Fashion DIET

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BEST PRACTICES OF SUSTAINABLE PRODUCT DEVELOPMENT THROUGH 3D-DESIGN AND VISUALIZATION

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ТРАКИЙСКИ УНИВЕРСИТЕТ
СТАРА ЗАГОРА

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Learning Objectives

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After reading this material, the learner/student will be able to:

- Characterize the concept of sustainability and digitalization for fashion and textiles.
- Describe the importance of digital innovation for a sustainable fashion and textile industry;
- Characterize product development for the mass customization fashion industry.
- Present sustainable solutions for product development - fashion and apparel industry.
- Characterize digital clothing development
- Describe best practices of sustainable product development –fashion and clothing industry

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Summary

- Sustainability and digitalization
- Digital innovation for a sustainable industry
- Product development for mass customization
- Sustainable solutions for new product development
- Digital clothing development
- Best practices of sustainable product development
- Reflections on the topics presented
- Questions to think about
- References and further reading

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Sustainability and digitalization

The goal of transforming Europe into a globally competitive, climate-independent digitised financial system and society rests on two pillars: the *green* and *digital* (“twin") transitions. (European Digital SME Alliance, 2020, p.1)

The EU Commission notes, these two transitions “new products and services, markets and business models, which must be grounded in our European values and our social market economy.” (European Digital SME Alliance, 2020, p.1)

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Sustainability and digitalization

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Sustainability and digitalization

The new feature of a sustainable European economy is digitalization. Under these conditions, companies, especially SMEs, must focus on the development of software programmes, AI, blockchains and the Internet of Things (IoT).

A sustainable digitalization (or sustainable digital transformation) means a process of "digitalizing the economy in a long-lasting, green, and organic way by building on its key strength: innovative SMEs and their business Ecosystems". (European Digital SME Alliance, 2020, p.1)

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Sustainability and digitalization

Sustainable digitalization (or sustainable digital transformation) has three main features:

Sustainable B2B digitalization	Green(er) technologies and a circular economy	Innovation-enabling policy & regulation
The goal is to create an innovation-driven ecosystem instead of using closed "off-the-shelf" solutions that lead to dependencies.	A digital sector that saves resources, increases efficiency, and enables repairability and reuse of products.	A holistic approach to rulemaking that supports innovation by emphasising openness of software and hardware.

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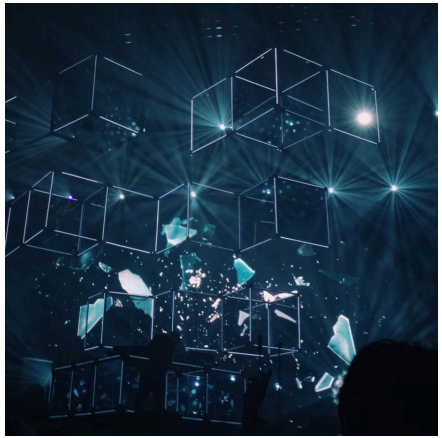
Sustainability and digitalization

A. Sustainable B2B digitalisation

Sustainable digitalization relies on long-term partnerships between *advanced digital* and *conventional* SMEs. It strives for a long-term orientation of digitization efforts and financing. (European Digital SME Alliance, 2020, p.4).

Pioneer SMEs and start-up's offer customised technological solutions for non-digital companies and accompany them on their digitalization process.

This synergy is usually created in ecosystems of digital SME associations and clusters, universities, public administrations and larger companies.



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Sustainability and digitalization

A. Sustainable B2B digitalisation

In digital hubs, for example, traditional and pioneer SMEs work together to develop innovative ideas that have significant benefits for ecological goals: from the integration of AI in processes and data management to the digitization of physical products using smart sensors.

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One prerequisite for a sustainable digital transformation of SMEs is the skills and competencies of their employees.
With the current wave of digitization, many job descriptions and the associated qualifications need to be updated to integrate the use of digital tools (advanced ICT skills and understanding of emerging technologies). (European Digital SME Alliance, 2020, p.5).

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Sustainability and digitalization

B. Green(er) technologies and a circular economy.

A digital Europe must achieve its climate and economic policy goals - protecting and preserving environmental resources by introducing circular economy models for hardware, climate-neutral CPU models and server centres, software developments to reduce energy consumption, improving third-party repairability and maintenance, extending the life cycle of hardware, and creating a framework that enables an open and competitive (aftersales) market. (European Digital SME Alliance, 2020, p.6).

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Sustainability and digitalization

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Create a market for independent repairers and thus lower prices for consumers.

Reduction of the ecological footprint.

Innovate processes needed for circular economy models from the start, rather than promoting products that follow aggressive lock-in strategies and use premature obsolescence.

Make products modular so that consumers can easily replace parts themselves, as is the case with some products;

Allow consumers access to quality repairs at fair prices that maintain product functionality, are safe, and protect privacy while giving them freedom of choice and upholding warranties.-Keeps the market open for new entrants and innovators.

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Sustainability and digitalisation

C. Innovation-enabling policy & regulation

- SMEs must innovate and develop new solutions for open hardware and software. (European Digital SME Alliance, 2020, p.9).
  - Make repairs and extend the life cycle of products, which contributes to environmental goals: the right to repair, wireless device regulations, platform regulation, product safety and liability, etc.
  - Regulation must address the real problems that are holding back our economy - gateways, anti-competitive behaviour, and tax evasion by tech giants - and avoid "one-size-fits-all" solutions that disproportionately affect smaller players.
  - European regulations should support openness of software and hardware alike, for example by reducing liability issues liability issues in the event of a malfunction of the software on a third-party device.

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Sustainability and digitalisation

C. Innovation-enabling policy & regulation

- Platform regulation must provide protection and opportunities for a digital transformation (Digital Service Act). (European Digital SME Alliance, 2020, p.9).
  - The Digital Services Act should introduce interoperability requirements for large gatekeeper systems (e.g., requirements for access to statistics, non-discrimination, transparency requirements) so that new revolutionary responses can enter foreclosed markets.

- To ensure a competitive digital environment, the EU Commission must define rules and procedures in the area of platform interoperability and data portability.

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Digital innovation for a sustainable industry

Digitization is the conversion system from an analogue form to a virtual form.
In other words, digital enablement involves converting an analogue method into a virtual form without altering the method itself in any way .(Gartner glossary).

Digitization can deliver efficiencies when the digitized information is used to automate strategies and enhance accessibility - but digitization does not aim to optimize approaches or facts.

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Digital innovation for a sustainable industry

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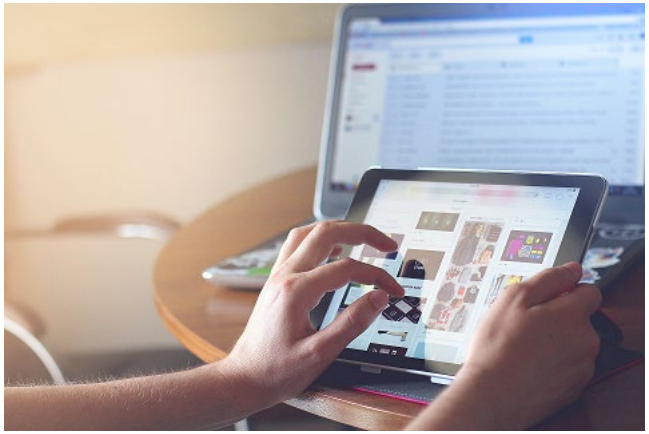
Digitalization means the use of digital technology to transform a business model and create new revenue and value opportunities; it is the process of shifting towards a digital business.
Digitalization goes beyond digitization and uses virtual fact technology to completely transform a company's processes. (Gartner glossary).



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Digitalization will increase productivity and performance while reducing costs. It improves an existing business method or procedure, but without replacing or revising it. That is, it turns a human-driven process or set of processes into a software-driven technique.

