

## Unit 5.3 Garment Assembly Production in Circular Economy

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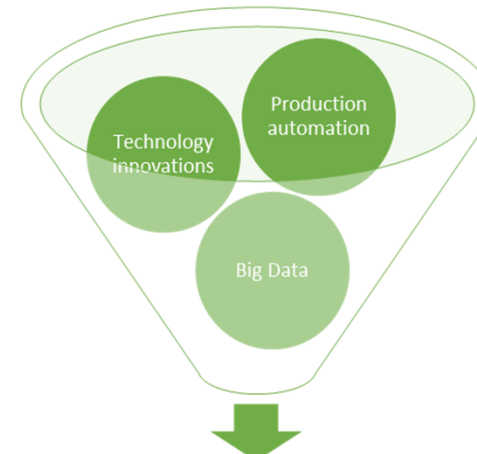
## MODULE 5 Sustainable Yarn, Fabric and Garment/Assembly Production

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#### 5.3.1 Contemporary processes for sustainable garment assembly production

##### How to survive in a competitive global market?

- ▶ Transformation from conventional manufacturing processes to flexible production systems.
- ▶ Combination of Big Data, production automation and product technology innovations.
- ▶ Advanced technologies increase operational efficiency through improved product planning and production processes.
- ▶ Benefits:
  - precise manufacturing – less waste;
  - local production - ability to deliver orders to customers as early as possible. <sup>1</sup>



**precise manufacturing, increased speed and faster delivery times, more local and sustainable, lower costs due to reduced shipping times and lower inventories**

**Figure 1. Flexible production system**

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#### Sustainable sewing and stitch-free seaming technologies

- ▶ Improving sustainability in the apparel industry.
- ▶ Trends in the apparel industry: customization, digitalization, 3D and digital printing, digital micro factory.
- ▶ „Personalized" production - the influence of Industry 4.0.
- ▶ With the modern IT, 3D visualization and AV technologies and the networking of the entire production process, it is possible to fulfill a personalized order in the shortest possible time. <sup>2</sup>
- ▶ QONDAC Networking system - networks, production monitoring solutions by Dürkopp Adler



Figure 2. QONDAC Networking system <sup>3</sup>

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#### Sustainable sewing and stitch-free seaming technologies

- ▶ The bottleneck in production is still sewing, partially digitalized.
- ▶ The choice of joining method (assembly) and the number of joints affect the time and energy required to disassemble a product.
- ▶ Stitch-free seaming advantages: about 15% less weight, due to less overlapping in stitch lines and no threads used; faster assembly and less fabric waste.
- ▶ Welding technology refers to the thermal joining and sealing of seams in textile thermoplastic materials without adhesives, chemical binders, staples, needle or thread.<sup>4</sup>



Figure 3. Stealth jacket with welded seams<sup>5</sup>

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#### Sustainable sewing and stitch-free seaming technologies

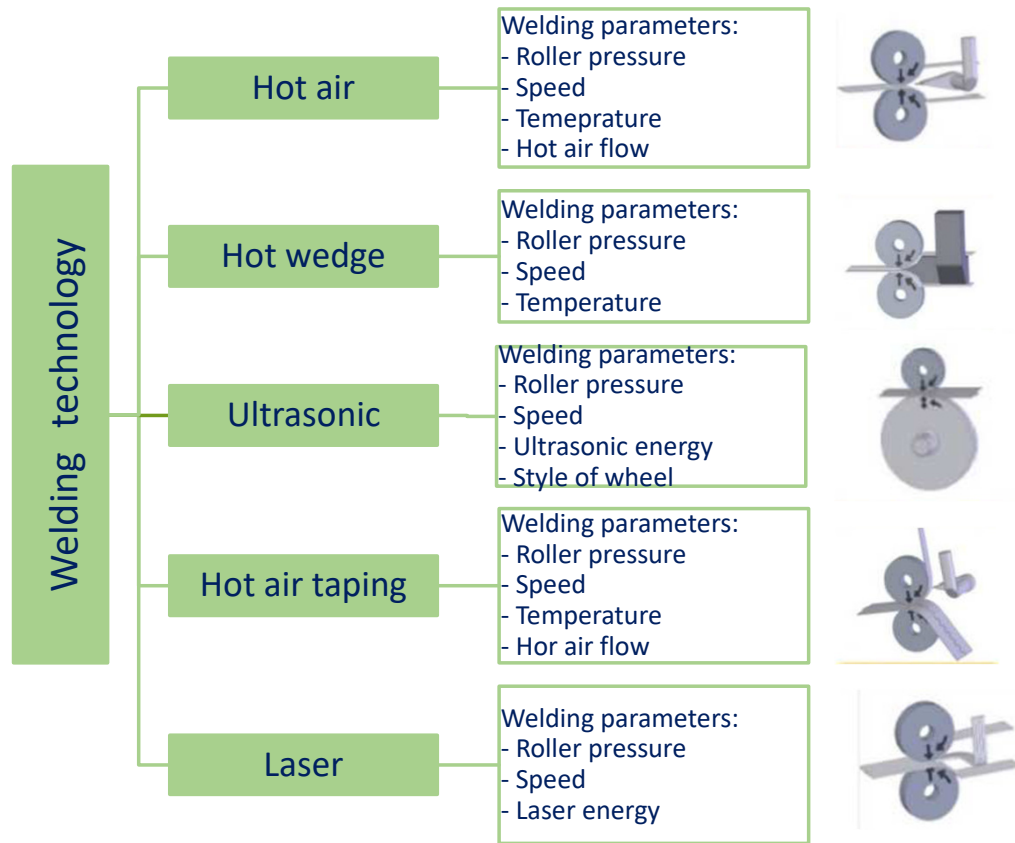


Figure 4. Principles of welding <sup>6, 7</sup>

Stitch-free technology can take the form of either welding or bonding, which are two different concepts:

