AMSTERDAM FASHION INSTITUTE

INTERNATIONAL FASHION MANAGEMENT

‘WHAT IS THE EFFECT OF 3DP ON THE SUSTAINABILITY OF THE SUPPLY CHAIN OF A RETAIL FASHION BRAND?’

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Amsterdam

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1. INTRODUCTION

1.1 RATIONALE

The fashion industry is the second most polluting industry in the world (Conca, 2015). Since the 20th century, clothing production is moved around the world. Brands and retailers have found low-cost manufacturing countries and clothes are produced in larger quantities in shorter timeframe (Weetman, 2016). Mass consumption results in around 80 billion garments produced worldwide per year. That is an average of just over 11 garments per person (Greenpeace, 2011).

Mass consumption has a big impact on the environment. Consumers buy a cheap garment for a special occasion, wear it once and throw it away. A UK survey of fashion purchasing for women found that the majority did not know how long they intended to keep their new purchases and that when cheaper items became stained or damaged they were more likely to dispose them (Siegle, 2011). Not only mass consumption but also textile industry generates a large amount of solid waste (Avelar et al., 2016).

Sustainability has become more important in the fashion industry. Big fashion companies, like H&M, are investing in sustainability. Ellen Macarthur foundation is working together with H&M Group on the Circular Fibre Initiative. Their goal is to only use recycled or other sustainably sourced materials by 2030 (Macarthur, 2017).

Additive manufacturing technologies like three-dimensional printing (3DP) are with a growth of 34,9% in 2013 the most increasing manufacturing technology (Jiang et al., 2017) and might offer interesting opportunities to increase the sustainability of the fashion industry. 3D print technologies are used by various brands and designers (Figure 1). Iris van Herpen and ThreeASFOUR have used it for high-end fashion while other brands and designers like Adidas, Danit Peleg, and Bradley Rothenberg are using this technology for the development of a product for the main stream market. “This industrial process is a new way to think about textiles and fashion” (Rothenberg, 2015). The question remains what will be the effect on the sustainability of the supply chain of a retail fashion brand?

This research report will focus on the advantages and disadvantages of 3DP in the fashion industry and how it will affect the sustainability of a fashion brand.

Figure 1: 3D printed garments and shoes.
1.2 STRUCTURE

This paper will start with an introduction of 3DP and the different technologies. This chapter will also show the results of the material and design tests. Chapter three will explain the supply chain of a retail fashion brand. The sustainability of 3DP regarding the fashion industry will be discussed in chapter four. This chapter will start with the three-bottom line perspective of John Elkington. The second part of this chapter will explain circular economy and how 3DP can be part of this. This report will end with an explanation of the effect of the sustainability of the supply chain of a retail fashion brand after the implication of 3DP.

1.3 METHODOLOGY

This research report examines the sustainability of 3DP and compares it with the regular supply chain of a retail fashion brand. Literature research will be done using the following; 3D Printing, Circular Economy, Sustainability, Recycling, Supply chain management, Retail, and Fashion.

Different tests will be done regarding material and design. These tests will be performed at the Amsterdam University of Applied Sciences (AUAS), with 3D printers Ultimaker 2+ and Ultimaker 2+ Extended. The tests will be done with PLA, Filaflex, Willowflex, Ninjaflex, and Flexifil. The material will be tested on flexibility, tearability, softness, and the ability to be used as support material.

A case study on the supply chain of H&M will be done to research the changes of the supply chain of a retail fashion brand. An interview with M. Kivits, buyer and product developer at Just Brands and C. Hoogduin, CR manager of Just Brands will give more information about their opinion of the possibilities and effects of 3DP in the retail fashion industry. Different 3D companies will be contacted for more information about print technologies and materials.
2. WHAT IS 3D PRINTING?

