3D Virtual Design & Prototyping

VS

On - Demand Production

How can 3D - Virtual Design & Prototyping be used for on - Demand Production?

AmsterdamFashionInstitute - 2018
Martine Veldink
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Date: 18 - 01 - 2018
Place: Eibergen, The Netherlands
Name: Martine Veldink

Signature
RESEARCH REPORT
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AUTHOR
Martine Veldink¹
500694201
International Fashion Management
September 2017 - January 2018
Amsterdam, The Netherlands

PROCESS COACH
Lisette Vonk
Coordinator Fashion Technology Lab & Virtual Reality Atelier

SECOND READER
Hein Daanen

18 - 01 - 2018

¹ […]@[…]
PREFACE

During my minor 3D Hypercraft at the Amsterdam Fashion Institute I got intrigued with 3D Design and Prototyping software’s and the possibilities it brings. Unfortunately, during the minor, the main focus was put on design. As a management student, this was frustrating as I saw many possibilities for this software to be implemented into the development and production phase. When I got to use the software during the specialization in iNDiViDUALS, in which I was being able to develop two styles of the SS18 collection completely digital and skipping the physical sample phases, it proved to me how much is possible through these new innovations. Together with my interest in 3D Virtual Design, and Prototyping and my determination to make the fashion industry’s production and buying behavior more efficient and innovative gave me the path to my research question.

Through the research, the world of Supply Chain Management evolved and became a big interest for me and I hope that in my professional career I can even further extend that knowledge.

I would like to thank my coach Lisette Vonk for her support and coaching during my graduation project. As well as the enthusiastic group of participants for my survey and the support of family and close friends. Also, a special thanks to all my colleagues, especially Laura Meijnen, Merel Messemaker and Malou Kaaijk for their support during my graduation process and our inventory issues as a strong motivation for this research.

Martine Veldink
ABSTRACT

Fashion is currently facing headwinds from environmental and economic issues with piles of unsold stock. With 3D technology well established in many other industrial sectors the fashion industry is slowly adopting the technology to optimize design and fabrication processes. 3D Technology Solutions have the advantage of a faster sampling process without physical samples being send back and forth. Focusing on the issue of unsold inventory and big clearances with extremely low margins in today’s retail market, various brands, such as Stitch Fix, UNMADE, and Fame & Partners have developed new strategies to cater better to the demand of their consumers. Can 3D Technologies support the fashion industry in the process of on-demand production? In this research report, an analysis of the possibilities of 3D Virtual Design and Prototyping in the different phases of: Planning, Design, Development Pre-Production, Sourcing & Production and Trading will be conducted. A small consumer survey under 50 participants tells a bit more about their shopping experiences. From research conducted in Supply Chain Strategies: from the Traditional Chain to the Push and/or Pull Strategy to new innovative strategies: Demand – Driven Supply chain and the Digital Supply Network to find the key Supply Chain Strategy for on-demand production and were 3D Virtual Prototyping could bring support.

3D Virtual Prototyping comes with advantages such as skipping the physical sampling phases and therefore easier and quicker design adjustments. Risks of implementing 3D are however the lack of experienced users and costly software that all need high investments. Consumers argued in the survey that they are not extremely enthusiastic about customizations tools as they ‘do not have a need for this’, they find it ‘too time consuming’ or have ‘no idea what to customize to garments’. Customization is a tool that could be used to produce on demand, but if consumers are not willing or eager to customize garments the demand could better be reached and analyzed through their digital footprint. Amazon and Stitch Fix are both working with Algorithm – Designers and Algorithm machines that are able to predict trends and see what a consumer might like or not like. The Digital Supply Network and the Demand Driven Supply Chain are the most innovative and changing supply chain strategies on the market but not yet fully designed for the rapidly changing consumer demand of the fashion consumer. Through combining the Digital Supply Network and the Demand Driven Supply Chain into a Supply Chain Strategy with support of 3D Virtual Design & Prototyping Solutions and an information stream between all chains it is able to support companies to cater to the demand of the fashion consumer.

Keywords: 3D Virtual Design - 3D Virtual Prototyping - On-Demand Production - Supply Chain Strategy -
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CHAPTER 1
INTRODUCTION

Fashion is a very traditional industry. But not all tradition needs preserving, especially not the current chaotic manufacturing system which involves a lot of time, money and guesswork (Papachristou & Bilalis, 2017). Three-dimensional (3D) technology, while well established and a powerful tool in many other industrial sectors like aerospace, architecture and industrial design, is still relatively new to the fashion industry. The fashion industry has been starting to adopt it in order to optimize the design and fabrication processes (Barrie, 2015). By providing convincing 3D simulations of garments the industry can change tremendously towards a more sustainable business model. Garments do not have to be shipped around the world multiple times anymore, but information can be exchanged online. Variations in fit, colors and print design can be achieved quickly (Koch, 2016).