Welding fabrics - parts of only synthetic fabrics are joined together by heat and pressure, either directly or with the application of a tape.

Bonding fabrics - can be performed on any type of fabric by placing a heat-activated material (adhesive) between the fabrics.<sup>4</sup>



Figure 5. Welded seams <sup>8, 9</sup>

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#### Sustainable sewing and stitch-free seaming technologies

- ▶ Digital micro factory :
  - ▶ Small, highly automated, technologically advanced, flexible
  - ▶ Less energy, less material, small labor force
  - ▶ Close proximity to customer
  - ▶ Customized products
  - ▶ Products manufactured after getting confirmed orders <sup>10</sup>
  - ▶ Gerber Technology – Fashion Tech Platform for customization/personalization on-demand production solutions <sup>11</sup>

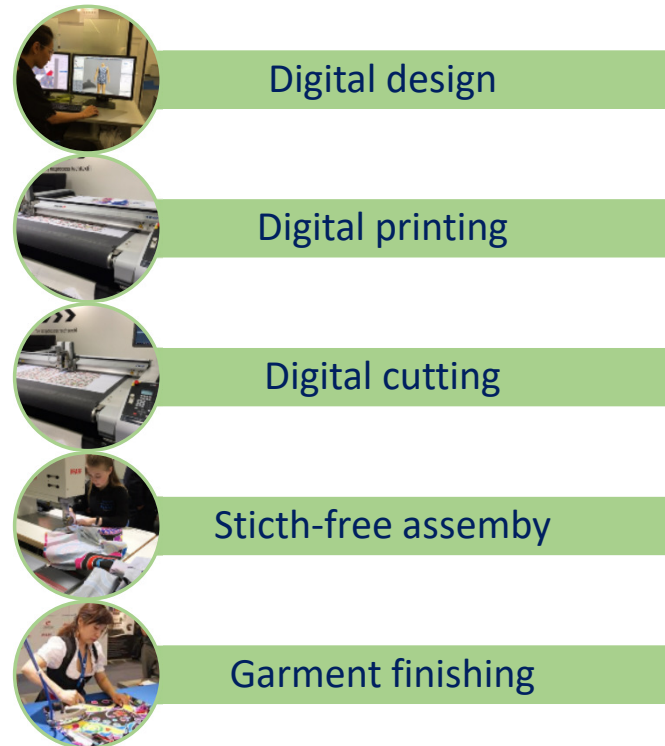


Figure 6. Principle of digital micro factory

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#### Industry 4.0 in garment/assembly production

- ▶ Integrates Cyber-Physical Systems (CPS), Internet of Things (IoT) and Big Data.
- ▶ Provides effective solutions to the growing problem of labor shortage and inexperience.
- ▶ Key Features:
  - ▶ Communication of CPS with each other and with humans in real time,
  - ▶ Virtualization,
  - ▶ Autonomous management of CPS based on the collected and processed Big Data,
  - ▶ Real-Time management by collecting and processing data in real time,
  - ▶ Internet of Services,
  - ▶ Modularity <sup>1</sup>



Figure 7. The principle of Industry 4.0 <sup>1</sup>

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#### Industry 4.0 in garment/assembly production

- ▶ Benefits: flexibility, increased quality, productivity and scalability, control and visibility, reduced operating costs and delivery times, customer satisfaction, customization.
- ▶ Challenges: high investment costs, security of digital data, technical challenges, lack of global standards, highly-skilled jobs.
- ▶ Industry 4.0 for garment/assembly production should include <sup>12</sup>:
  - ▶ Digital information transfer
  - ▶ Predictic maintenance
  - ▶ Intelligent human-robot technology for cutting
  - ▶ Intelligent manufacturing
  - ▶ Robotic quality control
  - ▶ Identification labels (RFID labels)



Figure 8. The benefits of Industry 4.0 <sup>13</sup>



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#### Industry 4.0 in garment/assembly production

- ▶ Innovative approaches in management activities in the garment/assembly industry to meet the requirements of Industry 4.0 <sup>12</sup> :
  - ▶ End-to-End Digital Integration
  - ▶ Wireless sensor networks
  - ▶ 3D product design
  - ▶ Customer's real-time order tracking
  - ▶ Real-time production planning
  - ▶ Real-time product tracking
  - ▶ Real-time employee performance management
  - ▶ Real-time supplier performance management
  - ▶ Balancing the production line
  - ▶ Human-robot collaboration in warehouse management
  - ▶ Real-time warehouse management
  - ▶ Sewing training with augmented reality

