach fosters a sense of engagement and empowerment among customers. They become active participants in the decision-making process, allowing them to make more confident and satisfying choices. The fashion knowledge base, constantly updated with the latest trends and customer feedback, becomes a reservoir of collective fashion intelligence.

In conclusion, the recommendation of relevant garments in e-commerce has transcended traditional paradigms through the fusion of a fashion knowledge base, interactive systems, and fitting demonstration platforms. This holistic approach not only elevates the customer experience by offering personalized and visually accurate recommendations but also establishes a symbiotic relationship where both the customer and the system contribute to the evolution of fashion choices in the digital realm.

4.3.1. CUSTOMER JOURNEY

The customer journey is the process that a person goes through from being unaware of a product or service to becoming a loyal customer. It is a fundamental concept in marketing and business strategy, and it typically consists of several stages. Let us dig into the customer journey stages to understand how businesses can effectively engage and satisfy their customers at each step.

- Awareness stage;
- Interest and Discovery stage;
- Consideration stage;
- Intent and Evaluation stage;

- Purchase stage;
- Post-Purchase Experience stage;
- Retention and Advocacy stage;

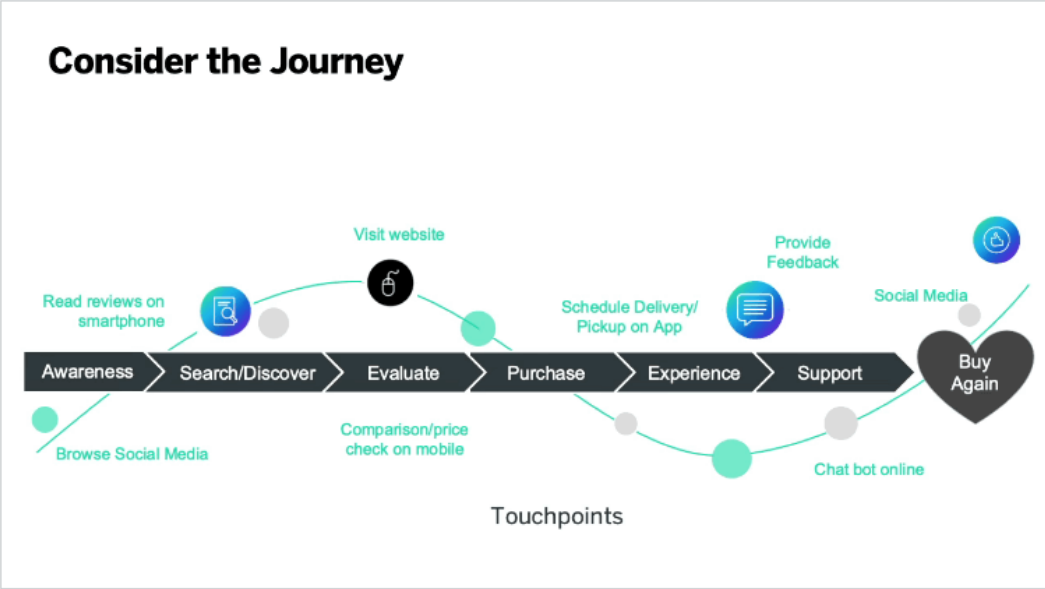

Figure 4.6 Customer journey

Source: https://www.qualtrics.com/experience-management/customer/customer-journey-stages/

Understanding and optimizing each stage of the customer journey is vital for businesses looking to create meaningful and lasting relationships with their customers. By tailoring marketing efforts, communication strategies, and customer interactions to address the unique needs and expectations at each stage, businesses can enhance the overall customer experience and foster long-term loyalty.

Awareness Stage: Nurturing Brand Discovery and Recognition

The primary objective during the Awareness Stage is to create a strong brand presence that resonates with the target audience. To achieve this, businesses leverage a multi-faceted approach encompassing advertising, social media engagement, and content marketing. Through captivating visuals, compelling storytelling, and strategic messaging, they aim to imprint their brand on the consciousness of potential customers.