3DP is an additive manufacturing tool and is defined as ‘the process of joining materials to make objects from 3D data’ (Mellor et al., 2014). It is a computer controlled production process whereby products are built on a layer by layer basis. The print design is made by a modelling program called Computer Aided Design (CAD). This program will slice the design in thousands of horizontal layers and send it to the printer (Wijk, 2016). The development of 3D technologies started in the 1980s and has occurred in four successive phases; rapid prototyping, rapid tooling, digital manufacturing and home production. Compared to traditional manufacturing processes, has 3DP several significant advantages such as; material efficiency, resource efficiency, and production flexibility (Rayna and Striukova, 2014). For the fashion industry, 3DP could be the transformation of haute couture to ready to wear mass production (Swack, 2016).

2.1 PRINT TECHNOLOGIES

There are different print technologies available, namely; Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereolithography (SLA), Electron Beam Direct Manufacturing (EBDM), Laminated Object Manufacturing (LOM), and Digital Light Synthesis (DLS) (Bergman, 2012; Wijk, 2016; 2012; DiSimone, 2017). Each of them provide another printer. The technologies with the most potential to use in the fashion industry are FDM, SLS, and DLS (Wijk, 2016; DiSimone, 2017).

2.1.1 Fused Deposition Modeling

The FDM print technology (Figure 2) is the cheapest 3DP technology and often used for printing at home (Statasys, 2017). FDM is a technology that builds parts up layer-by-layer by heating and extruding thermoplastic filament. This printer can print with hard and flexible filaments.

Flexibility is needed to give the wearer the possibility to move. Fashion designer Danit Peleg used a FDM print technique for her 3D printed collection (Figure 3). This collection is made with Filaflex, a flexible filament made of Thermoplastic Elastomer (TPE) (Peleg, 2017). Other flexible filaments for the FDM print technology are Ninjaflex, Flexifil and Willowflex. Ninjaflex is a Thermoplastic Polyurethane (TPU) based filament. TPU is more flexible than TPE and gets back in shape after tearing. Flexifil is a Thermoplastic Co-Polyester (TPC) and consist 43% renewable bio-based content (Formfutura, 2017). Willowflex is a flexible biodegradable filament made from compostable raw-materials. Objects made with Willowflex will compost in 2-3 years (Grotty, 2014).
An open structure printed with the FDM print technology needs support (Figure 4). Support is printed under need a floating layer to give the printer a ground to print on. For example, a hollow structure needs to be filled during the printing process. When the print is finished, the support can be removed by breaking it from the object.

Support can be printed with the same filament as the printed object and the removed support material can be recycled (3DHUBS, 2015). It is also possible to work with dissolvable support material. High Impact Polystyrene (HIPS) and Polyvinyl Alcohol (PVA) are dissolvable materials. HIPS can be dissolved in a bucket with liquid D-Limonene. The used D-limonene can be reused to dissolve HIPS of other 3D printed objects (Ashford, 2017). PVA will dissolve safely in tap water and requires no harmful chemicals (Ultimaker, 2017). For using two types of materials for the same print, it is necessary to use a printer with two extruders.

2.1.2 Selective laser Sintering

SLS is a powder-based 3D print technique (Figure 5). The powder will be hardened (sintered) with a CO2 laser (Wijk, 2016). This technique works with metal, glass, nylon, ceramic, and different kinds of plastic. The SLS printer is using the un-sintered powder as a support structure for the product. This powder can be re-used for the next print.

The SLS technique is used by ‘The Nervous System’ to create the ‘Kinematics dress’ in 2014 (Figure 6). This dress is made of nylon, a hard type of plastic, and is build out of several movable connections that gives the garment the ability to bend (Nervous System, 2014). This is necessary to create a garment that can follow the human body contours and give the user the opportunity to move. Hard filament can also be used for buttons, zippers, and accessories.
2.1.3 Digital Light Synthesis

DLS is a technique is a photo-polymerization technique based on a layer by layer hardening of a liquid resin by UV-light (Figure 7) (Carbon3D, 2017). The new Continuous Liquid Interface Production (CLIP) technique of Carbon works with a platform that pulls the print out of the liquid resin. The DLS technique works 25-100 x faster than traditional methods. That makes the technique interesting for mass production (DiSimone, 2017).