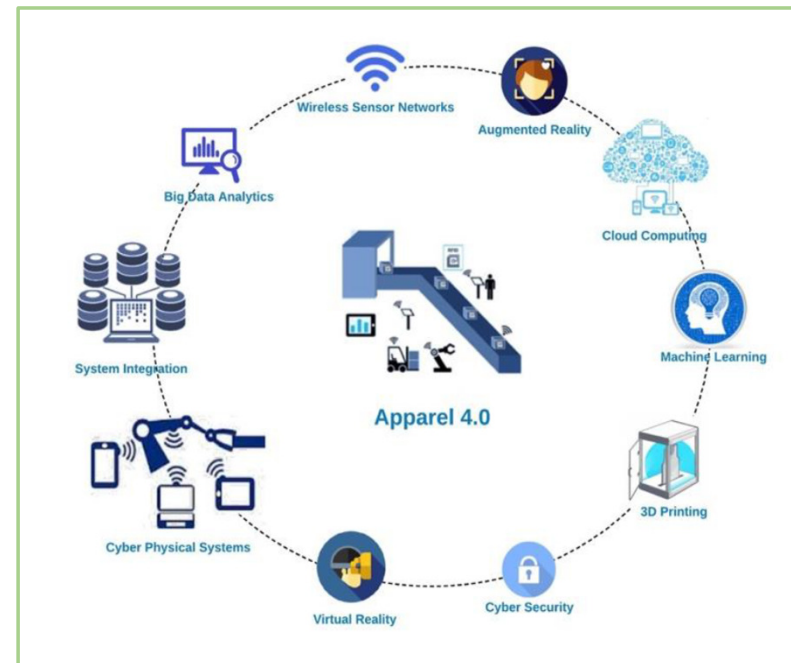


Figure 9. Apparel 4.0 <sup>12</sup>

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#### Fairtrade garment production

Fair trade establishes guidelines for the production of clothing that limit the basic model of free trade and focus on <sup>13</sup>:

- ▶ the environmental sustainability of production,
- ▶ the promotion of sustainable materials,
- ▶ the improvement of working and living conditions for workers,
- ▶ the emphasis on the quality of garment production with longer delivery times,
- ▶ refers to a brand or a single product certified and labelled by an independent organisation.



Figure 10. Workers in cotton fields <sup>14, 15</sup>, Fairtrade logo for a certified product and a WFTO logo <sup>14, 15</sup>

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**Fairtrade garment production**

The World Fair Trade Organization (WFTO) has established 10 principles that member companies should follow <sup>13</sup>:

1. Support producers with uncertain economic situations to become self-sufficient.
2. Transparency and accountability for all partners.
3. Fair trade practices must address the entire supply chain.
4. Fair payment - fair prices and fair distribution of profits.
5. Ensure there is no discrimination or child labor.
6. Ensure good working conditions.
7. Support marginalized workers to improve their skills.
8. Promote ethical trade
9. Respect for the environment

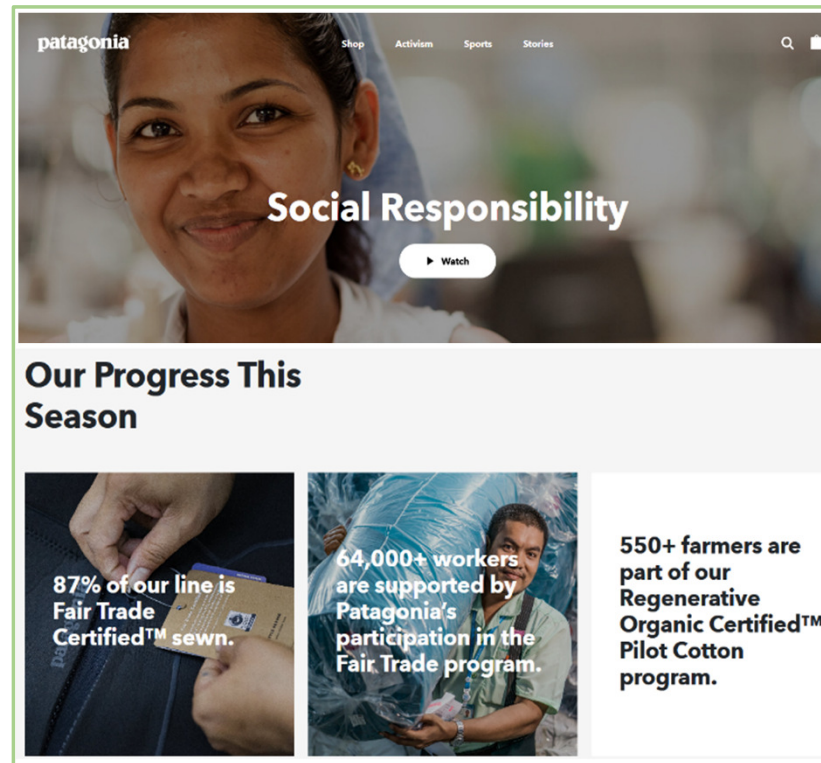


Figure 11. Patagonia – promoting Fair Trade <sup>16</sup>

## 5.3.2 Zero waste garment and non-garment manufacturing

### What is zero waste?

- ▶ Zero Waste means a product or process that eliminates waste materials, within the fashion industry a zero waste garment is systematically designed to avoid wasting materials. <sup>17</sup>
- ▶ The concept of zero waste means that everything is reused and nothing is discarded. <sup>18</sup>
- ▶ Zero waste encourages designers to minimise or even eliminate the waste generated in textile industry, both pre and post-consumer. <sup>18</sup>



Figure 12. Comparison of cutting techniques.<sup>19</sup>

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#### What is zero waste?