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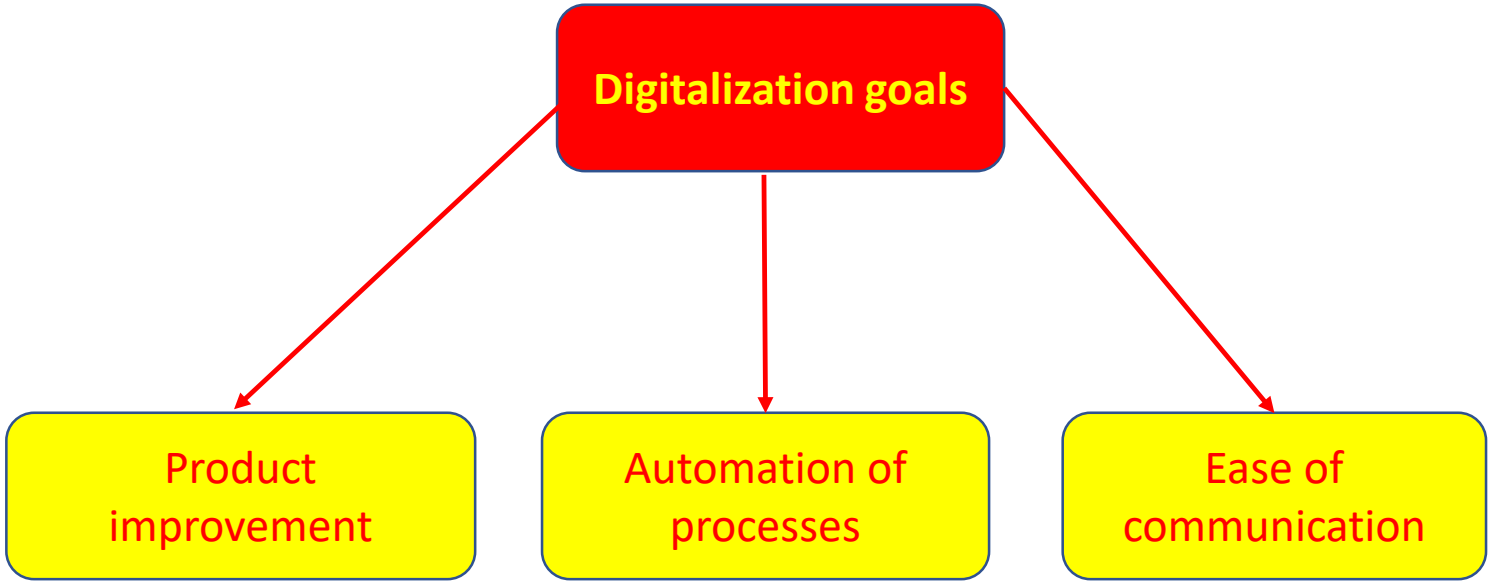
With digitalization, a company can develop new value chains and experiences that are collaborative, interactive, durable, and profitable.



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Digital innovation for a sustainable industry

Digital transformation means rethinking the way a company uses human resources, tools/apps, and methodologies to create new business models and new revenue streams driven by changing buyer expectations for products and services.

For traditional manufacturing companies, this means developing digital products, various apps or e-commerce platforms. (Clint, 2021).

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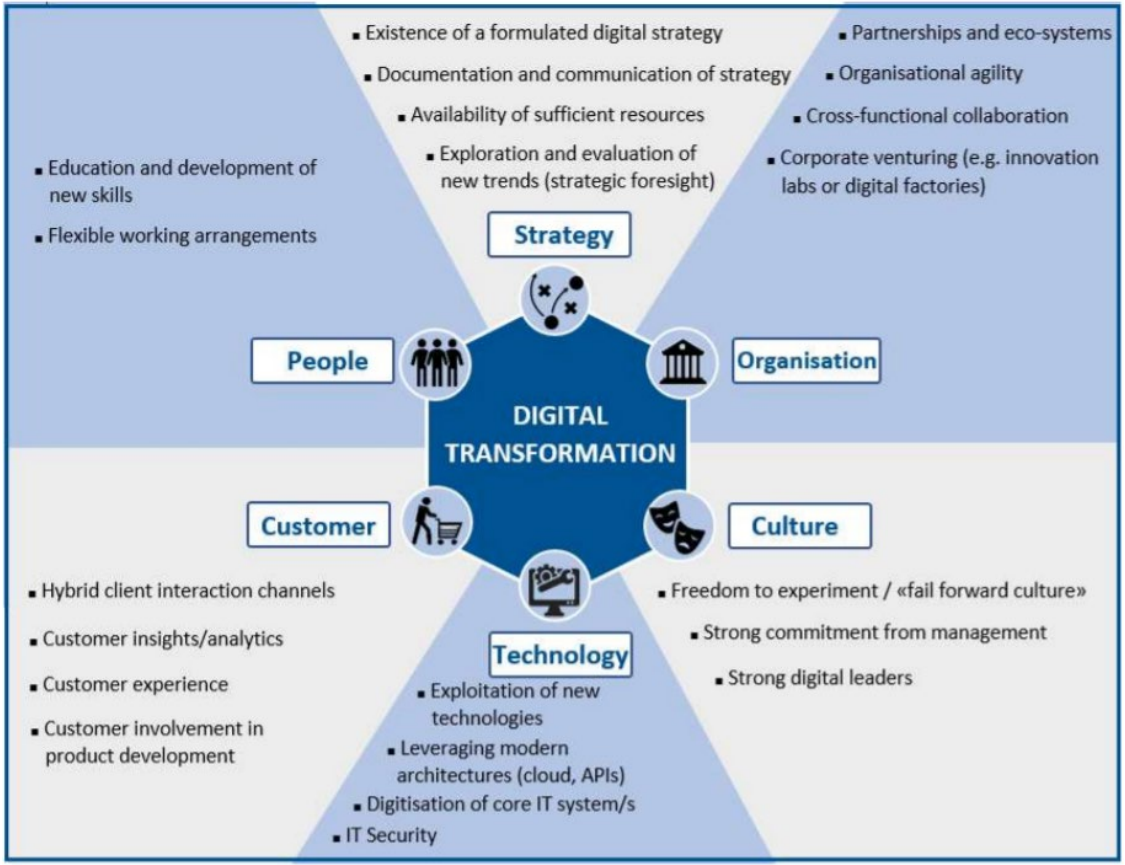
The key pillars for digital transformation are:

- Strategy,
- Organisation,
- Culture,
- Technology,
- Customers
- People.



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Digital innovation for a sustainable industry

The fashion, apparel, footwear and garment industries must embrace a complete digital transformation.

Digital transformation means: (DeSL, 2021)

- End to end→Tools to manage suppliers and cover all procurement processes.
- Virtualization→Move to digital assets and automated workflows for greater accuracy and speed.
- Real time data→Improved decision making backed up by machine learning and artificial intelligence.
- Integration→Seamless integration of key data into manufacturing equipment or vendor systems.

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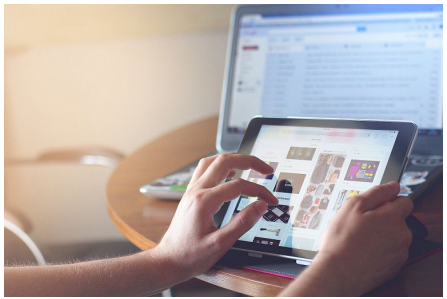
Digital innovation for a sustainable industry

The virtual world opens up new possibilities, both in the creative system and in the way we engage with and learn about style.
Technology is changing the way people spend their time on social media or in retail stores and with augmented reality.

Digital Village &Patrick McDowell (2020)

The modern customer uses various virtual channels to get information and make purchases.
This is an adventure that produces amazing impressions and experiences.



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Digital innovation for a sustainable industry

Digital product development has changed customer behaviour. By using 3D techniques, apparel manufacturers can make faster and better decisions during the development process of their products. Brand-new fashions can be tested on their websites without ever having to make a physical prototype or invest in raw materials.

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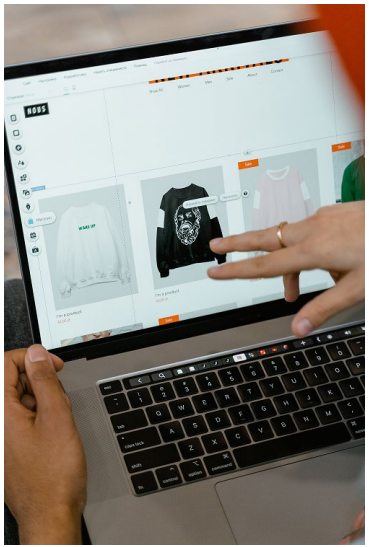

The customer insights can influence which garments are included in a selection and drive the supply chain to produce only what is ordered, while avoiding waste.

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Digital innovation for a sustainable industry

- Digital transformation determines the rethinking of the sales approach and distribution channels, design, production, advertising and marketing processes.

- The virtual transformation of product development is no longer a question of 'if', but of 'when'. AI-assisted design does not have to refer to an algorithm drawing the clothes or a robot sewing the pieces - it can mean a greener, time-saving approach for designers who now have assistive technology and actionable records to design better collections and avoid traditional obstacles - from sample costs to manufacturing delays.

Digital fashion show (2020)

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Digital innovation for a sustainable industry

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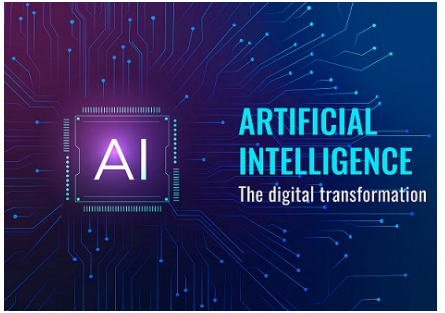
The key elements for a virtual fashion and clothing industry are:

(a) Artificial Intelligence (AI)

More and more consumers are shopping with manufacturers and retailers that align with their values. Successful AI solutions require strong interaction between what the business wants and what the customer wants.