The fashion industry is facing increased innovative and competitive pressure, rapidly rising production costs and increasing profit pressures with simultaneous increase in product and design variations (Papachristou & Bilalis, 2017). An environmental and economic problem in today’s retail market is unsold stock: a warm winter, consumer focusing more on experiences than their closets, and the ever elusive “Omni Channel Strategy” are just a few reasons why retailers are struggling (Recer, 2017). Haley Smith Recer is an MBA student at Columbia Business School and consultant for machine learning platform Claire and argues that one plan of action for this issue is the effort to buy more responsible up front and limit the amount of dead inventory at the end of a seasons (Recer, 2017). Marc C. Close, CEO of BeSpokify, argues that the fashion industry must supplement the mass-produced inventory to on-demand inventory (Close, 2017).

A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. Includes all manufacturers, suppliers, transporters, warehouses, retailers and the customer themselves. Each stage is connected through the flow of products, and information. These flows often occur in both directions. The traditional chain can be seen as the raw material supplier who supplies industrial product to the manufacturer, who makes the product and sells it to the distributor, who sells this product to the retailer and finally the consumer gets the product from the retailer (Basak, Seddiq, Islam, Akanda 2014).

Could the combination of 3D - Virtual Design and Prototyping support companies in choosing to produce on-demand instead of overbuying in the beginning of a season and facing issues with dead inventory at the end of a season? This research will be focused on answering that question so that retailers and fashion houses have an overview over how to adapt their supply chain with the newest technology and prevent struggles with dead inventory at the end of the season by producing on-demand.

To answer the research question certain topics have to be researched first: 3D Virtual Design & Prototyping (Chapter 2), on-Demand Production in the Fashion Industry (Chapter 3), and the traditional supply chain, and supply chain strategies: Push, Pull and Synchronous chains, as well as innovations in the Supply Chain Strategies (Chapter 4).
1.1 METHODOLOGY

The different topics will be researched through literature research. Scientific articles will be discovered by using Google scholar, the HvA library, UVA library, ScienceDirect, and the International Journal of Clothing Science and Technology. Various search terms will be used, such as: 3D Design, 3D Prototyping, 3D Design and Prototyping software, Virtual Design, Virtual Prototyping, 3D Simulation Fashion, Demand - Driven Forecasting, On - Demand Production, Supply Chain Theories, Supply Chain in Fashion, Supply Chain Management, Garment Manufacturing, SCM. Interviews will be held to receive the professional opinion of the fashion industry. In these interviews, questions concerning the 3D Design process in the industry, the acceptance of Virtual Garments and how this affects the work structure of companies will be asked. Also, interviews will be held about the topic of on-demand production and the build-up of the supply chain strategy. The interviews will be transcribed and analyzed. A consumer survey will be conducted to find out the consumers opinion towards shopping experiences. The survey consists out of questions focusing on their experience of the current retail market, experiences while shopping and if their demands are met. The last part of the survey consist out of questions regarding the consumer’s need for customized garments and what they would like to customize. The final part will present 3D Virtual Garments and questions are asked whether the consumer would buy the garments if presented in this way. The survey will be spread in English through social media. No age, gender, nationality or other restrictions will be set.
2.1.1 PLAN

Product Lifecycle Management (PLM) software helps manufacturers shorten product lifecycle times by at least half to boost efficiencies in the supply chain (Wright, 2014). PLM systems centralizes product information and links the entire product lifecycle: from sourcing and product development through approvals and production - triggering alerts and tracking progress along the way. WFX on demand has developed a PLM systems through a 100% Cloud-based application which gives its users the ability to not only share and collaborate with internal teams and global partners but also integrate with any 3rd Party Software (WFX On Demand, 2018). PLM is a big support throughout the lifecycle of the garment and therefor 3D Design and Prototyping companies have developed their own PLM systems. For example, a system offered by Gerber Technology can send and share data with all their other software solutions. Through this data sharing preliminary costing can be send to vendors, textiles can be prepped, and the best sellers of last seasons can be analyzed together with upcoming trends, materials and reusable specifications (Gerber Technology, 2017). Next to this Human Solution-Group offers PLM software in combination with 3D Virtual Design and Prototyping software’s (Human Solution Group, 2017).

2.1.2 DESIGN

With 3D-Design you can simulate and fit samples on custom-fit virtual avatars, make changes right on the screen and incorporate realistic 3D objects, such as buttons, buckles, straps and zippers. The 3D Creator from Optitex has the ability to share these 3D samples to eliminate styles on an early base (Optitex, 2017). Many software programs are connected with Adobe Illustrator and Photoshop to instantly view your design and/or prints. It is possible to visualize multiple colorways and a mix of fabric types in each colorway (Brozwear, 2017). To simulate the physical property of the fabrics accurately and the way they drape in real-life Clo3D has created a sophisticated algorithm that supports this. Alberto Lovisetto designer for Dainese motivates that they decided to adopt a 3D design solution to quickly understand the designers vision, and to show the development of projects in a clear and usable way (Clo3D, 2018).