The criteria for a zero-waste garment should include:

- ▶ appearance,
- ▶ garment fit,
- ▶ cost,
- ▶ sustainability,
- ▶ manufacturability <sup>20</sup>.

Considerations during the design of a zero waste garment:

- ▶ type of garment and its basic shape,
- ▶ width and length of fabric, fabric type,
- ▶ silhouette,
- ▶ fixed areas,
- ▶ special features,
- ▶ construction and finishing,
- ▶ pattern pieces <sup>21</sup>.



Figure 13. Zero waste pattern design <sup>19</sup>

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#### Approaches and techniques of zero waste design

- ▶ In zero waste design the pieces of pattern of a design are joined together in such a way that no fabric is wasted in cutting process. Spaces between the pattern pieces are eliminated.
- ▶ Zero waste as an answer to fast fashion, but it has been around for centuries: many traditional garments, such as the Japanese kimono and the Indian sari <sup>22</sup>.
- ▶ There are many approaches and techniques of zero waste design including draping, pattern cutting, and knitting <sup>23</sup>.



Figure 14. Jigsaw cutting <sup>19</sup>

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#### Approaches and techniques of zero waste design

There are a number of ways to achieve zero-waste fashion design:

- ▶ **Planned Chaos** - garment pattern blocks formed in a traditional fashion are combined to form the basic shape of the garment and all pieces are assembled <sup>19</sup>.
- ▶ **Jigsaw puzzle** - eliminating waste by cutting out small pieces from a single piece of fabric and fit all the pieces together like a puzzle <sup>19</sup>.
- ▶ **"Geo Cut" technique** – using pattern pieces cut in geometric shapes, e.g. squares, triangles and circles <sup>24</sup>
- ▶ .



Figure 15. "Geo Cut" and „Cut and Drape" techniques <sup>24</sup>

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#### Approaches and techniques of zero waste design

There are a number of ways to achieve zero-waste fashion design:

- ▶ **Cut and Drape** – various techniques such as cutting, draping, folding, steam moulding and machine and manual sewing are used <sup>24</sup>.
- ▶ **Direct panel on Loom (DPOL)** - a technique that uses an electronically controlled loom to weave made to measure garment sections <sup>25</sup>.
- ▶ **Seamless knitting** - knittwear is produced in one whole piece three-dimensionally directly on the knitting machine <sup>26</sup>.
- ▶ **3D printing** - of garments at large scale can lead to zero-waste production <sup>27</sup>.



Figure 16. 3D printed dress <sup>28</sup>



### 5.3.3 Eco-labelling of garment and non-garment products

„Eco-labelling is a voluntary method of certifying and labelling environmental performance that is practised worldwide. An eco-label identifies products or services that are proven to be environmentally beneficial within a specific category“.<sup>29</sup>



Figure 17: Types of labels<sup>29</sup>

#### What is the aim of eco-labelling?

- ▶ **Promoting** products with reduced environmental impacts throughout their life cycle and functions.
- ▶ **Encouraging** consumers to change their consumption patterns and use resources and energy more wisely.
- ▶ **Enabling** consumers to identify products that:
  - ▶ are environmentally safe,
  - ▶ made from eco-friendly materials,
  - ▶ do not contain chemicals harmful to the user.
- ▶ **Providing** assurance that products meet social, ecological, and environmental standards.<sup>30,31</sup>

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#### Characteristics of eco-labels

- ▶ Identification of the overall environmental preferences of a product.
- ▶ Information on environmentally related product qualities.
- ▶ Tool to identify environmentally safe products.
- ▶ Assurance of the use of eco-friendly raw materials and ingredients.
- ▶ Additional product quality as a marketing tool.
- ▶ Assurance of less stress on the environment.
- ▶ Selling value of products increase.<sup>31</sup>

#### Effectiveness of eco-labels

- 1 Consumer awareness of eco-labels
- 2 Consumer acceptance eco-labels
- 3 Changes in consumer behavior
- 4 Changes in manufacturer behavior
- 5 Net gains for the environment