Carbon 3D used this technique to create a shoe sole for Adidas (Figure 8) (Kusnadi, 2017; Carbon 3D, 2017). 3D printing allows Adidas to tailor make shoes perfectly for the consumers feet. The CLIP technology cuts the time it takes to print the sole from an hour and a half to as little as 20 minutes (Reuters, 2017). The shoe sole of the Adidas sneaker is made out of Elastomeric Polyurethane (EPU). The CLIP print technique makes it possible to create an object without support and waste material. Carbon 3D confirmed that these materials consist toxic chemicals and that they are not recyclable.

2.2 Materials

Table 1 shows an overview of the tested materials PLA, Filaflex, Willowflex, Flexifil, and Ninjaflex. The tests are made with FDM printers, Ultimaker 2 and Ultimaker 2+ Extended at the Makers Lab of AUAS. The materials are tested on flexibility, tearability, softness, and the ability to be used as a support material.

<table>
<thead>
<tr>
<th>Filament</th>
<th>Toxic raw materials</th>
<th>Support material</th>
<th>Softness</th>
<th>Flexibility</th>
<th>Tearability</th>
<th>Price / Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLA</td>
<td>None - Bio-bases materials</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>€19.50</td>
</tr>
<tr>
<td>Filaflex</td>
<td>Yes - Thermoplastic Elastomer</td>
<td>No</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>€67.50</td>
</tr>
<tr>
<td>Willowflex</td>
<td>None - Bio-based materials</td>
<td>Not recommended</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>€99.65</td>
</tr>
<tr>
<td>Flexifil</td>
<td>Yes - Thermoplastic Co-Polyester with 43% renewable bio-based content</td>
<td>Not recommended</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>€72.70</td>
</tr>
<tr>
<td>Ninjaflex</td>
<td>Yes - Thermoplastic Polyurethane</td>
<td>No</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>€88.65</td>
</tr>
</tbody>
</table>

Table 1: Properties of different filaments. Outcomes are based on literature research and filament testing. (- it is not / + it is / ++ it is very)

PLA is a hard filament made out of sugar canes, corn, or wheat (Moreau, 2017). Compared to the flexible materials is support material printed with PLA easy to remove. Danit Peleg has proven that Filaflex can be used in the fashion industry. Filaflex and Ninjaflex are strong and soft materials. They go back in shape after tearing. The softness of the material results in a fail of the support material test (Figure 9). The materials are not strong enough to carry the weight of the upper layer. Flexifil and Willowflex are less soft and flexible and they break under stress. These materials are able to function as support but the flexibility of the materials makes it hard to remove it from the object, what will give the object a messy look (Figure 10). All the materials can be recycled except for Willowflex (Recreus, 2017; Garcia, 2013; Grotty, 2014; Formfutura, 2017). For a broader overview of the material tests see appendix 10.1.
2.3 Fabric construction

Brands and designers do not only research on the material of a 3D printed garment but also on the fabric structure. Maria Mora-Sanchez did research on 3D printed textiles and tried to create textiles with the same behaviour as current textiles in the market. The construction of her textiles gives a garment the ability to stretch, follow the human body curves, and they can adapt to body changes (Mora-Sanchez, 2017). The fabric (Figure 11) has an open structure and is attached on different corners of the triangles. This makes it possible to stretch the fabric (Figure 12). Danit Peleg uses a zig zag pattern (Figure 13) to create stretch in her garments. It is also possible to create flexibility with hard material. The Kinematics dress is created with multiple, movable connections (Figure 14). It is not possible to create a stretch fabric with hard materials. To create the textile construction of Kinematics with a FDM printer and flexible materials, it is recommended to use a dissolvable support material.