2.1.3 DEVELOPMENT/ PRE-PRODUCTION

In the development phase a solution offered by one of the software companies is the Silhouette Table which gives you the opportunity to draw in full scale or pin pieces of garments or samples to the table and trace the pattern shapes directly into automatically converted digital patterns (Gerber Technology, 2017). Through the support of PLM systems in this phase it is possible to develop Technical Packs by using the generate detailed PLM-ready specifications for manufacturing together with the digital pattern and visualized
sample ready to send to the manufacturer. In this phase adjustments can be made to the design focusing on fit problems (Gerber Technologies, 2016). Three key solutions for development and designing from Lectra are Modaris, figure 4, which is a pattern making solution: developed to meet industry demands for shorter lead times, perfect fit and streamlined development. Kaledo, figure 5, gives designers the means to make creative ideas to reality: simple and effective apparel – specific tools to cut down the time needed to create new styles and carry over bestsellers. Diamino, figure 6, is developed to facilitate marker creation to save fabric and increase productivity (Lectra, 2017). With the 3D Flattener, you can efficiently and accurately design form-fitting garments; it gives you the opportunity to apply stretch prior to creating the pieces to precisely match body dimensions and fabric which is ideal for tight-fitting garments like wetsuits (Optitex, 2015). Grading, figure 7, can be supported in 3D and visualized on different size avatars to make sure all sizes are correct and can save the need for sizing sample packs. Lectra, Gerber and Optitex offer advanced technology solutions to support the Grading process (Lectra, 2017; Gerber Technology, 2017; Optitex, 2015).

2.1.4 SOURCING/PRODUCTION

Digital Patterns developed in the previous phase can either be plotted or send through cloud technologies to the manufacturer. Different software companies offer Plotting machines to print out patterns on full scale (Gerber Technology, 2017). One of the biggest advantages of using 3D Solutions is that the number of samples is being reduced at least half due to the 3D simulations (Koch, 2016). As the patterns are developed digitally the marker for pattern placement can automatically be developed that maximizes the placement of markers and utilizes every possible piece of fabric, generating enormous savings (Tukatech, 2017).

2.1.5 TRADING

As all the garments are virtually designed the next step is a Digital Collection in which you can portray a sales showroom (Optitex, 2017). Hugo Boss launched a digital showroom, figure 8, for their pre-fall collection of 2018. Hugo Boss wants to replace physical samples and make the buying process easier. On a screen of 1.65m the collection was visualized and through a touch screen the entire overview of the collection was made visible by showing the styles, colors, and combinations. Orders could be placed directly. Tommy Hilfiger has also used a digital installation to present their collection through a touch retail shopping wall and a digital showroom. Customers could swipe through the collection and ask for more data or analytics per style (Hendriksz, 2017; Buis, 2017).
2.2 DIGITAL FASHION WORLD

Every two years in Frankfurt the International trade fair for the garment-manufacturing and textile processing industry is held: Texprocess. This year (2017) digitalization was key (Texprocess, 2017). Mentioned by Barrie and Wright as one of the biggest highlights of the fair was the Digital Fashion world from Human Solutions Group. Human Solution Group presented the entire product development process digitally by using their own software programs (Barrie & Wright, 2017). This gives an idea how a fully digital process could be imagined. Human Solution Group portrayed the Digital Design Room, Digital Production Room, Digital Show Room and a Virtual Reality Room. The rooms are linked to each other by sending data back and forth. In the digital design room the ideal sample is being designed, tested and approved digitally by using a Digital Fashion Board which uses data from the ‘Vidya’ 3D simulation software which is linked to the PLM system ‘GoLive’ which uses international body dimensions from the portal ‘iSize’ to help define the target group including price ranges, materials and accessories determined in the PLM system. After this a pattern is developed in ‘Cad.Assyt’ and simulated and visualized in ‘Vidya’. The result is a pattern file that can be send to production. This proved that a fully digital product development chain is possible, meaning sample-free all the way to production and helping to significantly reduce time to market according to the review written by Barrie & Wright of Texprocess 2017 (Barrie & Wright, 2017; Human Solution Group, 2017; Texprocess, 2017).

2.3 IMPLEMENTING 3D - VIRTUAL DESIGN & PROTOTYPING

Papachristou and Bilalis (2017) did a qualitative research investigating the level of acceptance in the global clothing and fashion industry as well as the challenges, opportunities and barriers that need to be overcome in order for digital prototyping to accelerate business processes on an integrated basis. Through their survey it was found that the biggest disadvantage was the lack of experienced users with technical knowledge. Academic participants argued that the time it takes to learn this new technology is too long, and how insufficient the tool can become when comparing a skillful simple technician with an amateur 3D user. Wallace (2009) showed in her study about Virtual Sampling and about the Revolutionized of the fashion design process that (…) there is a drawback to mention, lack of appropriate knowledge and skills to assess the virtual simulation; the inadequate and costly hardware and software; time-consuming and complex software to learn and to apply for designers; fear of changing job roles and possibility of artistic freedom (Eksdale, 2013).