**Figure 18:** Factors used to measure the effectiveness of an eco-label<sup>31</sup>

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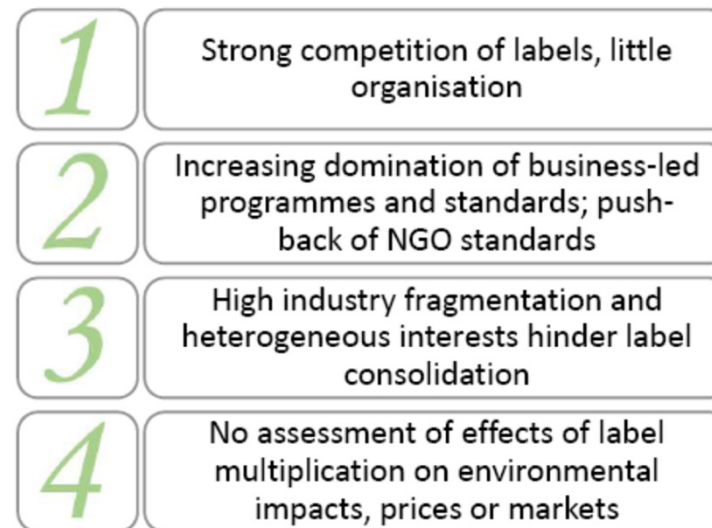
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#### Benefits of eco-labeling

- ▶ **Global marketing response**
  - ▶ Pressure to comply with the international eco-labels.
- ▶ **Improved product quality**
  - ▶ Elimination of harmful substances.
- ▶ **Financial savings**
  - ▶ Saving of water, chemicals, and energy.
- ▶ **Improved environmental performance**
  - ▶ Elimination of toxic and hazardous substances and conservation of water, energy, and raw material usage.
  - ▶ Safer and better working conditions in the workplace.<sup>31</sup>

#### Negative consequences of eco-labeling

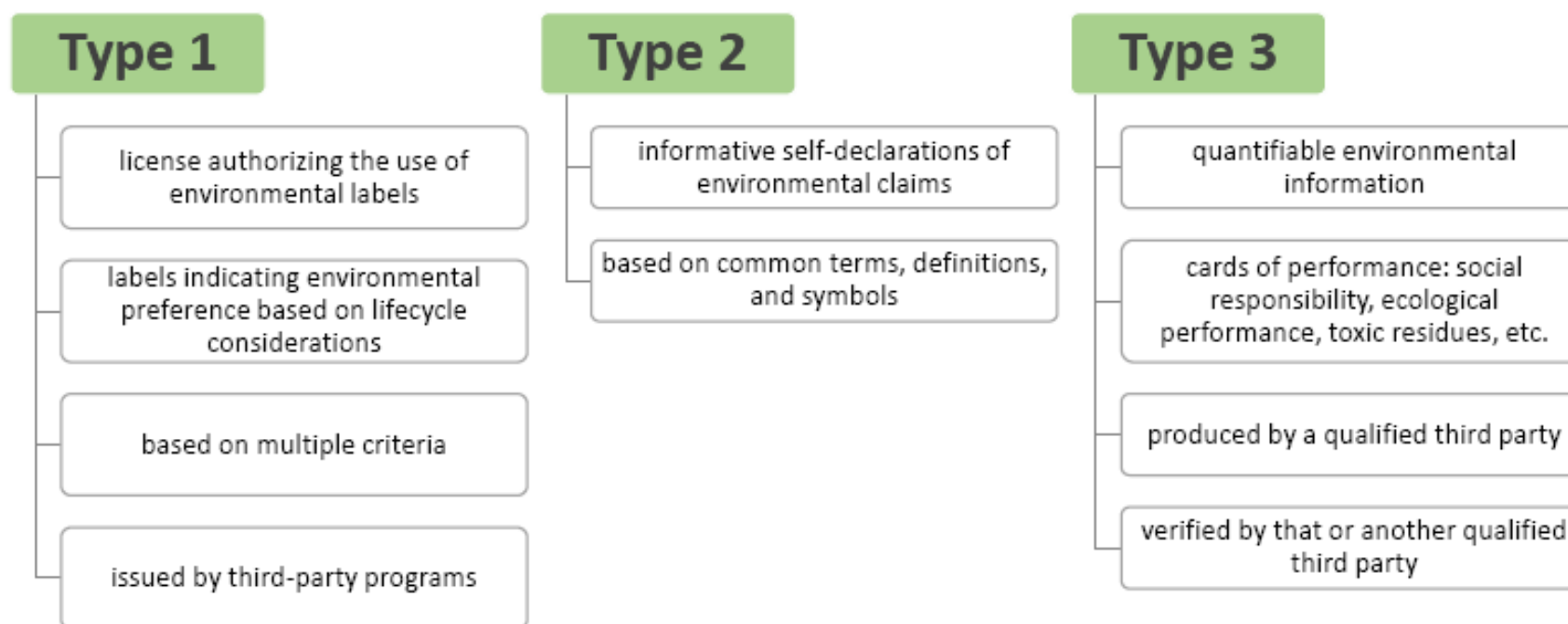
- ▶ **Eco-labels used as trade barriers<sup>32</sup>**



**Figure 19:** Competition and multiplication of Environmental labelling and information schemes in apparel sector<sup>33</sup>

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**Figure 20:** Scheme of typologies of voluntary eco-labels according to the specification of preferential principles and procedures (ISO)<sup>32</sup>

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#### Eco-labels

- ▶ **Oeko-Tex Standard 100**<sup>31,34</sup>
- ▶ Certification system for textile raw materials, intermediate and end products:
  - ▶ Class I : Products for babies up to the age of 2 years.
  - ▶ Class II: Products with direct skin contact, such as blouses, shirts and underwear.
  - ▶ Class III: Products not in direct contact with the skin, such as skirts, trousers and jackets.
  - ▶ Class IV: Furnishing and decorative materials.
- ▶ **Sustainable Textile Production (STeP)**<sup>35</sup>
- ▶ Certification system for brands, retailers and manufacturers.
- ▶ Replaces the previous OEKO-TEX® Standard 1000.