In the digital age, online channels become the battleground for establishing brand visibility. Social media platforms serve as dynamic arenas where businesses can showcase their ethos, values, and offerings. Additionally, paid advertising across various platforms enables targeted exposure, ensuring that the brand message reaches individuals who are likely to be interested.

In essence, the Awareness Stage sets the tone for the entire customer journey. Businesses that successfully capture attention, convey a compelling brand story and create a positive initial impression lay the groundwork for continued engagement. As individuals move through subsequent stages, the impact of a well-executed Awareness Stage becomes increasingly evident, shaping perceptions and influencing decisions in the dynamic landscape of the customer journey.

Interest and Discovery Stage: Unveiling Solutions and Guiding Exploration

The central objective of the Interest and Discovery Stage is to sustain the momentum generated during the Awareness Stage and facilitate a more profound connection with potential customers. Businesses recognize the evolving interest and respond by offering a wealth of valuable information through various channels.

Content marketing continues to be a cornerstone strategy, with businesses creating in-depth blog posts, informative videos, webinars, and other resources that not only showcase their offerings but also educate and guide customers in their decision-making process. This content is strategically crafted to address common queries, concerns, and pain points, positioning the business as a helpful resource and establishing authority in the industry.

Social media engagement takes on a more interactive dimension. Businesses leverage platforms like Facebook, Twitter, and Instagram to not only share content but also to engage in conversations with their audience. Answering queries, responding to comments, and participating in relevant discussions further solidify the brand's presence and contribute to a sense of community.

Interactive content, such as quizzes, assessments, and interactive product demos, adds a dynamic element to the exploration process. By allowing customers to actively engage with the brand, businesses deepen the connection and gather valuable insights into individual preferences and requirements.

Influencers and thought leaders in the industry can play a significant role during this stage. Collaborating with individuals or entities that align with the brand's values and resonate with the target audience can enhance credibility and introduce the business to new circles of potential customers.

The Interest and Discovery Stage is a pivotal point in the customer journey where businesses not only showcase their offerings but also guide customers through an educational journey. By providing valuable insights, fostering engagement, and responding to the evolving interests of potential customers, businesses set the stage for informed decision-making as individuals progress through subsequent stages of the customer journey.

Consideration Stage: Navigating Choices and Informed Decision-Making

The central objective of the Consideration Stage is to guide potential customers through a nuanced decision-making process, ensuring that they have the necessary information to make a well-informed choice. Businesses recognize the evolving seriousness of interest and respond by presenting comprehensive details about their products or services.

Detailed product descriptions and specifications become paramount. Businesses aim to showcase not just what their offerings are, but how they specifically address the needs and preferences of potential customers. This transparency fosters trust and helps individuals envision how the product or service aligns with their unique requirements.

Customer testimonials and case studies take center stage during the Consideration Stage. Real-world examples of satisfied customers and successful implementations serve as social proof, providing potential buyers with insights into the actual experiences of others. By highlighting positive feedback and demonstrating the tangible benefits of the offering, businesses aim to alleviate any lingering doubts and reinforce the value proposition.

Comparison tools and charts are valuable assets during this stage. Businesses often provide side-by-side comparisons with competitors, outlining key features, pricing structures, and differentiators. This empowers potential customers to weigh options objectively and make informed decisions based on their specific priorities.

Interactive demonstrations and trials further engage potential customers. Whether through virtual experiences, free trials, or interactive tours, businesses offer hands-on opportunities for individuals to experience the product or service. This first hand encounter helps bridge the gap between theoretical understanding and practical application, allowing potential customers to envision the value in a real-world context.

Personalized communication becomes increasingly important. Email campaigns tailored to the specific needs and preferences of potential customers can provide targeted information, address lingering questions, and offer exclusive incentives, further nurturing the relationship and guiding individuals toward a favorable decision.