A very important aspect of this new way of working is the contribution to sustainability. The digital evaluation of the fit is very accurate in the 3D simulation. This has positive effects on sample budgets and means less physical samples, lower transportation costs, the use of less material and, above all, it saves time (Siersema & Kuijpers, 2011). To start implementing 3D Virtual Design & Prototyping in the supply chain an organization needs to complete a digitalized product directory (i.e., every stock keeping unit (SKU) that is sold). This directory includes all product manufacturing and/or supplier data, including pricing, lead times, availability and delivery dates (Burton, 2015).

Compared to other industries, fabric properties have been proven to be an obstacle, as those are related to feel, drape and reaction on the body (Papachristou & Bilalis, 2017). That is why the other industries have implemented 3D quicker, because the materials are so much different than woven and knitted fabric argues Digital Product Creation Consultant Christian Harris (Harris, 2014; Siersema, 2015). Next to the time to develop the directory, and training a big financial investment needs to be made. The Digital Fashion World of the Human Solution Group represented the multiple solution programs needed to fulfill all steps to fully integrate 3D into the supply chain. Another issue that can be argued is the lack of communication between different 3D software tools. If you work with a factory in Asia that has one solution to a problem and you have another solution, the exchange of files between the two can cause to lose stitching information and the physical parameters used (Muller, 2015).
CHAPTER 3
ON-DEMAND PRODUCTION

Retailers end up often out of stock, overstocked or delayed since market trends are changing much faster than the current process of developing a collection. In the fashion industry, there is an unsuccessful prediction of sales, the ability to plan 6 months ahead has become a risk of financial losses and unsold inventory. Producing on-demand follows the actual demand with direct sales without inventory, the opportunity to order directly, no minimum order quantities a quick response to your consumers’ needs and always the best sellers in the shop (Kabaivanova, 2017).

In the early 2000’s the book, The Fashion ChaChaCha by Dany Jacobs and Andreas Stockert stated that in most cases the fashion industry works in a traditional, old-fashioned way named the push principle which thinks from the designer to the consumer. It is not only the material flow, it is also the flow of information and ideas which go into one direction in a product view driven manner (Fashion ChaChaCha, 2004). In 2002 International Business Machines Corporation (IBM) went on a journey to transform its supply chain from a “push” model to a demand-driven business model: the “on-demand business”. With big results; by 2003, the company cut its supply chain costs by $7 billion. Inventory was at its lowest points in 20 years and customer satisfaction was at an all-time high (Harrington, 2005). However, when catering to the actual demand the time to market can become longer, depending on which supply chain strategy and the number of chains. It is also more difficult to take advantage of the economy of scale, since batch production or truckloads are harder to achieve hence the price of the garment can go up (Baspal, 2016).

3.1 CONSUMERS

In the State of Fashion of 2017, a report from McKinsey & Company and the Business of Fashion (BoF) that lays the foundation for rigorous in-depth research and analysis of the global fashion industry, a survey was conducted to find the top 6 challenges facing the fashion industry. One of the trends is ‘Speed of Changing Consumer Preferences’: Consumers are demanding more customized and personalized fashion and expect this at a lower rate. In 2017 consumers’ needs and behaviors will likely become more sophisticated, more technology-driven, and harder to predict than ever, with fashion companies striving to keep up (Business of Fashion & McKinsey&Company, 2016).

Through market research constructed with 55 participants a question raised was: “When you go shopping, do you find what you are looking for?” Forty-six-point-two percent responded “Sometimes, after a long search” and 50.9% agreed with “Most of the time” (figure 7). Further asked was if they thought that Fashion Brands react to their preferred trends on time (figure 8) (1 to 5: 1 Yes - 5 No) 38.5% of the respondents left the answer in the middle, only 9.6% answered with Yes. Asked was if they wished they could personalize clothing before purchasing: 40% answered with No and 60% answered with Yes (Figure 9).

Reasons why respondents did not want to personalize their clothing:

“Not necessary”

“I think this would make the decision process even harder for me. If it were to be small changes that improve the fit of my kind of body then I would like it”

Other answers said consumers did not have the need for anything personalized, it will cost more, or the participants in the survey did not want to wait for their clothing. The participants that did want to personalize clothing were asked what kind of clothing they preferred to be customized. Most of them answered jeans, trousers or tops. When asked more specifically about what they would like to personalize these garments was mostly the fit of the garment (figure 10). 87.1% of the respondents that wanted to personalize their clothing are also willing to pay extra for adjustments, 44.4% of these are willing to pay between 10 - 25% extra.

Through this consumer research it was found that 60% of the consumers is looking for personalization. Following the statement of the State of Fashion Report of 2017 from Business of Fashion and McKinsey & Group that consumers are demanding more customized and personalized fashion. Only the group of participants that wants to personalize clothing focuses mostly on fit rather than design features.
When you go shopping, do you find what you are looking for:

Half of the participants (50.9%) agreed that Most of the Time they find what they are looking for when going shopping. Interesting to analyze with the question below about their preferred trends. Only a small group (9.1%) barely finds what they are looking for which can be analyzed as the trendsetters of the market.

Do you think that Fashion brands react to your preferred trends on time?

The result of these questions are divided. Most participants were divided over 3 and 4 which does give the impression they do not always find trends on time with their consumers.