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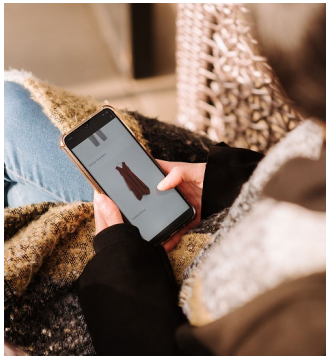

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(b) Garment Personalization

Curated tips, customized products and stories are fundamental to connect with customers. Customers are inclined to reveal their non-public information to have a extra personal experience.

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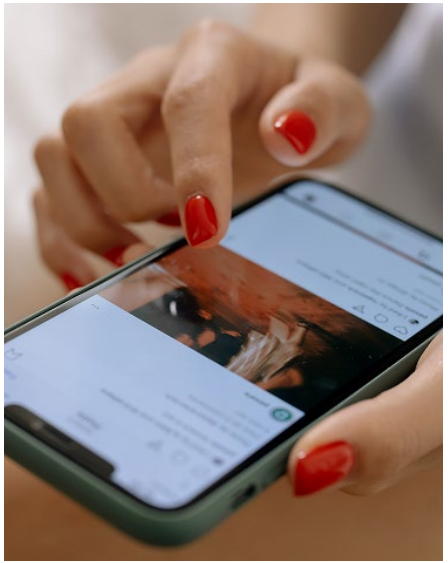
The key elements for a virtual fashion and clothing industry are :

(c) Social Commerce & Shoppable Posts

Brands and shops are maximizing their sales chances with Instagram Shoppable Posts. Advertising via social channels leverages the influence and reach of social interactions, resulting in new customers and revenue.

(d) Interactive Content Material

Dynamic and engaging content that provides users with an immersive and seamless experience is essential to help consumers feel more connected to manufacturers and, in turn, become more engaged in the purchase decision.



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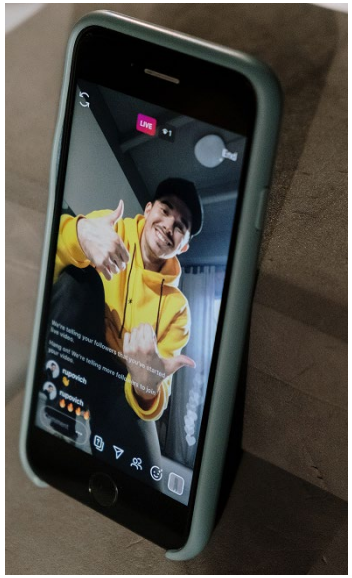
The key elements for a virtual fashion and clothing industry are :

(e) Visible search

Visible search takes the personal experience to a whole new level, offering retailers the opportunity to increase brand discovery and sales opportunities.

(f) Convergence

All images are in live performance, and executives want more than one technology to be used at a time for maximum benefit.



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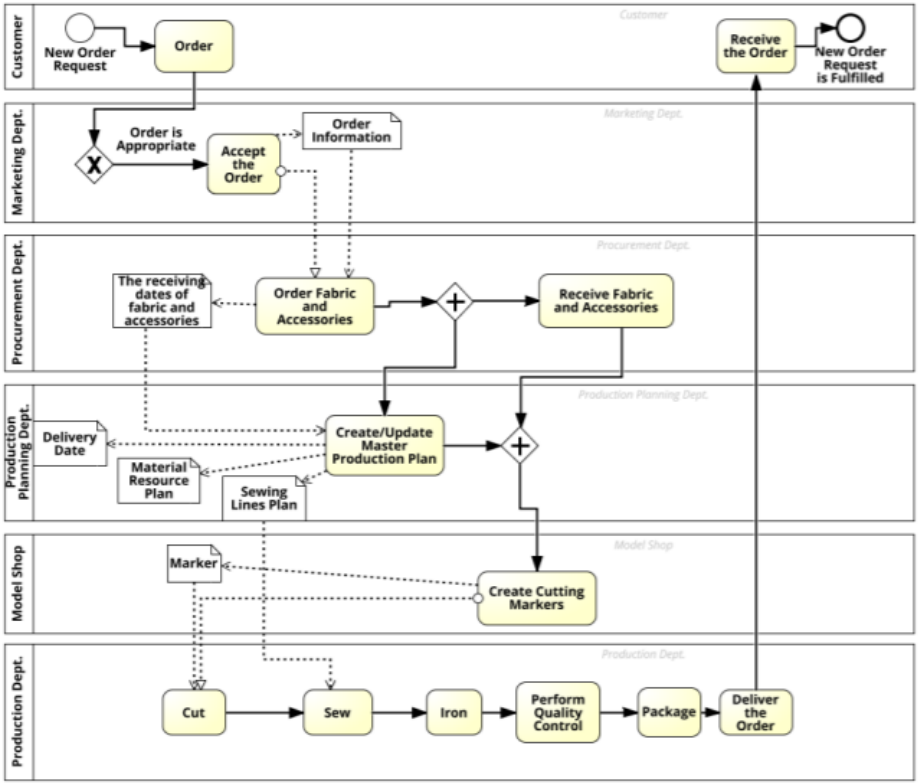
Product development for mass customization

"The clothing and apparel industry which is one of the main sectors of the industrialization movement for developing countries, involves the use of fabric and materials to produce men's, women's, and children's clothing, knitted underwear and outerwear." (Ebru, 2018, p.169).

Production system processes



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Product development for mass customization

Fashion DIET

Industrialization → It changed the way clothes were made. Production systems evolved to mass produce trendy designs in trendy sizes at a low unit price.

Mass production → Enables the production of fashionable clothing at a lower cost, leading to an increase in quantities, prices and sales. The fashion industry today is characterised by rapidly changing fashion cycles, excessive production volumes, excessive consumption and frequent disposal behaviour. The consumer is not readily connected to the manufacturer, and goods are produced solely on the basis of market studies and fads.

Mass customisation → This new approach offers high-value insights into reducing overproduction and overconsumption, extending product life and minimizing waste. It combines the personalization and versatility of customized goods with mass production and specific target groups.

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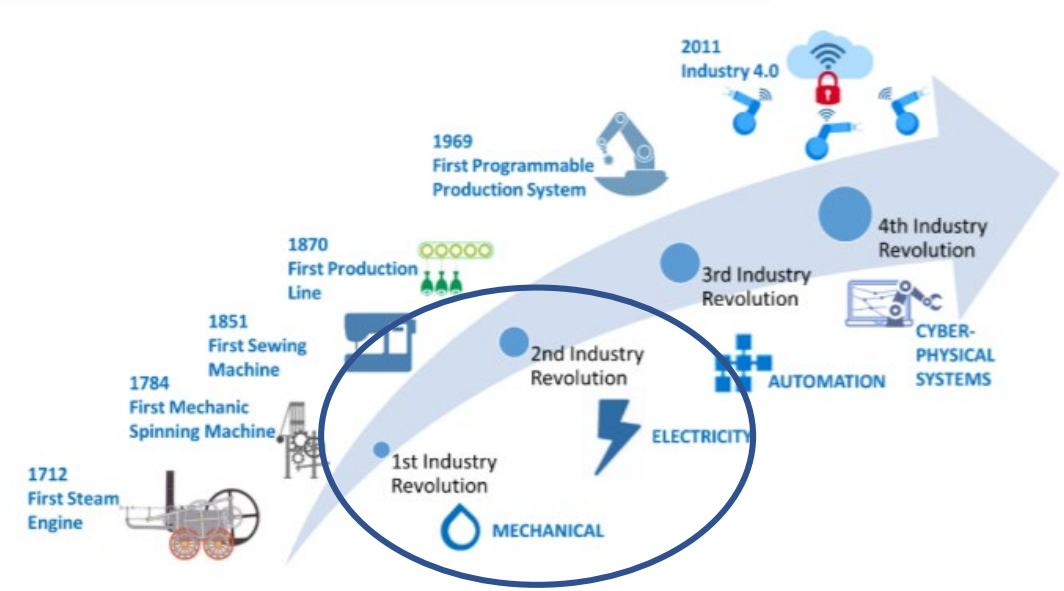
Product development for mass customization

"After three important industrial revolutions, as mechanical, electrical, and digital revolution, the world is now witnessing the 4-th Industrial revolution that integrates emerging IT concepts, including Cyber-Physical Systems (CPS), Internet of Things (IoT) and big data (Srivastava, 2016)" . (Ebru, 2018, p.170).