Responsive customer support is crucial during the Consideration Stage. Offering multiple communication channels, such as live chat, helplines, and email support, ensures that potential customers can easily seek clarification, address concerns, and receive timely assistance. A positive support experience contributes significantly to the overall perception of the brand.

The Consideration Stage is a pivotal juncture where potential customers transition from exploring options to actively evaluating which solution aligns best with their needs.

Intent and Evaluation Stage: Navigating Towards Decision-Making

The central objective of the Intent and Evaluation Stage is to capitalize on the increasingly serious interest displayed by potential customers and guide them toward a confident decision. Businesses recognize the evolving intent and respond by employing focused marketing and communication efforts.

Targeted marketing efforts take center stage during this phase. Retargeting campaigns, personalized promotions, and exclusive offers are strategically deployed to re-engage individuals who have shown strong interest but may not have completed a purchase. These initiatives serve to create a sense of urgency and provide additional incentives for potential customers to convert.

Clear communication about pricing structures, available discounts, and any applicable terms and conditions helps build trust and confidence in the decision-making process.

In-depth product demonstrations or trial extensions can further solidify the decision-making process. Offering extended trial periods, providing access to advanced features, or facilitating hands-on experiences allows potential customers to explore the product or service in greater detail, reinforcing their understanding and conviction about its suitability.

Responsive and personalized customer support continues to play a pivotal role. Businesses ensure that potential customers have access to prompt assistance and that any remaining queries or concerns are addressed comprehensively. A positive support experience at this stage contributes significantly to a customer's overall perception of the brand and the anticipated post-purchase support they can expect.

Social validation through user reviews and endorsements gains prominence. Businesses encourage satisfied customers to share their experiences, providing testimonials that serve as powerful endorsements. Positive reviews and recommendations from peers contribute to building trust and alleviating any lingering doubts potential customers may have.

The Intent and Evaluation Stage marks the final steps before a potential customer commits to a purchase. As individuals navigate through this stage, the groundwork is laid for successful conversions in the final stages of the customer journey.

Purchase Stage: The Culmination of Decision-Making

The central objective of the Purchase Stage is to facilitate a smooth and frictionless transaction process, ensuring that potential customers become actual customers with

minimal barriers. Businesses recognize the culmination of the decision-making journey and respond by streamlining the purchase experience.

The transaction process itself becomes a critical focal point. Businesses invest in user-friendly and secure checkout systems, ensuring a hassle-free experience for customers. Multiple payment options, transparent pricing, and clear calls-to-action contribute to a seamless purchasing process, minimizing the likelihood of abandoned carts.

Post-purchase communication plays a vital role. Businesses promptly confirm orders through automated emails or messages, providing customers with detailed information about their purchase, including order summaries, shipping details, and estimated delivery times. This proactive communication helps manage customer expectations and instills confidence in the buying decision.

Order tracking and updates further contribute to a positive purchasing experience. Businesses provide real-time information about the status and location of the customer's order, keeping them informed and engaged throughout the delivery process. This transparency reinforces the trust established during the earlier stages of the customer journey.

In the digital era, social sharing and celebration of purchases have become prevalent. Encouraging customers to share their new acquisitions on social media, possibly with a branded hashtag, can amplify the positive experience. This not only showcases the brand to a wider audience but also fosters a sense of community among customers.

Ensuring a hassle-free returns and exchange process is crucial for customer satisfaction. Clear policies, easy-to-follow procedures, and responsive customer support in the event of any issues contribute to building trust even after the purchase is complete.

The Purchase Stage is not merely a transactional conclusion but a crucial moment in building a lasting customer relationship. Businesses that prioritize a seamless transaction process, proactive communication, and post-purchase engagement contribute to a positive overall experience. As customers transition from potential to actual buyers, the foundation for loyalty and potential advocacy is laid for future interactions in the customer journey.