Do you wish you could personalize clothing before purchasing?

What kind of clothing would you want to personalize?

What would you like to personalize to that garment?

Most personalization focus on fit which gives an impression consumers perhaps look more for a tailor service within retail brands.
3.2 HOW TO PRODUCE ON-DEMAND?

Currently factories have a full running cycle for production for the future season: the FW18 collection is produced in the Spring of 2017 and the SS19 collection is produced in the Fall of 2018. Interrupting this cycle to on-demand manufacturing would involve large investments in both technology and human labor for factories. How can we shift the old processes to on-demand production?

Rebecca Minkoff, Michael Kors, Theory and Tory Burch are already ahead of the game by accepting customers pre-orders right after a new collection is released (Amed, Mellery-Pratt 2016). Mass customization pure players and direct to consumer pre-order brands emerge every year and are starting to win customers hearts according to fashion tech professional Nataliya Makulova. (Makulova, 2016). The brands named by Makulova started from the original production process and are transitioning. New brands like BeSpokify, ATACAC, UNMADE, Awl & Sundry, eShakti, BAMIN and Fame & Partners are coming up and have started off with on-demand production, often in combination with customer customization opportunities.

3.2.1 UNMADE - BESPOKIFY - FAME & PARTNERS

The vision of UNMADE Fashion is about expressing your individuality through the clothes you wear, but current industrial manufacturing fails to account for this (UNMADE, 2017). (…) UNMADE is the industrial solution to change this. UNMADE works with three key elements: Personalization editors, E-commerce integration and on-demand manufacturing. UNMADE takes customized designs straight to production. According to their website, they are able to do this for the same unit cost as mass production. The personal editor allows customers to directly modify the clothes they buy: you can change colors, shift patterns, add monograms etc. The personal editor can be integrated with existing E-commerce solutions. UNMADE enables existing knitwear factories to add unique orders alongside existing bulk production to enable one-offs at the same unit cost as mass production. They work with on-demand production through customization. Analyzing their approach, you can see that their consumers create the ‘demand’ online through the personal editor and therefore an item can only can be produced once an order is placed by the consumer themselves. The knitwear is being sold from €60, - up to €200, - depending on the design and fabric choice (UNMADE 2017, Issa 2016, Arthur 2015).

Another approach to on-demand production is offered by BeSpokify. The biggest difference to BeSpokify from UNMADE is that BeSpokify works business to business. As a brand, you can have your customers purchase customized products at your own website and BeSpokify will deliver order details and patterns to the manufacturer and even help you find a bespoke manufacturer. BeSpokify works with Apparel Brands, Uniform Manufacturers (tailored outfits for hotels and airlines for example) but also tailors and dressmakers. BeSpokify works in four phases. Step 1: Design: launching products using their pattern library or add own designs using their cutting-edge parametric pattern-drafting system. Step 2: Measure: you can add the customers measurements through 3D body scans or hand measurements. Step 3: When ready you can select the customers measurements and product choices. A fully custom pattern is generated in seconds and ready for export. Finally, the pattern is instantly plot/cut or you download an DXF file and receive an order summary with all the information needed for the manufacture. BeSpokify does not charge for license fee or subscriptions. As a company, you pay for what you use, the higher the monthly volume the cheaper it becomes. Next to this the company offers consultancy services adding custom patterns, manufacturing automation, eCommerce integration, 3D virtualization, customizers/configurators and on-demand production starting at $50/hr. (BeSpokify, 2017).

Another player in the world of customization is Fame & Partners, who call themselves the woman’s personal atelier. Depending on the style you can make small adjustments to your wishes but not comprehending the design. For example: The Margaux dress for $199, - (figure 11). This dress can be customized on the website with the following features; add separate ruffle arm bands, raise back neckline, make knee length, add double ruffle to the hem. Each feature can be added for an extra $9, - (figure 12). The dress is available in three color options without extra charge, but an additional palette of colors is available with a charge of $16, -. Fame & Partners offers two different delivery methods: the standard free options in which you receive your order within 7 – 10 business day, or the option to deliver in 6 weeks and you receive 10% discount of your order.
3.2.2

**ALGORITHMS IN FASHION**

Stitch Fix offers online personal styling at affordable prices. Algorithms produce recommendations for stylists who use their personal experience and knowledge of the customer to curate those recommendations down to just five items per fix. Through purchasing, answering questions and/or communication with your stylist, each fix becomes more accurate. Stitch Fix combines technology, data science and the human touch of seasoned stylist to make personalized scalable. What the companies sell is based upon recommendations that emerge from customer surveys, Pinterest boards, weather patterns and personal notes to stylists (Stitch Fix, 2017). In Stitch Fix’s IPO document the company warned potential investors that they “have not always predicted our client’s preferences and acceptance level of our trend items with accuracy which has resulted in significant inventory write offs and lower gross margins”. According to Shira Ovide technology does help Stitch Fix with inventory risk, due to the recommendation on their personal taste it has a better sense of how many customers might like for example fur-lined loafers. The company see’s what styles consumers like and make its own versions to sell at a higher profit margin (Ovide, 2017) (Ahuja, 2015) (Knight, 2017). Amazon is opening its markets into the fashion segment; and may lead the way when it comes to replacing stylists and designers completely with Algorithms. Amazon is currently working on several machines – learning systems that could help provide an edge when it comes to spotting, reacting to and perhaps even shaping the latest fashion trends (Knight, 2017).