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Product development for mass customization

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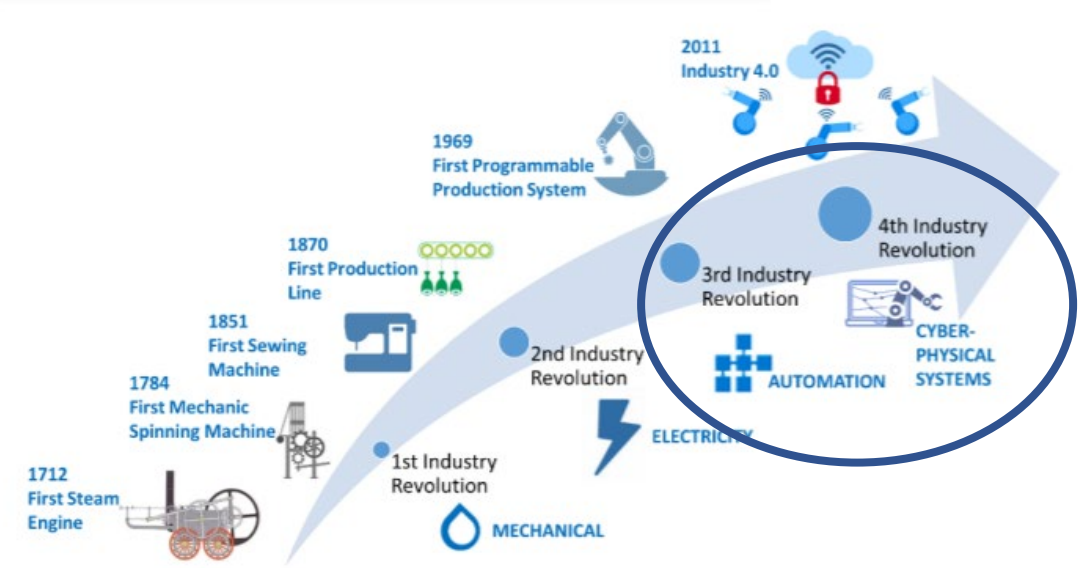

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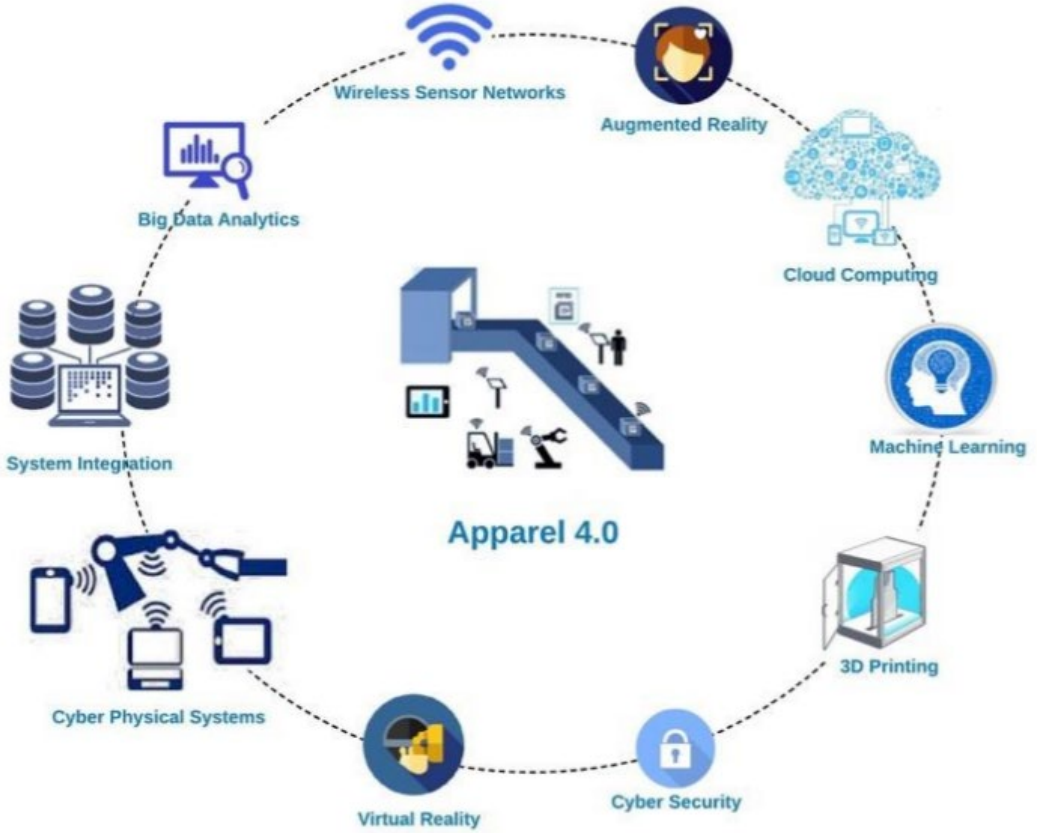
Product development for mass customization



"Emerging information technology services enable the development of cheaper and more efficient production processes through efficient integration of smart device hardware with cyber-physical systems. "(Ebru, 2018, p.174).

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Product development for mass customization

In the apparel industry, “mass customization refers to the production of tailor-made fashion, taking into account the customer's personal taste, at the right time and at the right price”. (D.G.K. Dissanayake, 2019).

In today's fashion market, the consumer’s tendencies have shifted to a personalized garment with the right size and their preferred design. This evolving preference for personalization of products requires apparel manufacturers to move from mass production to mass customization .

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Product development for mass customization

Customers and stores are increasingly demanding customized products and services, and apparel manufacturers are rethinking their product and manufacturing tactics.

Apparel Mass Customization Model	
Point of Customer Involvement	Apparel Mass Customization Options
patterns	custom fit or design
design	component choice: size, style, fabric
production planning	data forecast
manufacture	small-lot repeats
delivery	point-of-sale data
post purchase	customer adjustments

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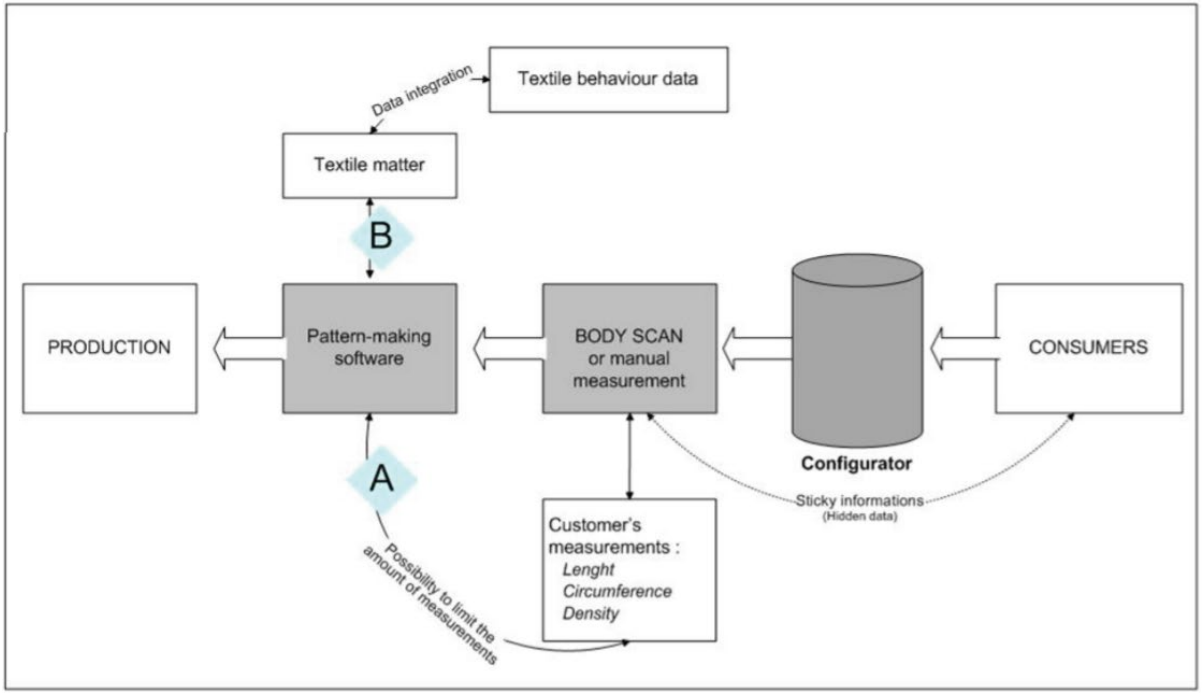
Product development for mass customization

The mass customization strategy creates a web platform where customers can simultaneously visualize the layout and change the model at will.