Post-Purchase Experience Stage: Nurturing Loyalty and Building Advocacy

The central objective of the Post-Purchase Experience Stage is to solidify the positive impression created during the earlier stages of the customer journey and to exceed customer expectations after the transaction is complete. Businesses recognize the importance of post-purchase engagement and respond by implementing strategies to enhance customer satisfaction and loyalty.

Follow-up communication becomes a cornerstone of post-purchase engagement. Businesses send thank-you emails or messages expressing appreciation for the customer's purchase. These messages often include details such as order summaries, shipping information, and contact details for customer support. This not only provides valuable information but also reinforces the brand's commitment to customer satisfaction.

Post-purchase surveys offer an avenue for gathering feedback. By seeking input on the overall buying experience, product satisfaction, and areas for improvement, businesses gain valuable insights into customer sentiments. This feedback loop is instrumental in refining products, services, and the overall customer experience.

Providing resources for product usage and support is crucial. Businesses offer user manuals, online guides, and video tutorials to help customers maximize the value of their purchase. Robust customer support channels, including live chat, helplines, and email, ensure that customers can easily seek assistance or resolve any issues they may encounter.

Personalized recommendations contribute to ongoing engagement. Leveraging data from the customer's purchase history, businesses suggest complementary products, upgrades, or accessories that align with the customer's preferences. This not only enhances the overall shopping experience but also presents opportunities for upselling and cross-selling.

Loyalty programs and exclusive offers incentivize repeat business. By rewarding customers for their loyalty through points, discounts, or exclusive access to promotions, businesses encourage them to return for future purchases. This fosters a sense of belonging and appreciation.

Anticipating and addressing potential issues is crucial. Proactive communication about order status, shipping delays, or product recalls demonstrates transparency and helps manage customer expectations. Swift resolution of any post-purchase concerns contributes to maintaining a positive brand perception.

Encouraging user-generated content, such as reviews, testimonials, and social media shares, is a powerful strategy. Happy customers often become brand advocates, and their positive experiences shared with a wider audience contribute to building trust and credibility.

The Post-Purchase Experience Stage is a pivotal juncture in the customer journey where businesses have the opportunity to solidify relationships and cultivate customer loyalty. By implementing strategies that go beyond the transactional and focus on ongoing engagement, support, and personalized initiatives, businesses lay the groundwork for a positive and enduring customer relationship.

Retention and Advocacy Stage: Fostering Long-Term Relationships and Brand Champions

The central objective of the Retention and Advocacy Stage is to extend the customer lifecycle, turning one-time buyers into loyal patrons and enthusiastic advocates for the brand. Businesses recognize the value of retaining existing customers and inspiring them to become active promoters, and they respond with targeted strategies to nurture long-term relationships.

Actions like: Loyalty Programs and Exclusive Offers; Personalized Communication and Engagement; Proactive Customer Support and Relationship Management; Exclusive Events and Community Building; Soliciting and Showcasing Customer Testimonials; Referral Programs; Continuous Feedback; Surprise Initiatives; Ongoing Value Addition; can promote and reinforce the satisfaction of the customers. The Retention and Advocacy Stage represents the culmination of effective customer journey management. By deploying strategies focused on loyalty, engagement, and advocacy, businesses create a cycle of sustainable growth fueled by satisfied and loyal customers.

4.4. PREDICTION OF THE MARKET EVOLUTION ACCORDING TO THE CUSTOMERS`ACTIONS

In the ever-expanding realm of e-commerce, predicting market evolution has become a critical endeavor, and a significant breakthrough in this pursuit lies in analyzing and understanding customers' actions. As technology advances and data analytics become more sophisticated, e-commerce platforms leverage customer behavior insights to anticipate market trends, tailor offerings, and enhance the overall shopping experience.

The prediction of market evolution in e-commerce is intricately tied to the study of customer actions, a rich source of valuable data that encompasses browsing patterns, purchase history, and engagement metrics. Advanced algorithms and machine learning models sift through this vast pool of information to discern patterns and extract meaningful insights, enabling e-commerce businesses to make informed decisions about their products, marketing strategies, and overall market positioning.