Marc C. Close who is the CEO and co-founder of BeSpokify, argues in his article for Business of Fashion that fashion business need to start transitioning into technology soon. He advises to digitize historical designs and build a rich database of products split into their individual variants. A designer or AI designer can easily reference this library to assemble unique products without having to create anything from scratch. Collect and analyze all data that you have: such as points-of-sale data, e-commerce analytics and metrics about your customers. “Your biggest competitive advantage is locked away in the data that flows through your business, day in day out” (Close, 2017). Nonetheless, being too dazzled by data is a danger. If all brands replace the creative process with data analysis to predict what consumers want, a downward spiral in which they create too much of the same product could be difficult to avoid is being argued by the BoF and McKinsey in their State of Fashion Report of 2017.
A supply chain is defined as a network of organizations that are involved through upstream and downstream connections. The different connections processes and/or activities add value in the form of products and/or services to the final hands of the customer or consumer (Rogers & Tibben-Lembke, 1999). A supply chain is a network of connected and interdependent organizations, jointly and cooperatively working together to control, manage and improve the continuation of material and data from suppliers to the end user (Lysons & Farrington, 2012). Figure 13 is a visual description of the apparel supply chain from Daspal (2016). The entire apparel supply chain consists of every organization starting from the first fiber supplier. Each organization comprises various functional domains, as manufacturing, planning, marketing etc. are shown. Effective supply chain manages flow of demand and supply, which move in opposite direction to each other (Daspal, 2016).
4.2 **PUSH and/or PULL STRATEGIES**

Apparel Supply Chain Strategies can traditionally be categorized in three strategies, depending on the type of demand and supply: Push, Pull and Synchronous (Push & Pull). (Daspal, Niroomand 2016, Sehgal 2009)

### 4.2.1 **PUSH STRATEGY**

The Push strategy supplies to the stable demand of similar products. Production and distribution decisions are based on long-term forecasts. The Push strategy is a characteristic of the 1950 - 1970s; companies mostly had vertical organization structures, power emanating from the top down with a well-defined chain of command, focusing on manufacturing in a demand surplus environment of mass-product. Cycle stock and work-in-process stock are often the type of inventory due to the Push strategy. For companies it is extremely difficult to match the supply when there is a variable demand. An advantage of the Push strategy is the larger production batches in which you can take advantage of the Economy of Scale. You create also more buffer/safety stock. A direct disadvantage of this is the incapability for catering a demand of short quantity (Baspal, 2016) (Schlegel, 2017). In the push approach, there is a big emphasis on forecast, consumer-buying behaviors are not predictable, in order for push planning to be successful the forecast must be accurate. This is a major challenge for today’s companies, with lots of added costs to store all the inventory; risks of goods expiring or spoiling before they’re sold if the forecast is incorrect (Nimoorand, 2016).

The Bull Whip Effect is an effect created through the Push strategy. This effect is caused by the inability of each individual manufacturer of fiber’s, yarn, fabric and garment to access the actual demand. The bull whip explains the increasing demand variability in the upstream direction of the supply chain. Each manufacture has a poor visibility of the actual demand and so each builds up a buffer against unforeseen demand-variability, see figure 14 (Baspal, 2016) (Ambastha, sd) (Hau L. Lee, 1997).

### 4.2.2 **PULL STRATEGY**

Due to the more unstable market demand in the period of 1970 to 1990, apparel organizations were unable to supply competitively small orders and long forecast based decisions resulted into inventory pilling up at every stage of the supply chain, caused due to the bullwhip effect. Companies had to adjust their production and distribution as per the actual demand given by the customer, pull oriented supply chain, instead of what the company makes; push oriented (Baspal, 2016). However, creating an entire supply chain that is driven by the demand of the consumer causes that the time to market becomes long, depending on the strategy and number of networks involved. A typical cycle time from order to the market is 60 – 90 days (Baspal, 2016).

![Figure 14 Bullwhip effect: Fibre2Fashion](image-url)
### 4.2.3 PUSH AND PULL STRATEGIES

As mentioned above the disadvantages from a Push or Pull strategy have forced companies to look into new strategies that take advantage of both the Push and Pull strategy, which resulted into a combination of the two strategies: Push – Pull Strategy, which also can be named as Synchronous Supply Chain. In this strategy, the first stages of the supply chain are based on the Push system were as the final stage are based on the Pull system. The stages between the Push based strategy and the Pull based strategy is being referred as the Push – Pull Boundary (Baspal, 2016) (Nimoorand, 2016) (Sehgal, 2009). Setting up the Boundary at phase 1 in the below figure, represents a full pull based supply chain: planning of the products starts when customer places the order and creates firm demand. Setting the boundary at 4 represents a full push-based supply chain: products are built, distributed and ready for the customer demand. The phases in between may be assembled when the customer order is placed to distribution scenarios where products are ready but distribute or shipped in response to demand (Sehgal, 2009).