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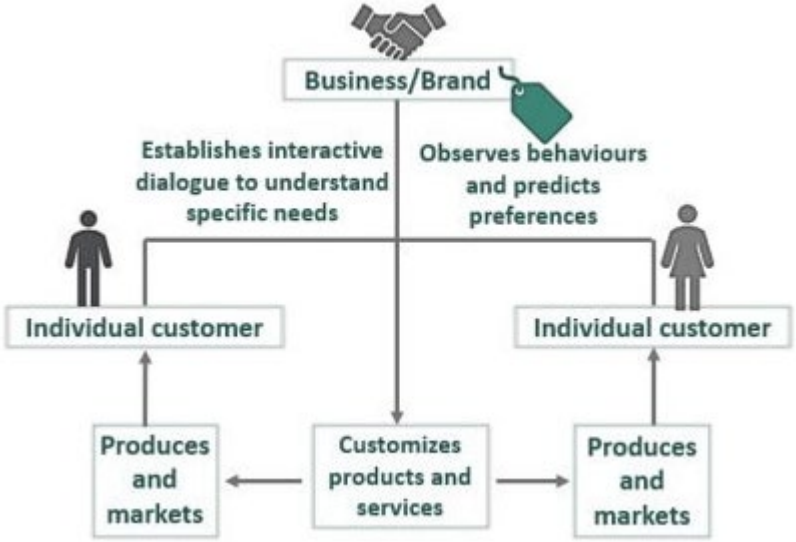
Product development for mass customization

For a mass customization process, product personalization is a must.

Personalization has many facets, as it can impact customer experience, customer support, product services, email advertising, product features, push notifications, and even customers.

3D product development is a solution to offer a *personalized* item that meets the customer's requirements.



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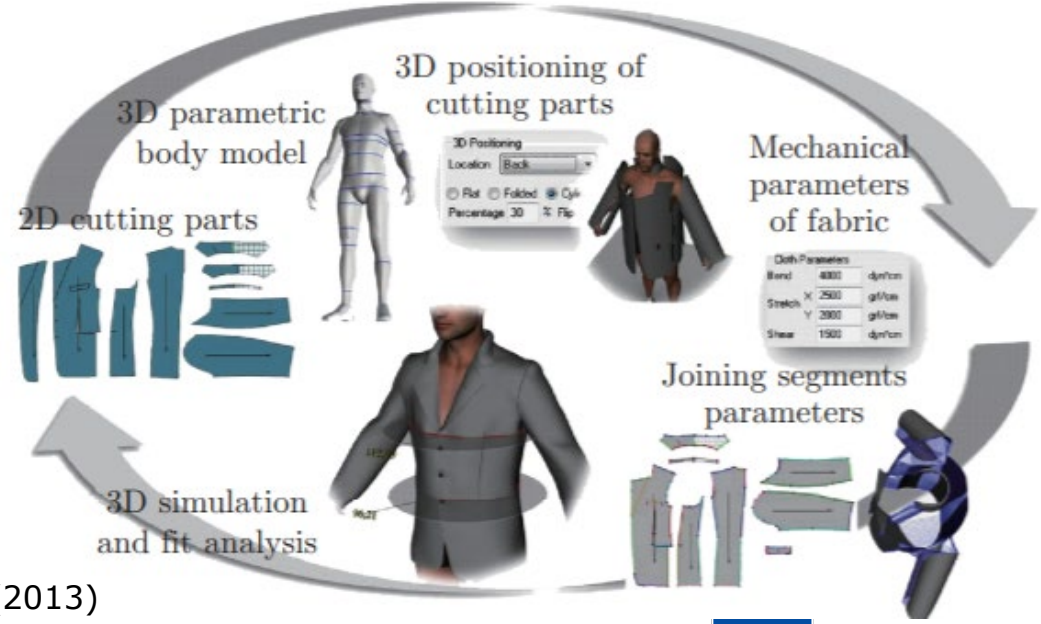
Sustainable solutions for new product development

The development of 3D clothing is the solution of changing the fashion and clothing industry into a sustainable one. and it has the possibility of creating a new whole business.

The 3D process is a complex process as it involves various aspects: software, hardware, device integration, PLM, training, well-trained workforce, avatars and so on.



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Sustainable solutions for new product development

Industry 4.0 for fashion and textile industry offers (Ebru 2018), p.172)

Interoperability	Cyber-physical systems are able to communicate with each other and people in real-time through the use of IoT and Internet of Services.
Virtualization	Sensor data is connected through simulation models in a virtual environment.
Autonomous Management	Cyber physical systems make their own decisions by determining optimum decisions based on the collected and processed big data.
Real-Time Management	Collecting and processing data in a real-time fashion with distributed processing and big data approaches.
Internet of Services	Cyber physical systems deliver their services to people and other systems via Internet of Services.
Modular structure	Providing a modular structure to adapt to rapidly changing requirements.

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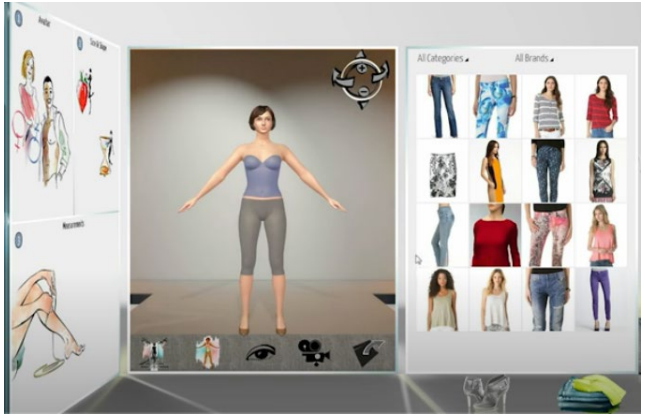
Sustainable solutions for new product development

New VR technologies are the prerequisite for a realistic, 3-dimensional (real-time) simulation and visualisation of individualized garments put on corresponding virtual mannequins of real customers.



Trying On Clothes - triMirror - Virtual Fitting (2013)

- Virtual try on allows customers to try on products using their digital camera-equipped devices, such as mobile phones. Augmented reality (AR) also allows users to contextually visualize and interact with the item in question and analyses the style, size and suit before making a purchase. (Ioannis P. & Kostas K.,2012)
- Virtual try-on actually aims to improve customer care and decision making by providing appropriate consumer services.

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Virtual technology:

Allows the visualization of garments and enables one to decide whether the version meets the customer's requirements or not.

Provides a real image of the final model; the version is provided on the avatar with all the needed details: materials, seam lines, accessories.

Creates digitally verified patterns; if the model fits the avatar perfectly (in terms of stability and dimensions), its patterns are checked and can then be used to produce it.

Offers the possibility to create a library of models by changing materials or making different combination of other materials, changing the product length, dividing some elements, adding accessories, transforming volumes, etc.

Shortens the development time of a new model.

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Digital clothing development

CAD software solutions are the tools that are used in of the most important applications of computers to clothing design support. With the right tools and features of CAD, the user:

- Creates delicate materials with low bending stiffness instead of rigid, solid objects;
- Adds additional parts of the garment, such as the collar and sleeves, and puts them together by using unique pattern creation rules that differ significantly from traditional assembly techniques;
- Obtains the 3D virtual prototype on the avatar.

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Digital clothing development

The **digital approach** to the virtual development of apparel product models can be implemented as follow:

- **2D design process** of the product components, followed by a 3D simulation on the corresponding virtual mannequin; (2D→3D)
- **3D design process** that is directly carried out on the mannequin, followed by the extraction of the 2D patterns that are necessary for the manufacturing process (traditional process) of the selected model.(3D→2D)
- **3D printers**.

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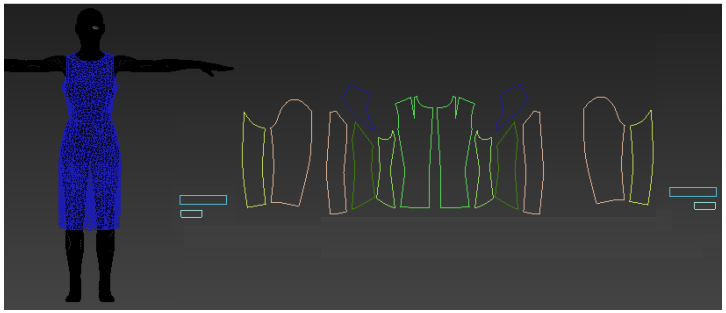
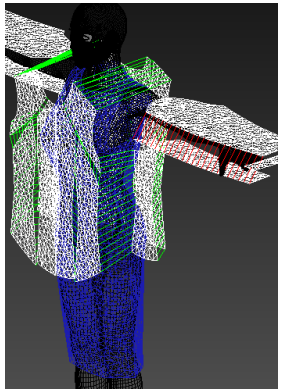
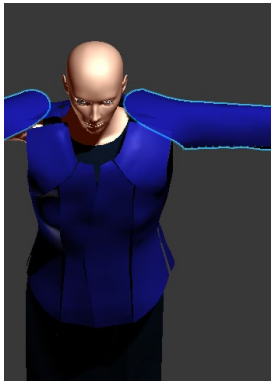
Digital clothing development

The digital approach: **(2D→3D)**

- Design the 2D garment patterns and then transfer them to 3D environment to achieve the 3D simulation process.