One key aspect of predicting market evolution is understanding customer preferences and trends. By tracking what products customers are searching for, clicking on, and ultimately purchasing, e-commerce platforms can identify emerging trends and consumer preferences. This enables businesses to proactively adjust their inventory, ensuring they are well-positioned to meet the evolving demands of the market.

The use of recommendation engines is another powerful tool in predicting market evolution. By analysing customers' past actions, these engines can suggest relevant products based on their preferences and behaviours. As customers interact with these recommendations, the system learns and adapts, continuously refining its predictions. This not only drives sales by increasing the relevance of product suggestions but also contributes to a more personalized and engaging shopping experience.

Moreover, customer actions play a crucial role in forecasting demand and optimizing inventory management. E-commerce platforms can anticipate spikes in demand for certain products by analysing customer behaviour during specific seasons, events, or trends. This foresight allows businesses to stock up on popular items, minimizing stock outs and ensuring a seamless shopping experience for customers.

The rise of social commerce has added another layer to predicting market evolution. As customers increasingly engage with brands and products on social media platforms, their actions – likes, shares, comments, and clicks – become valuable indicators of market interest. E-commerce businesses can leverage these social signals to gauge the popularity of products and adjust their strategies accordingly, amplifying the impact of their marketing efforts.

Furthermore, real-time analytics and monitoring of customer actions enable e-commerce platforms to swiftly adapt to changing market dynamics. Whether it's responding to a sudden surge in demand for a particular product or addressing issues such as abandoned carts, the ability to monitor and interpret customer actions in real-time empowers businesses to stay agile and responsive.

While the predictive power of customer actions is formidable, it's crucial to recognize the ethical dimensions of data usage. Respecting customer privacy and ensuring transparent data practices are essential to building trust and maintaining a positive customer-business relationship.

In conclusion, the prediction of market evolution in e-commerce centers on the ability to decipher and leverage customer actions effectively. By using the power of data analytics, machine learning, and real-time monitoring, e-commerce platforms can not only foresee market trends but also proactively shape their strategies to meet the ever-changing expectations of their customer base. As technology continues to advance, the synergy between customer actions and market evolution will likely play an increasingly critical role in the success and sustainability of e-commerce.

4.4.1. DIGITAL CONSUMER

In the rapidly evolving landscape of technology and connectivity, the distinct characteristics and preferences of different generations shape their interactions with the digital space. From the Silent Generation's cautious embrace to Generation Alpha's innate digital fluency, each cohort exhibits unique internet usage patterns, device preferences, online habits, and favored technologies. Exploring these generational differentiators provides valuable insights into consumer behaviors, helping businesses, marketers, and tech innovators tailor their strategies to meet the diverse needs of their target audiences. This examination traverses the historical progression of internet adoption, spanning from those who witnessed its infancy to the emerging cohort growing up in a world where connectivity is synonymous with daily life. Understanding how each generation navigates the digital landscape unveils opportunities for creating more effective and inclusive technological solutions that resonate across age groups.