![Figure 15 Push & Pull Boundary](image)

### 4.3 DIGITAL SUPPLY CHAIN

In the report State of Fashion of 2017 by the Business of Fashion (BoF) and McKinsey & Company, one of the top 10 trends that defines the Fashion Agenda of 2017 is called Upstream Technology. The need to adopt a digital process effectively will presumably place added pressure on creatives across all market segments to take up new tools - from virtual design to virtual sampling to increase efficiency and integrate design-to-cost. Digitization is key to supply-chain efficiency, lower procurement costs, and enhanced sourcing opportunities. Digitized inventory management and predictive analytics aligned to investments in Customer Relationship Management (CRM) have the potential to allow fashion companies to link inventory around the world to a single view for the consumer. (State of Fashion, 2017).

Digital technology is disrupting traditional operations and now businesses are digital businesses according to Adam Robinson (2016). The impact of digital businesses on supply chain strategies is particularly great, due to this business need to unlock the full potential of digital by reinventing their supply chain strategy. A characteristic of the Digital Supply Chain is the full supply chain visibility. Research showed that just 32 percent of businesses can see into their suppliers’ inventory. And less than half (47 percent) say that their supply chain is “very effective” at meeting customers’ service levels (Hanifan, 2015). With cloud technologies and analytics implementing in the supply chain it gives you end-to-end supply chain visibility. Through this new source revenues are visible sooner and a vision of exactly where the new demand is emerging and were the best source of supply is located: resulting into serving the customer better. Leveraging analytics, cloud technology, 3D printing and social media to introduce scalability right across the supply chain will result into a more dynamic and flexible enough supply chain that is significant to growth. Such technologies can be used to build scalable supply chain infrastructures that streamline the manufacturing process: shortening cycle times and cutting costs. Supply Chain eventually become the Digital Supply Network (DSN) more connected, intelligent, scalable and rapid than the traditional supply chain (Accenture, 2016).
ON - DEMAND DRIVEN SUPPLY CHAIN

The Demand-Driven Supply Network (DDSN) is "a system of coordinated technologies and processes that senses and reacts to real-time demand signals across a supply network of customers, suppliers, and employees to improve operational efficiency, streamline new product development and launch, and maximize margin," according to Boston-based AMR Research (Budd, et al., 2012).

Figure 16 from the Boston Consulting Group exhibits the traditional supply chain versus the demand-driven supply chain (DDSC). Through-out the supply chain the biggest change is the real-time information flow: there is no delay in passing information across the entire supply chain (Budd, Knizek, Tevelson, 2012). Committing to the DDSC comes with a few risks. The Boston Consulting Group gave risks why companies are not fully committing to this strategy: Inventory is too lean, no safety stock to address supply shortages or unexpected spikes in demand. And also, companies don’t want their proprietary data getting into the wrong hands. In figure 15 you can see the information flow going through the entire chain, with this you make sensitive information visible to others that can potential points to vulnerability and conflicts of interest. Also, companies state to the Boston Consulting Group that if we constantly react to short-term changes in supply and demand, we’ll lose our focus and incur added costs; companies need very clear product, marketing, and operational strategies to help establish priorities and provide a compass for making decisions. (Budd, Knizek, Tevelson 2012)
A methodological sample size limitation of the report is the quantity of participants in the conducted survey, which was only 55. Also as the result of the survey concludes that only 40% of participants could argue the question asked and if this should have been further explained what the options and possibilities of customizations regarding garments could be: an example could have been given. Unfortunately, due to the stop of communication from Tamara Koch, 3D designer, a personal interview could not be added into the report which would have given Chapter 2 more depth.

Further research can be implemented into the use of Algorithms in Fashion. Application of Algorithm Designers and/or research machines that predict what consumers like or do not like through their digital footprint: could the combination of algorithms and social media platforms support retailers and fashion houses in the development of their collections?
CONCLUSION

3D Virtual Design and Prototyping brings solutions to the market for each phase in the lifecycle of a garment. From the initial fashion drawing to the final showroom presentation, supported through a PLM system that centralizes product information and links the entire product chain. Through this system time cycles are reduced and a style can quicker and easier be adjusted in the design phase. It makes it easier to go back and forth between design and production because sampling is done virtually. The current market for on-demand production focuses mostly on personalization by customers themselves. Contradicting the consumer research done which concludes that only 40% of the participants would be interested in having garments be personalized, especially focusing on fit issues. Customers are perhaps not yet ready to put their own personality or ideas into garments. Therefore I would not suggest this as a combination of producing on-demand with 3D Virtual Design and Prototyping. Another way to analyze the customers demand is in their digital footprint and through Algorithm Designers. Three main supply chain strategies evolved from the research: The Synchronous Supply Chain, The Digital Supply Network and the Demand - Driven Supply Strategy. These strategies need to come together as one supply chain strategy with a continuously stream of information. A chain gives the idea of a beginning and an end: the supply chain of today’s garment industry should be stronger linked than ever to cater the high demands of consumers. A new supply chain strategy can also support companies to shift to being digital. 3D Virtual Design and Prototyping could support on-demand production when focusing on reducing the time to market: quicker sampling, communication internally and externally with the use of PLM systems. A new supply chain strategy is advised that caters to the flexibility of the consumers demand but also the practicalities of the companies and all networks involved.