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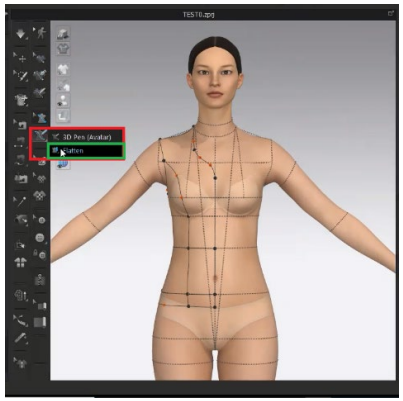
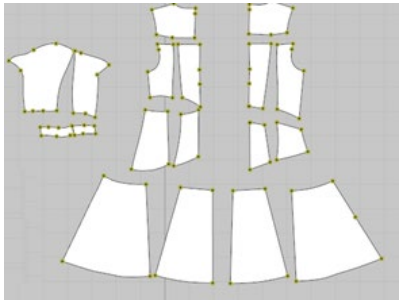
Digital clothing development

The digital approach: **(3D→2D)**

- Design 3D garment model and then flatten the parts.





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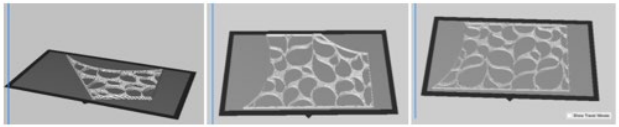
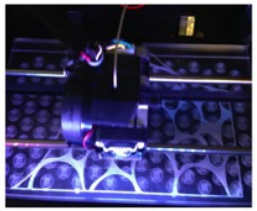
Digital clothing development

3D printers.

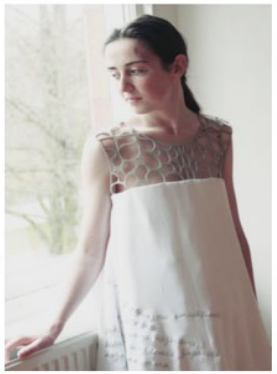
"With 3D printers and CAD software's, engineers can develop a 3D garment model." (Sun, 2016, p.3).



Garment pieces (upper parts) in computer design.



Printing pieces (3D printer)



Dress with the top part made by 3D printing

CC BY Sun (2016), p.3

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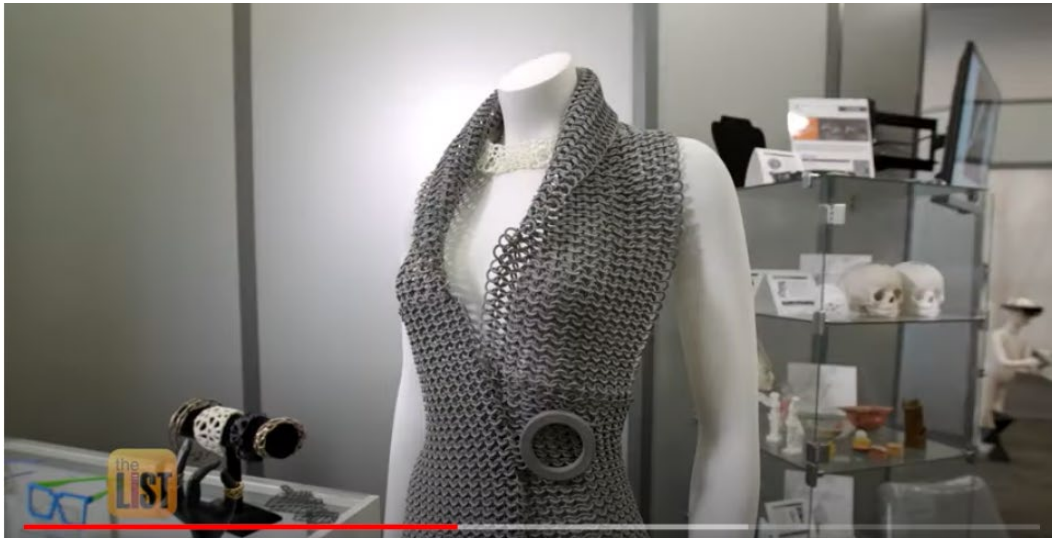
3D printer



3D Printed Fashion is About to Go Mainstream (2019)

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Digital clothing development

A sustainable layout model requires removing the boundaries between styling and pattern making.
This new holistic technique can be achieved by using CAD, which allows simultaneous 2D and 3D design and visualization of the model combined with layout adjustments in real-time. The multitude of physical prototypes and the need for the visits of designers, marketers, and customers to shops will be drastically reduced and replaced by seamless online collaboration.

CC BY Zoran et al. (2009)

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Digital clothing development

3D simulations need to be accurate and relatively reliable so that they can be used across the company to reduce the number of prototypes and thus reduce the environmental footprint by wasting less material.

3D tools should provide designers with a very high level of accuracy to ensure that the garment designed in the 3D digital version can be used in 3D simulations.

These tools also provide the opportunity to explore and develop new models based on the initial model.

CC BY Olaru et al.(2012)

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Digital clothing development

Techniques for garment simulation:

A. Physical Simulation

With this version, the designer can assemble garment patterns from CAD fabric patterns, sew them together, and animate the fabric in dynamic scenes with arbitrarily selected fabric houses. The designer must set appropriate values of parameters of the body and run a simulation in order to obtain the final shape of the garment.

The designer can check whether the garment fits the body or not (visualise the tension map).

Marvelous Designer Cloth Simulator 101 (2015)

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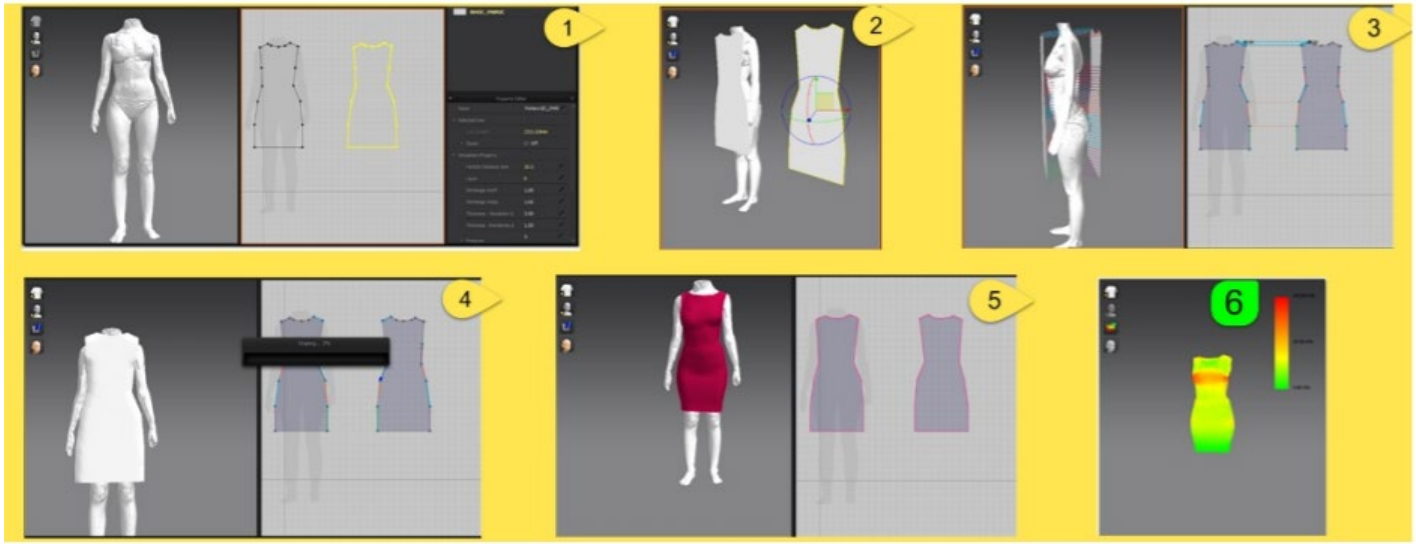
Digital clothing development

Simulation process of a dress model : import 2D pieces (1), arrange the pieces around the virtual body (2), declare the assembling lines (3), simulate the model (4, 5), visualize the stress tension map of the model (6).