Figure 21: Oeko-Tex Standard 100 logo<sup>31,34</sup>



Figure 22: STeP logo<sup>35</sup>

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#### Eco-labels

- ▶ **EU Ecolabel**<sup>36</sup>
- ▶ Eco-label for products and services with a reduced environmental impact throughout their life cycle.
- ▶ Awarded only to the most environmentally friendly products on the market.
- ▶ Criteria based on information from LCA and product-oriented environmental performance assessment.
- ▶ **EU Flower**<sup>37</sup>
- ▶ Eco-label for all textile products, including textile clothing and accessories, fibers, yarns, fabrics and interior textiles.
  - ▶ Wall and floor coverings excluded.



Figure 23: EU Ecolabel logo<sup>36</sup>



Figure 24: EU Flower logo<sup>37</sup>

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#### Eco-labels

- ▶ **Global Organic Textile Standard GOTS<sup>38</sup>**
- ▶ Requires the use of certified organic fibres.
- ▶ Provides both demanding environmental and social criteria.
- ▶ Criteria are applicable to all processing stages.
- ▶ GOTS certification must base on independent on-site inspections.
- ▶ GOTS label grade of „**organic**“:
  - ▶ minimum of 95 % certified organic fibers.
- ▶ GOTS label grade „**made with organic**“:
  - ▶ minimum of 70 % certified organic fibers.



Figure 25: Global Organic Textile Standard <sup>38</sup>

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#### Other eco-labels

- ▶ **Blue Angel**<sup>39,40</sup>
- ▶ Oldest eco-label for products and services.
- ▶ 4 protection goals: health, climate, water and resources.
  
- ▶ **Nordic eco label**<sup>41</sup>
- ▶ Eco-label for the Nordic countries.
- ▶ Strict environmental requirements at all relevant stages of a product's life cycle.
- ▶ The "swan" symbol.
  
- ▶ **Bluedesign**<sup>42, 43</sup>
- ▶ Tracks the path of each textile along the manufacturing process
- ▶ Ensures improvements at every stage.
- ▶ Components are analyzed before the production.



Figure 26: Blue Angel logo<sup>39,40</sup>, Nordic eco label logo<sup>41</sup> and Bluedesign logo<sup>42,43</sup>



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#### 5.3.4 Innovative concepts of profitable circular opportunities in the clothing sector

##### Why is the shift to a circular economy in the clothing sector so important?

- ▶ The fashion industry is under intense pressure to reduce carbon emissions and waste, not least from a new generation of consumers demanding greater environmental responsibility.
- ▶ The potential value of the circular economy in the fashion industry could be as much as \$5 trillion, according to a new report by a group of high-level industry and academic experts.
- ▶ The goal is to make fashion traceable, transparent and more sustainable for businesses, consumers - and the planet.<sup>44</sup>

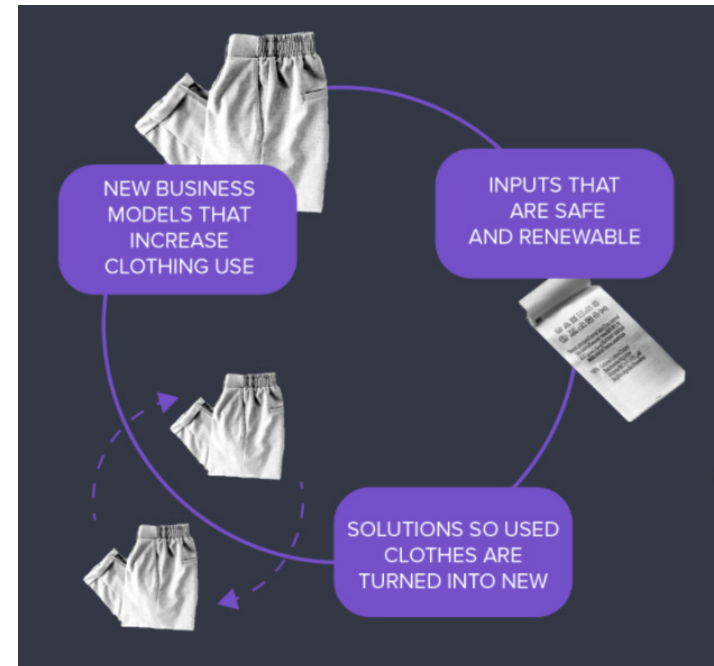


Figure 27: Focus areas of a new global textiles system<sup>45</sup>

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#### Characteristics of a new global textiles and clothing system