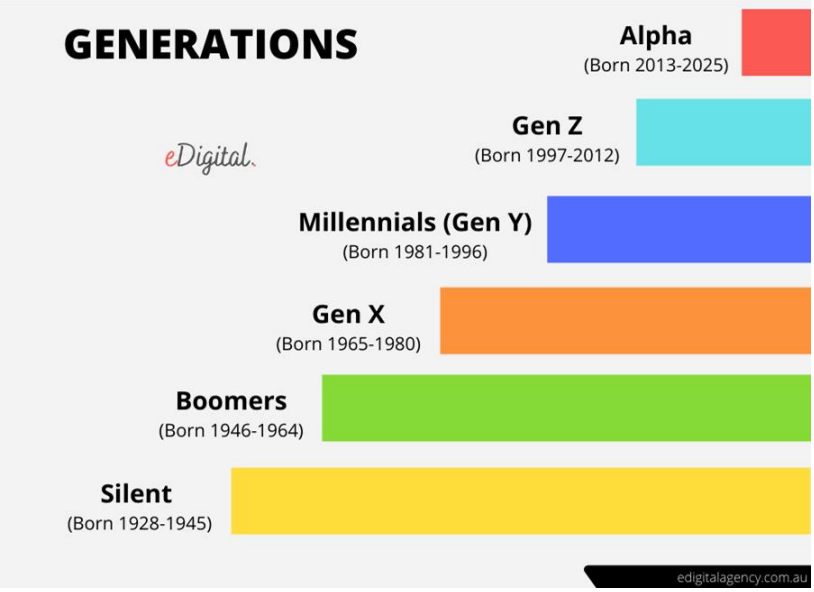

Figure 4.7 Digital consumer generations
Source: https://www.edigitalagency.com.au/

Silent Generation (born 1928–1945):

Internet Usage: The Silent Generation has adapted to the internet but may not be as digitally immersed as younger generations. They often use the internet for basic tasks such as email and information gathering.

Devices: Desktop computers are commonly used by this generation, although some may also use tablets or smartphones.

Habits: They tend to have more reserved online habits, focusing on specific tasks rather than extensive social media engagement.

Preferred Technology: Familiarity with traditional technologies, and a preference for reliability and simplicity in devices.

Baby Boomers (born 1946–1964):

Internet Usage: Baby Boomers have embraced the internet, using it for various purposes, including social media, online shopping, and staying informed.

Devices: They predominantly use desktops and laptops, but there is an increasing adoption of smartphones and tablets.

Habits: Baby Boomers engage in social media but may not be as tech-savvy as younger generations. They value online security and privacy.

Preferred Technology: User-friendly interfaces and devices that simplify tasks. Increasing interest in e-commerce and online services.

Generation X (born 1965–1980):

Internet Usage: Generation X was among the first to fully embrace the internet. They use it for work, communication, and entertainment.

Devices: Comfortable with desktops, laptops, and increasingly mobile devices. They value flexibility in device usage.

Habits: Active on social media, but also value privacy. More likely to engage in online forums and discussions.

Preferred Technology: Devices that offer both productivity and entertainment. Early adopters of new technologies.

Millennials (born 1981–1996):

Internet Usage: Millennials are digital natives, heavily reliant on the internet for communication, socializing, work, and entertainment.

Devices: Primarily use smartphones but are versatile with laptops, tablets, and other gadgets.

Habits: Highly active on social media, engage in online content creation, and are more likely to trust online reviews and recommendations.

Preferred Technology: Embrace new technologies, prioritize connectivity, and value seamless integration across devices.

Generation Z (born 1997–2012):

Internet Usage: Generation Z has grown up in a hyper-connected world, relying heavily on the Internet for communication, education, and entertainment.

Devices: Predominantly use smartphones, with a preference for mobile apps and platforms.

Habits: Actively participate in online communities, consume a diverse range of digital content, and prioritize visual communication.

Preferred Technology: Embrace emerging technologies, such as augmented reality (AR) and virtual reality (VR), and value experiences over ownership.

Generation Alpha (born 2013–now):

Internet Usage: As the youngest generation, Generation Alpha is still in the early stages of internet adoption, with limited independent access.

Devices: Growing up with touchscreen devices, tablets, and educational apps. Likely to have increased access to smart toys and devices designed for children.

Habits: Digital natives from birth, they may have a more intuitive understanding of technology. Parental controls and content restrictions are significant factors.

Preferred Technology: Likely to be early adopters of new educational technologies and interactive devices.

Understanding these generational differences in internet usage, devices, habits, and preferred technology is crucial for businesses and technology developers to tailor their products and services to the preferences and expectations of diverse consumer groups.