CC BY Spahiu et al.(2014), p.5

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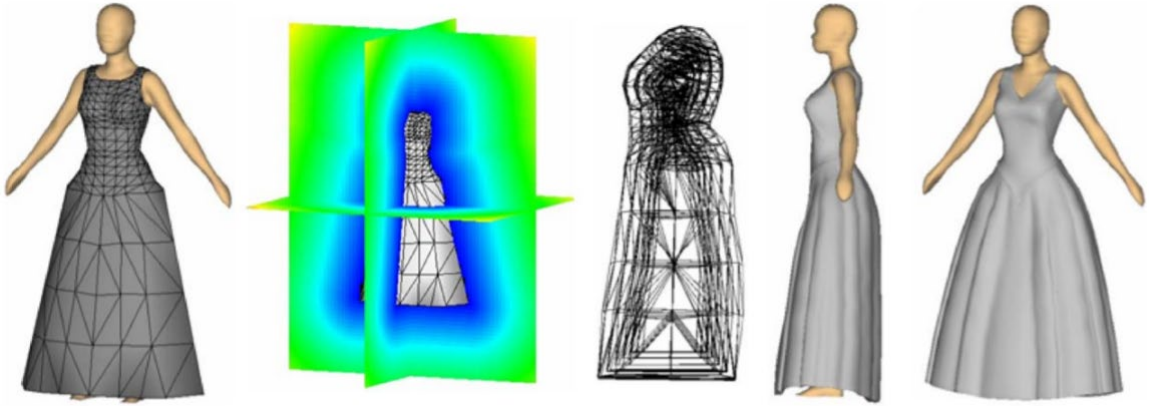
Techniques for garment simulation:

B. Geometric Simulation

Garment design and simulation are extensively studied in both computer graphics and computer-aided design. (Yong-Jinet et al, 2010).



CC BY Yong-Jinet et al.(2010)

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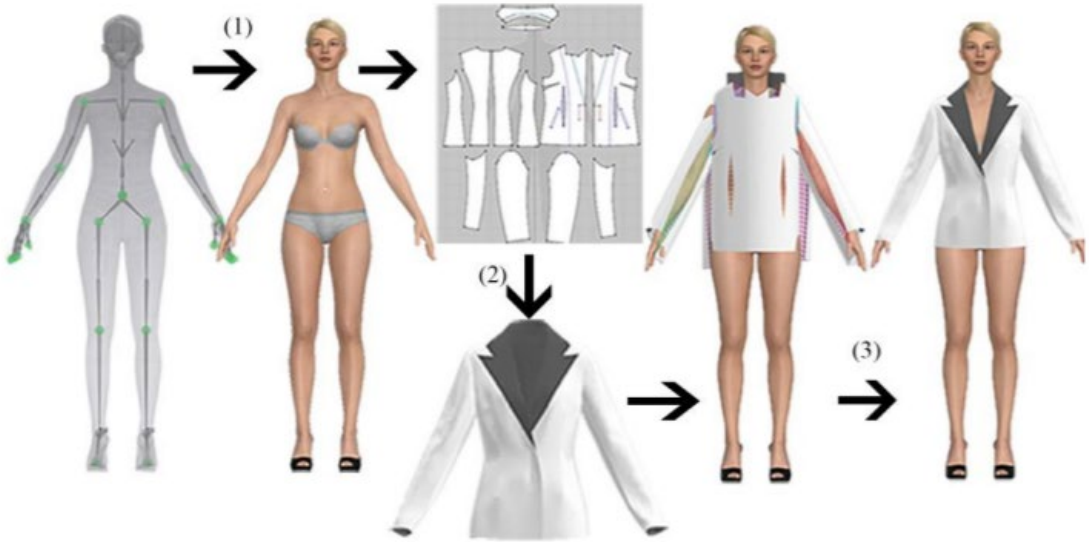
Digital clothing development

The development of virtual clothing models raises some questions:

a) Virtual and physical items must have the same appearance;
b) Difficult implementation;
c) Problems with fit/adaptation/customization.



CC BY Qianqian & Xiaodong (2021).

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Best practices of sustainable product development

Fashion DIET

CC0 Avadanei, adapted from Hau,1997, p.9-10

Mass customization is a trend in which products for the mass market are gradually customized to meet the needs of customers. It is an effective competitive strategy to maximize customer satisfaction and minimize inventory costs.

Today's customer demands rapid delivery of a highly customized product (Hau et al. ,1997, p.9) →**personalization**.

To accommodate the growing variety of products and their rapid delivery, many companies need to adopt a new paradigm: Design for Mass Customization (Hau et al. ,1997, p.9-10)

- Product modularity
- Process modularity
- Agile supply chain network design

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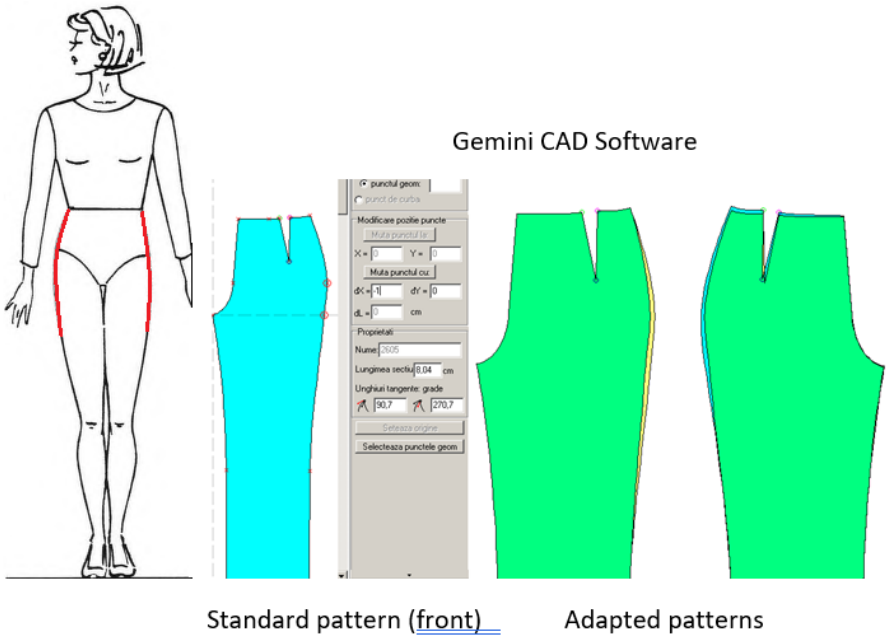
Best practices of sustainable product development

Personalized models of garments can be developed using the virtual tools of special software.

In a **2D** environment, the designer has the following options:

- ***Change*** existing and suitable patterns to the client's body shape and to the model's characteristics. The initial patterns are designed in standardized sizes.

The 2D patterns are then imported into the 3D environment CAD for the simulation process.



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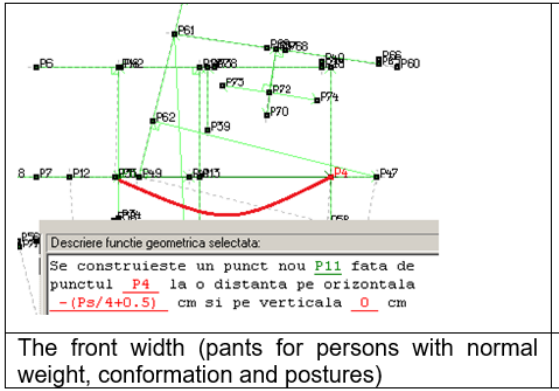
Best practices of sustainable product development

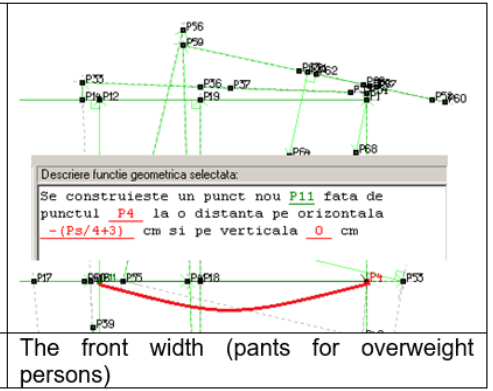
In a **2D** environment, the designer has the following options:

- ***Directly*** design custom/ individual garment patterns by taking the customer's body shape and the model's characteristics (made-to-measure design process).

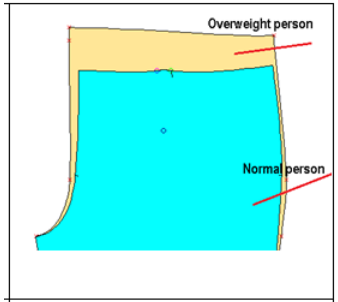
The 2D patterns are then imported into 3D CAD environment for simulation process.



The front width (pants for persons with normal weight, conformation and postures)



The front width (pants for overweight persons)



Front pieces superposed

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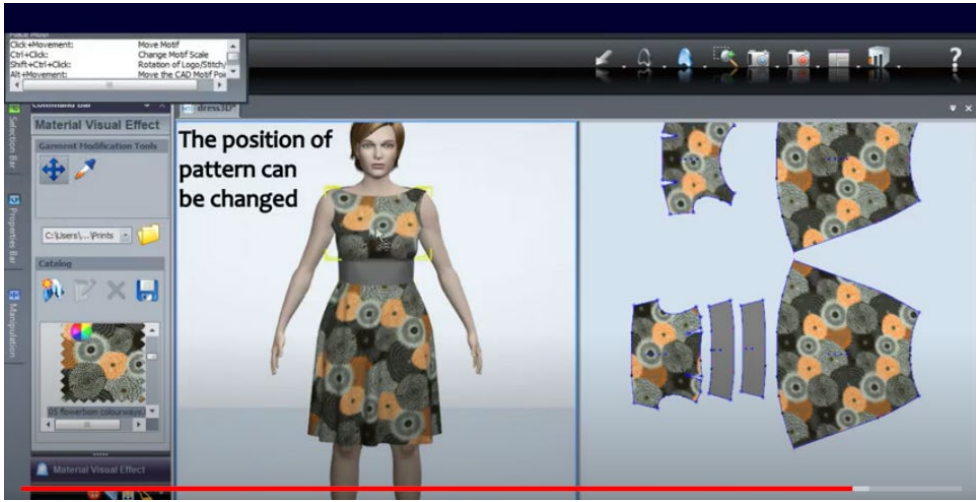
Best practices of sustainable product development

The 2D patterns are then imported into 3D CAD environment to obtain the 3D prototype (simulation process).