- ▶ Access to high quality, affordable, individualised clothing that may not be affordable through traditional sales.
- ▶ Clothing is used more frequently, allowing its value to be fully captured. After use, their redesign should be aligned with contemporary recycling processes.
- ▶ Use of renewable energy and renewable resources where their use is necessary.
- ▶ Consideration of the true cost (environmental and social) of materials and production processes in the price of products.
- ▶ Regeneration of natural systems and no pollution.
- ▶ Ecosystem of companies from small to large.<sup>45</sup>



Figure 28: Circular fashion economy<sup>46</sup>

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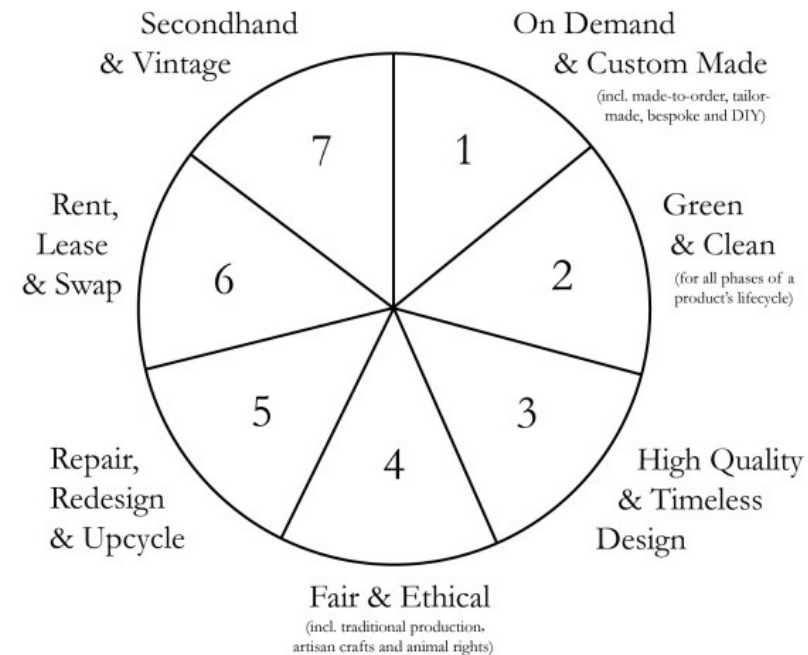
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#### Circular fashion definition

- ▶ It can be defined as clothes, shoes or accessories that are designed, sourced, produced and provided with the intention to be used and circulated responsibly and effectively in society for as long as possible in their most valuable form, and hereafter return safely to the biosphere when no longer of human use.<sup>47</sup>

#### Principles of circular fashion economy

- ▶ Use, wash and repair with care.
- ▶ Consider loan, rent, swap or redesign instead of buying new.
- ▶ Buy quality as opposed to quantity.<sup>48</sup>



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By Dr. Anna Brismar 2019

**Figure 29:** Seven forms of sustainable fashion by Anna Brismar <sup>49</sup>

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#### Advantages of Circular Fashion Economy

- ▶ Reduced dependency on imported raw materials.
- ▶ Creation of eco-friendly industries and jobs.
- ▶ Eco-friendly brands benefit from a better public image.
- ▶ Reduction in environmental damage caused by resource extraction.<sup>48</sup>

#### Limitations of non-linear fashion

- ▶ Dependency on the consumers' actions.
- ▶ Creating a new business model on the basis of recycled goods is tough.
- ▶ The entire cycle requires integrating product life cycle from raw material to disposal.<sup>48</sup>



Figure 30: Sustainable fashion becomes more than just a trend<sup>50</sup>

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#### Inovative sustainable concepts in textiles and clothing economy

- ▶ Resale.
- ▶ Clothing for rent.
- ▶ Upcycling of clothing into non-clothing products.
- ▶ Do it yourself (DIY) upcycling.
- ▶ Interaction between producer and customer: repair, amendment, return.

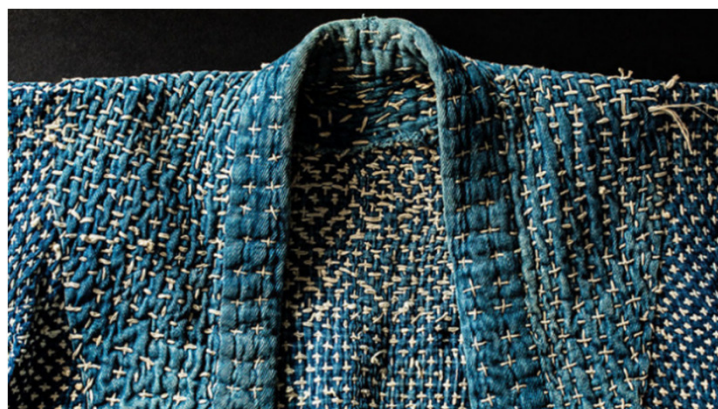


Figure 31: Sashiko repairing technique<sup>51</sup>



Figure 32: Visible mending<sup>52</sup>

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#### Clothing for rent

- ▶ **New-wave of fashion rental.**
  - ▶ Every day clothes.
- ▶ **Pioneering platform – Rent the Runway.**
  - ▶ Other platforms: Hurr, Hirestreet, Baukjen, Onloan, Rotaro, Endless wardrobe, By rotation, Nuuly.
- ▶ **Support and promotion:**
  - ▶ Media and influencers.
  - ▶ Marie Kondo living and space saving concept.
- ▶ **Concerns:**
  - ▶ More frequent cleaning.
  - ▶ More frequent transport.<sup>53</sup>