Figure 11: Textile by Nikki Admiraal based on design of Maria Mora-Sanchez (2017)  Figure 12: Stretched textile of Maria Mora-Sanchez (2017)

Figure 13: Zig Zag textile by Nikki Admiraal based on design of Danit Peleg (2015)  Figure 14: Fabric construction of the Kinematics dress (2014)
3. SUPPLY CHAIN MANAGEMENT

Due to the globalisation, textile manufacturing has shifted to less developed countries to decrease the labour costs (Romberg, 2013). This has increased the shipment of goods. The shipping industry is responsible for 1bn tonnes of greenhouse gas emissions per year, similar to the emissions of Germany. The shipment of goods is responsible for 23% of those 1bn tonnes (Siegle, 2014; Scott, 2014; Olmer et al., 2017). The fashion industry is a typical ‘linear economy’ (Figure 15) where large amount of cheap goods is; made, used, and disposed (Weetman, 2016). The production of fashion can be done by different manufacturers (H&M, 2017; Just Brands, 2017). Fashion brands buy from manufacturers in different countries to spread risks, time, and costs (Breuer, 2013). A garment is assembled with different parts like; fabric, yarn and trims. These parts could come from multiple vendors (H&M, 2017; Weetman, 2016).

For this paper, a case study for Hennes & Mauritz (H&M) is used. H&M has become one of the leaders in the fashion industry. Together with brands like Topshop and Zara, have they changed the fashion industry into ‘Fast fashion’ (Sull et al., 2008). Fast fashion is achieved by low-priced products that will be in store for a shorter period of time (Turker et al., 2014; Bhardwaj et al., 2010; Nagurney et al., 2011). H&M works with a circular supply chain (Figure 16) and they produce without waste. They collect post-consumer waste use this together with fabric waste for the production of new textiles (H&M, 2016). The sustainability of 3DP and the effects on the supply chain will be discussed in the following chapter.

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4. SUSTAINABILITY AND CIRCULAR ECONOMY

Sustainability is a term with different perspectives. Several experts (Williams, 2017; Slaper and Hall, 2011; Lejeune, 2016) have another point of view regarding sustainability. The three-bottom line perspective of sustainability created by John Elkington (2009) shows a broader perspective of sustainability regarding; people, planet, and profit. To ensure there’s enough food, water, and prosperity in 2050, we need to switch from a linear to a circular economy (Government, 2017). The circular economy is one where everything is re-used, without wasting anything (Symonds et al., 2017). The relationship between industry and environment is important for the industrial business performance (Lieder et al., 2015). For this paper, the three-bottom line of Elkington (2009) and circular economy defined by Symonds (2017) are used.

4.1 People - Social Responsibility

The ‘People’ of the three-bottom line perspective reverse to fair business practices towards labour and the community in which a company conducts its business (Elkington, 2009). Labour standards and corporate social responsibility (CSR) in the fashion industry have come under serious attention in recent times (Heale, 2013). The circumstances in factories are concerning. Factory workers have to work long hours under bad conditions and they get paid far less than the living wage (Reinhard, 2013; Abnett, 2016). Since social responsibility is not mandatory by law, companies do not spend much attention on this matter (Lubach, 2017).

3DP is computer controlled and can produce locally without the need of these workers. This change can be concerning. When these already poor workers are no longer needed, it may push them even further into poverty (Taylor, 2016). The prediction of 5 million jobs lost by 2020 to technology is serious but other jobs, for example; services, public health and education will still exist (Burrows, 2016).

4.2 Planet - Environmental protection

The fashion industry has received public attention regarding environmental performance. Brands have been blamed for environmental damage that occurred during the production of their clothing (Seuring and Muller, 2008). This damage can arise when land is poisoned with pesticides, water is polluted with chemicals, a high amount of energy is used, and an unnecessary amount of waste is created (Van der Velden, 2016). The ‘Planet’ of the three-bottom line refers to sustainable environmental practices (Elkington, 2009). The research and videos of Planet Earth has increased the awareness of the consumers about the environmental impact (Lieder et al., 2015). This results in a growing community that stands up for sustainable fashion and fashion brands are becoming more transparent and sustainable (Schroeter, 2017; Post, 2017).