Lectra Modaris 3D Tutorial (2021)

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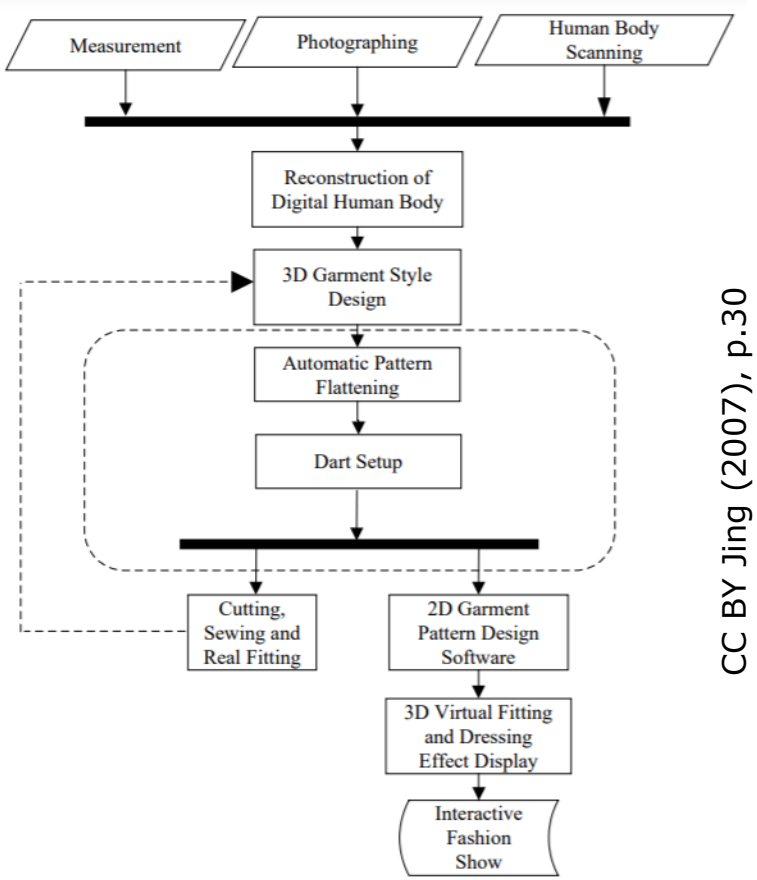
Best practices of sustainable product development



CC BY Jing (2007), p.30

In the **3D** environment, the model is developed directly on the virtual customer body.
It also allows the designer to solve layout problems before the physical prototype is created, saving time, resources and money.

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Best practices of sustainable product development

"The curves are smoothed a bit, and in the next step, they must be described mathematically, stored in the construction database and designed using parameters in order to be able to change and adapt the ease allowance automatically. " (Sybille et al, 2017, p.3)

The model pieces are flattened (traditional manufacturing process).

CC BY Sybille et al. (2017), p.3

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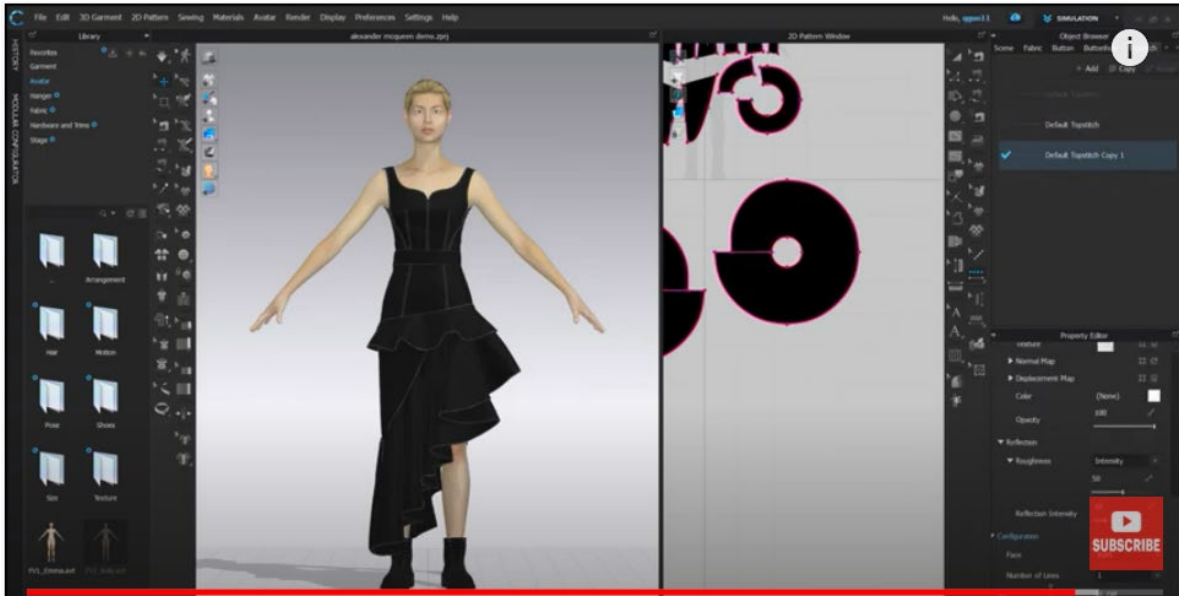
3D→2D product development (traditional manufacturing process)



CLO 3D Timelapse Alexander McQueen /Dress Demo (2020)

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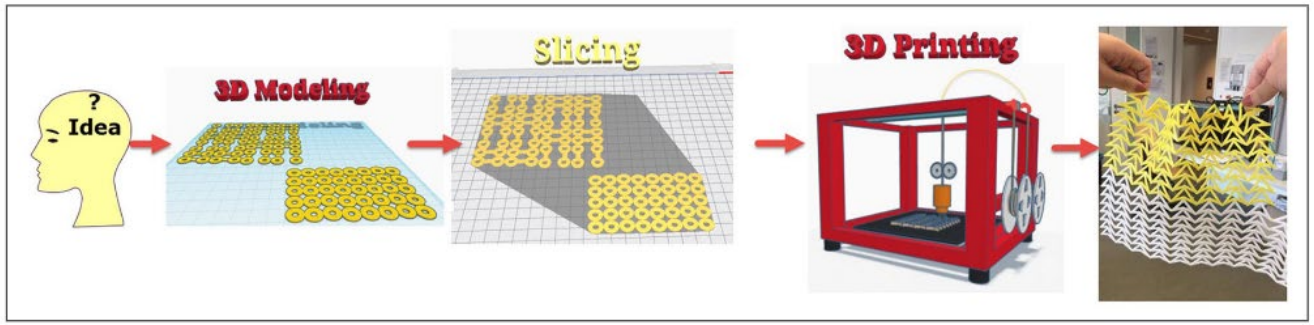
Best practices of sustainable product development

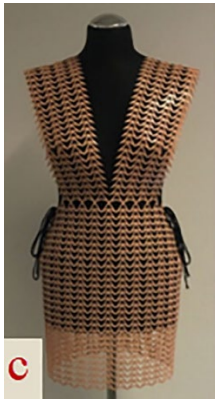
"3D printing is a well-known technology for creating 3D objects by laying down successive layers of various materials. Among the wide range of applications, fashion industry has adapted these technologies to revolutionize their brands. " (Spahiu et al.,2020, p.1)

Preliminary stages



CC BY Spahiu et al. 2020, p.3

Final model



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Reflections on the topics presented

- The constant evolution of virtual technology that defines our personal and professional lives inspires and amazes us. The ever-expanding digital world opens up new possibilities, both for the creative process and for how we interact with and discover fashion.
- The trend toward digital transformation is on the rise. It aims to meet consumers' needs, involve them in the creation process, protect the environment and the world's resources, help companies adjust their cost structures, improve the value chain and consolidate their position in the market.
- It is the time to think about how we can use digital technology to produce what is necessary at an efficient cost, without harming the environment and producing excessive amounts of waste.

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Questions to think about

Fashion DIET

Can digitalization transform the fashion and apparel industry into a sustainable one?

What benefits can virtual technology bring to the fashion industry?

What techniques are used to develop a digital model of a garment?

What are the best methods to develop sustainable models of garments?

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