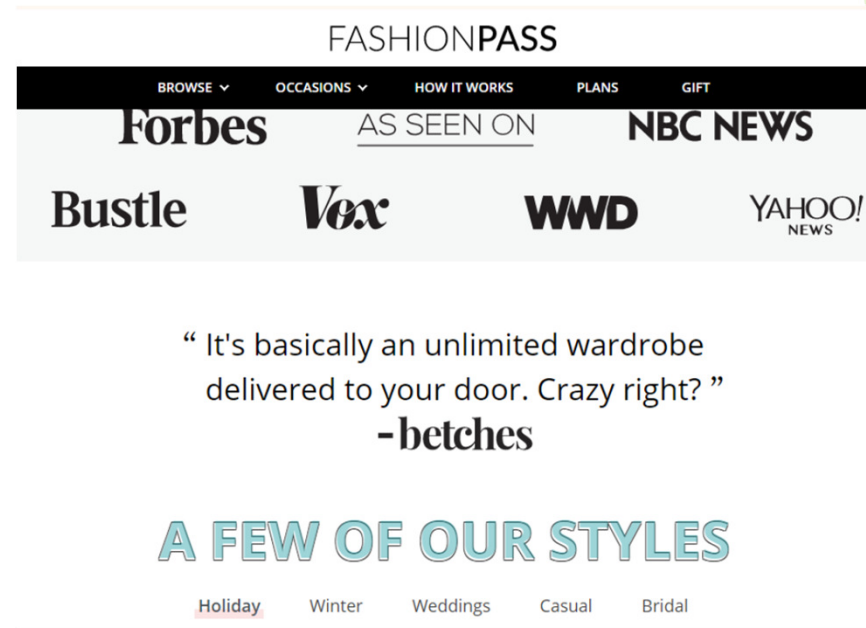


Figure 33: Fashionpass rental web page<sup>53</sup>

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#### Upcycling to non-clothing designers products

- ▶ Interior design
  - ▶ Plof (Atelier Belge).<sup>54</sup>
- ▶ Architecture<sup>54-56</sup>
  - ▶ Bricks – FabBRICK.<sup>55</sup>

#### Do it yourself – DIY upcycling

- ▶ Contemporary applicability of the DIY concept.
  - ▶ Hobby and free time.
  - ▶ Therapeutic potential.
  - ▶ Educational projects.
  - ▶ DIY in fashion.

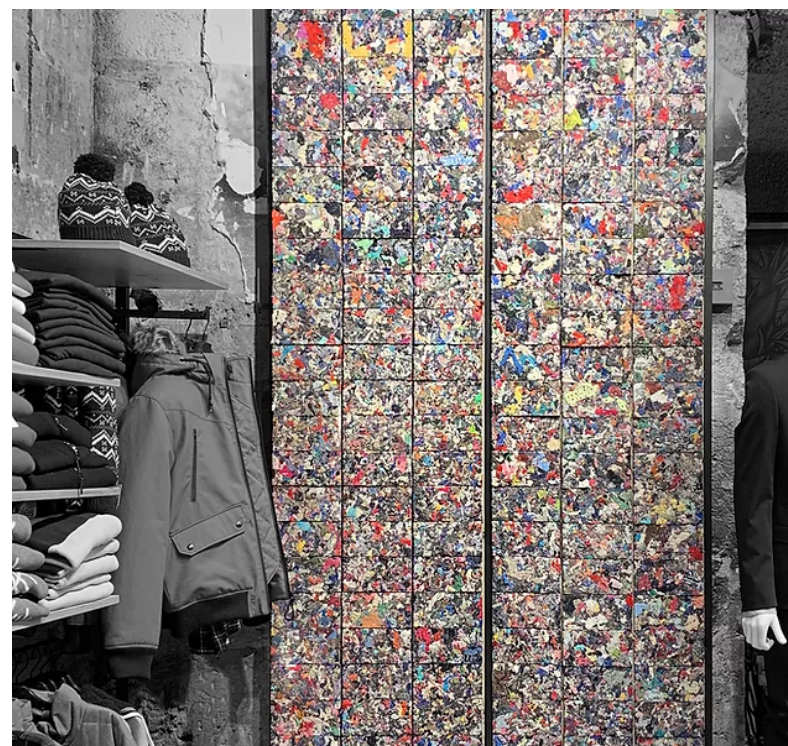


Figure 34: FabBRICK building bricks<sup>55</sup>

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#### Resale

- ▶ Second-hand.
- ▶ Vintage.

#### Producer - Customer interaction<sup>57-60</sup>

- ▶ Repair and restoration – visible mending.
- ▶ Alteration and customization.



Figure 35: Visible mending<sup>61</sup>



Figure 36: Clothing alteration<sup>62</sup>



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