A 3D printed product consist out of one material and this material can be produced by one supplier (Bergman, 2012). Since a product can be produced in one piece, is assembling no longer needed, what will shorten the list of manufacturers needed for the production of a garment (Weller et al., 2015). Reducing the number of third party companies can decrease the number of shipments between vendors and manufacturers. This will save costs, time, and make supply chains more efficient and sustainable (Ratti, 2016). Regarding Dr. Joseph DiSimone (2017), CEO of Carbon3D, can 3DP produce commercial quality products at a game-changing speed. The design programmes give a better view of the products and can take over the sampling of a product. This makes it possible to design and produce right after each other (Figure 17).

![Figure 17: Production supply chain regarding DiSimone (2017)](image-url)
Fashion brands use samples for the development of a garment (Koch, 2017; Weetman, 2016). Sometimes, samples need to be made overseas and shipped back to the head office of a fashion brand. This has to be done a couple of times before the production can start (Breuer, 2013). 3DP can skip the shipment during the sampling process of a product. Samples can be print locally, adjusted, and print over and over again (Bergman, 2012; O’Connor, 2016). To create a circular sampling process, the material of previous prints can, depending on the material, be recycled (3DHUBS, 2017).

3D virtual prototyping (3DVP) can work together with 3DP at the prototyping stage of a garment. Specialised computer software like Clo3D, can transform a 2D pattern into a 3D pattern that can be showed on a virtual avatar. 3DVP is used by brands to increase the efficiency of the sampling process and reduce the costs of pattern development (Figure 18) (Olaru et al., 2014; Koch, 2017). Working with 3DVP gives the opportunity to easily change designs. Sampling time takes up to 70% of the development stage of a garment. This can be reduced with 20%-50% with 3DVP (Gran, 2016). Also, the fitting time can be reduced by using 3DVP and 3D scanning for the right sizes (Chowdhury et al., 2012).

![Figure 18: Prototyping supply chain (Source: Koch, 2017)](image)

Producing customized products in the right sizes will reduce the number of returned products (Jiang et al., 2017). Standard sizes are a problem in the fashion industry and they fit less than 20 percent of the total addressable population. Too many consumers fall between the cracks of standard sizing. Customers often choose more than one size and return the items not right fitted. This requires extra shipping what leads to environmental damage (Close, 2017; Weetman, 2016). Using 3DP combined with 3D scanning can decrease the global size problem. The customer can print their clothes in their own size.

### 4.3 Profit – Economic performance

Profit is about the financial state of a company, the business model in which the company receives revenue (Elkington, 2009). New technologies will have influences on different processes in the production of a garment (Mellor et al., 2014). It will create a new supply chain design, changes in logistics, product life-cycle and consumer behaviour (Bogers et al., 2016; The Economist, 2012; The Economist, 2013; Berman, 2012). These changes may lead to turbulence in the industry (Jiang et al., 2017).

The number of online purchases has increase significantly the last couple of years. The results of a survey by analytic firm ComScore show that consumers make 51% of their purchases online in 2016. Compared to 48% in 2015 and 47% in 2014 this percentage has raised (Farber, 2016). A growing demand of online products results in a large number of firms and retailers that offer products online. The online availability of digital 3D designs has impact on the economic performance of a fashion brand. Because of the online accessibility, the designs can very easily be copied and resold. The major fear of brands is pirated products that will appear on the market. Experts (Jiang et al., 2017; Gershenfeld, 2012; Margoni, 2016) compare the 3-D printing techniques with the technologies for digital books and music downloads. The illegal accessibility of books and music is an example of this problem (The Economist, 2011). The positive side of online platforms of example Spotify, is that they create a platform for starting artists (Cornell, 2014). The rising number of online platforms for 3D designs show that this could work 3DP and it might give starting fashion designers more awareness.