Leveraging data-driven predictions, businesses can proactively tailor their strategies, enhance customer experiences, and seize opportunities for innovation. By staying familiar with the evolving patterns in customers' actions, companies can navigate the competitive market ground, foster long-term customer relationships, and position themselves strategically for sustained growth in an environment where consumer dynamics continue to shape the future of commerce.

CONCLUSION

In the confluence of cutting-edge technologies and the evolving landscape of consumer behavior, the triad of personalized 3D garment fitting, virtual salespersons, and the prediction of market evolution based on customers' actions emerges as a transformative force in the retail and fashion realms.

Personalized 3D garment fitting, a pioneering fusion of technology and fashion, redefines the traditional paradigms of garment sizing. By leveraging advanced 3D scanning and modeling technologies, this innovative approach enables precise tailoring of clothing to individual body measurements. The strategic integration of data-driven personalization ensures that each garment aligns with customer preferences, marking a departure from standardized sizing charts. The result is an immersive and highly personalized shopping experience, where customers not only visualize but actively participate in the creation of their unique apparel.

Complementing this personalized journey is the advent of Virtual Salespersons. In the digital domain, they can be intuitive guides, offering tailored recommendations and product insights. They leverage customer data, preferences, and interactions to provide a personalized shopping experience. Virtual Salespersons bridge the gap between online and in-store experiences, offering real-time assistance and enhancing customer engagement.

Finally, the prediction of market evolution based on customers' actions forms the strategic backbone that unites these technologies. By analyzing and interpreting customer behaviors, businesses can anticipate market trends, preferences, and emerging demands. This predictive approach allows for agile decision-making, enabling businesses to adjust strategies in real time and stay ahead of the dynamic market landscape.

The synergy between personalized 3D garment fitting, virtual salespersons, and predictive market evolution embodies a paradigm shift in the retail industry. This convergence propels a customer-centric approach where individual preferences, technological innovation, and market foresight converge. As businesses embrace these transformative technologies, they go on board on a journey to not only meet but exceed customer expectations, ushering in an era where personalization, virtual assistance, and predictive insights redefine the very essence of the customer-retailer relationship.

BIBLIOGRAPHY

[1] Benjamin, A. A., Santos, G. M. F. D., Rodrigues, R. L. F., Falcão, R. F., & Rocha, R. R. (2021). A influência de sistemas de recomendação de produtos em plataformas de comércio eletrônico: Insights sobre o consumidor Brasileiro. *Revista Liceu On-Line*, 11(2), 28–52.

[2] https://liceu.emnuvens.com.br/LICEU_ON-LINE/article/download/1858/1150

[3] Bernard, G., & Andritsos, P. (2017*). A process mining based model for customer journey mapping*. 1848, 49–56. http://ceur-ws.org/Vol-1848/CAiSE2017_Forum_Paper7.pdf

[4] Boardman, R., Henninger, C. E., & Zhu, A. (2019). Augmented reality and virtual reality: new drivers for fashion retail? *In Springer eBooks* (pp. 155–172). https://doi.org/10.1007/978-3-030-15483-7_9

[5] Nelson, P. (1970). Information and consumer behavior. *Journal of Political Economy*, 78(2), 311–329. https://doi.org/10.1086/259630

[6] Kalmkar, S., Mujawar, A., & Liyakat, D. K. S. (2022). *3D E-Commers using AR. International Journal of Information Technology and Computer Engineering*, 26, 18–27. https://doi.org/10.55529/ijitc.26.18.27

[7] Moon, H., Han, S. H., Chun, J., & Hong, S. W. (2016). A design process for a customer journey map: A case study on mobile services. *Human Factors and Ergonomics in Manufacturing & Service Industries*, *26*(4), 501–514. https://doi.org/10.1002/hfm.20673

[8] Rosenbaum, M. S., Otálora, M. L., & Ramírez, G. C. (2017). How to create a realistic customer journey map. *Business Horizons*, 60(1), 143–150. https://doi.org/10.1016/j.bushor.2016.09.010

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