Brand values are important for a fashion brand and when a consumer can print their design in different colours and materials, the brand image will change (Hoogduin, 2017). To keep the brand values, a fashion brand could make a combination of design and material with the right colours for their collection and send this as a package to the consumer to print it at home. When the consumer will print the design in their own material, the brand can send an incomplete design without their brand name (Kivits, 2017). Online purchased products don’t have to be packed, shipped and distributed. Consumers will be able to purchase designs online and then, if they have a 3D printer at home, print the products at home (Bergman, 2012).
Working with 3DP in the production of goods will give the opportunity to produce on demand (Ford, 2016). This will provide no inventory and no dead stock of materials and goods (Hoogduin, 2017; Kivits, 2017). Working with on demand production gives also the opportunity to produce small quantities of customized goods for a relatively low cost (Bergman, 2012). It reduces the inventory cost, risks and quantity. Locally production allows companies to decrease delays and better fit the supply to real demand (Bogers et al., 2016).

### 4.4 Circular economy

3DP makes it possible to work without or with less production waste. In general, 95% - 98% of waste material can be recycled (Petrovic et al., 2011; Wagner, 2010). When a product is broken it can be replaced by a printed part or be used as material for a new print. Using 80% of recycled material with 20% new filament will increase the quality of the print (3D HUBS, 2015). To recycle old prints (Figure 19), the print has to be cleaned and dried. The next step is to shred the material in smaller pieces. There are different kinds of shredders, industrial and for home use, to shredder the materials (Filamaker, 2017). After shredding, the pieces are ready to be extrude. This can be done with an extruding machine. There are several extruders available (Filabot, 2017).

![Figure 19: Filament recycling process (3DHUBS, 2015)](image)

3DP has not only the ability to use material over and over again but also to transform plastic waste into goods. Dave Hakkens, winner of the ‘Dutch Design Talent award’ in 2017 is founder of Precious Plastic. His initiative will recycle plastics worldwide and create new products with 3D printers (Hakkens, 2017). The Better Future Factory, another initiative started in 2012 offer an ABS filament made from car dashboards and Polyethylene Terephthalate (PET) filament made form PET bottles (Martirossian, 2015). Recycling is interesting when it comes to reducing costs. Instead of dumping waste, a company can sell waste (McDonough and Braungart, 2002). A fashion company has the availability to sell dead stock (Weetman, 2016). Another possibility is recycling fabrics instead of buying new (Ecocycle, 2016).
5. LIMITATIONS

This paper shows the changes for the supply chain of a retail fashion brand after implementing 3DP. The research is focussed on the changes of the sustainability. Implementing 3DP will also affect the financial state of a company. The number of retail fashion brands using 3DP is limited. This is why the financial changes after the implementation are not discussed. Therefore, there cannot be conclude if 3DP is interesting for a retail fashion brand regarding investments and costs. It would be interesting when further research can be done on this matter to see if 3DP is not only interesting to increase the environmental benefits but also to increase revenue.

During the interview with Just Brands, M. Kivits and C. Hoogduin were curious about the comfort of the garments. It did not work out to create a garment in an early stage of the research period. Therefore, the comfort is not tested. It would be interesting to test the comfort of the garments to see if consumers are interested in wearing 3D printed garments. This could change the interest of company to implement 3DP in the production process.

The sustainability of 3DP is based on the different between a regular supply chain and a supply chain after the implementation of 3DP. There is not done further research on the sustainability of the production and usage of 3D printers itself. Research on this matter will show the total environmental changes of 3DP.

6. CONCLUSION

The print technologies, researched in this report have all positive and negative points when it comes to sustainability and usability. The DLS technology is fast and can work on a bigger scale. This is interesting for the fashion industry but for this technology, same as the SLS technology, needs recyclable materials be developed to make it work in a circular supply chain. The FDM technology is, depending on the materials, the most sustainable technique. The disadvantage of this technique is the slow speed and it is more difficult to work with support material.

The fashion industry and in particular fast fashion companies are focussed on the fast production of a high number of products. Reducing time by using 3DP could be interesting for a fashion company. 3DP can transform a linear supply chain to a circular supply chain. It has also the ability to create circular processes within the supply chain. Figure 20 shows different sustainable changes in the supply chain of a retail fashion brand after the implementation of 3DP.

The online accessibility of designs has a negative side regarding the rights of a design. It gives consumers the opportunity to download a design and print it over and over again after one purchase. The positive of the digital designs is the ability to easily change designs. The number of vendors can be reduced since a 3D garment consist out of one material. The recycling of materials will decrease new material costs, but this will not work with all filaments. The biggest environmental change caused by 3DP is the decrease in shipments. Labour costs and inventory costs will decrease by local production on demand. Depending on the material, can post-consumer waste be recycled and can a fashion brand using 3DP be part of the circular economy.
9. SOURCE LIST


10. APPENDIX

10.1 Material test results

**Filaflex**

Picture 1 shows a printed fabric sample, inspired by a design of Danit Peleg. This design gives the flexible material the opportunity to stretch. Picture 3 shows the design of the support material test design the hollow inside need to be filled with support material to print the upper circle. The print on picture 2 shows the failed print. The printer is stopped before it could finish the print.

**Flexifil**

Picture 4 shows the result of the support material test. Flexifil works as a support material but it is hard to remove it after printing. The print has a messy look. Flexifil is flexible but not elastic, it breaks after tearing.

**Ninjaflex**

The print of picture 6 is used for the tearing test. Ninjaflex is very flexible and goes back in shape after tearing. Picture 7 shows, that it is not possible to print support material with Ninjaflex. Because of the flexibility, it is not strong enough to carry the weight of the next layers.

**Willowflex**

Picture 9 shows the support test. Willowflex is not recommended as support material. It is strong enough to print with support, but it is really hard to remove the material. Willowflex has failed the tearing test. It does not go back in shape after tearing.

**PLA**

PLA is a hard material. The support test is done with a Dimension uPrint SE. This printer has two extruders. This printer used support of another material. After printing the support material is removed in a chemical bath. This gives a clean result. This printer cannot print with flexible materials.
10.2 Interview Just Brands

The most interesting answers of the Interview with M. Kivits, product developer and buyer at Just Brands and C. Hoogduin, CR manager at Just Brands.

What do you think of the recycling of 3D printed products?
It will only work if you use a small number of different materials. When you have a collection made out of different materials, you can’t recycle different materials together. What we see in the denim industry is that recycled denin is expensive and that makes it less attractive for fashion brands. So, recycling is only interesting when it decreases the costs of new materials.

What do you think of the home production of garments?
Where are the materials available for the consumer? Maybe in the future they can buy it in the super market. And when they return it they will get a deposit. It is important that the materials are affordable for the consumer.

It is difficult to keep the rights of the designs. Maybe we have to create a lock on the designs. We could create a design without our brand name when the consumer will print it at home in their own material. Otherwise they will print our design in pink. That will not fit our brand values. We can create a combi deal with a design and the right design.

What is interesting for Just Brands?
Before Just Brands can used 3DP for the production of their garments, the material need to be developed. The plastic look and feel of the material is not interesting for Just Brands at the moment.

Are you interesting in using 3DP for trims or accessories?
We could use 3DP for the production for the trims. They are made of metal. It would be positive to produces the trims locally at the manufacturer. We use one vendor for all of our buttons and trims and we ship it from that vendor all over the world to our manufacturers. We have gifts for the consumer. For example, when they spend 200 euro they get a power bank or socks or gloves. We could create a 3D printed present to give the consumer a feel of 3DP.