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APPENDIX

Interview with Susie Bruer, Head of Production at Stitch Fix and Author of Blue is the new Black

Looking back at Blue is the new Black and the time-line attached to it would you still recommend this approach or have many things changed in the past years?

SB ** There are many different approaches to timelines and sometimes you need more than 1 to make a collection work. Have a framework to start with is essential and this basic framework will start you in a direction from which you can change and adjust depending on your needs

As you are currently working for Stitch Fix could you perhaps tell me if to your opinion through their innovative approach with offering their services the workload is better divided?

SB ** StitchFix is a unique business model but in the end we are still producing product (garments) to be sold. For my team, we use different timelines depending on what we are producing, when we are producing it and where (in the world) we are producing

Do you work with a similar time-line than your book?
SB ** I use the same as the book and then I adapt it for my needs as above.

Could you tell me a bit about the Supply Chain Strategy Stitch Fix approaches: I have read in a few articles that you also develop your own clothing line and use data from your consumers to develop these garments.

SB ** I can’t tell you too much about the specifics of our Supply Chain as I am bound by an NDA (non disclosure agreement) but I can tell you that we do produce our own clothes and we use the feedback and data from our clients to encourage a lean manufacturing process. This means, we only produce what we need unlike many other brands who over produce and are then left with large quantities of markdown / discount

What is your job description at Stitch Fix and how much does it differ from working with ‘traditional’ fashion brands?

SB ** My title is Director of Production for the Men’s division. It is very similar to other companies in terms of managing a team, creating a sourcing strategy and making great quality product

Is Stitch Fix currently working with the support of 3D Simulation Design and/or Prototyping Solutions?
SB ** I’m sorry but I can’t say yes or no to this..

What is your professional opinion about 3D Simulation Design and/or Prototyping Solutions, do you see a future of this on the market?
SB ** I think it’s really interesting and can be a complete game changer for the industry in terms of saving sample cost and also time in proto making. I’m excited to see this develop and become the norm for manufacturing
Survey Results: Consumer experience

Gender

Age

Where do you prefer to shop?

When you go shopping, do you find what you are looking for?

55 reacties

Always

Most of the time

Sometimes, after

Barely

Never

I rarely go shop...

Depends what I...

I never go shop...

0 (0%)

28 (50,9%)

25 (45,5%)

5 (9,1%)

0 (0%)

1 (1,8%)

1 (1,8%)

1 (1,8%)
Do you think that Fashion brands react to your preferred trends on time?

55 reacties

- 7 (12.7%)
- 18 (32.7%)
- 20 (36.4%)
- 9 (16.4%)
- 1 (1.8%)

Do you wish you could personalize clothing before purchasing?

55 reacties

- Yes: 60%
- No: 40%

Could you please explain why not?

Omdat het voor mij niet nodig is
I generally don’t personalize anything I purchase
I think this would make the decision process even harder for me. If it were to be small changes that improve the fit for my specific kind of body then I would like it.
I also buy clothes sometimes that I think aren’t my style in the first place, but I like them anyways. If I would personalise first I would buy something “safe” everytime instead of trying new things.
Not interested
I do not prefer it over regular fashion
Don’t feel the need and too much effort
I want to take it home immediately
Geen behoefte aan gepersonaliseerde kleding
No need to
I just want to buy the clothes that i like on first sight. And it is too much work.
It will cost more and it is not necessary
I’m not fashion knowledgeable so I wouldn’t know what to do.

No need
I think its just not necessary! If I would like to have something personalized I would go to a tailor
I’m happy with what is offered in stores
dat kan ik zelf als ik het nodig vind
Because I think if you personalize chothing, the costs will rise.
I think some consumers would like that, but my style is quite classic, so I would only personalise something if I e.g. would buy a suit and have it tailored
Not needed
too much effort
I don’t know how I would personalize a piece of clothing.
What kind of clothing would you want to personalize?

Shirts (2)
Jeans (2)
Everything (2)
Pants (2)

Niet gewoon tshirts, bijv. echt je eigen pak in elkaar zetten. Of nog vetter als je zoals project runway je eigen stof kan tekenen/ontwerpen
Any kind of garment
Clothing for the legs like skirts of pants
My jeans
basics to make them not basic and unique
Shoes
Trousers, its hard to find the ones that really fit
Basics
All kinds of clothing
Alle kledingstukken, van jassen tot t-shirts, broeken, schoenen, sokken, onderbroeken.. zodat het eigen word en waarde aan kan hechten
Sweaters, jeans, shoes.
Trousers

What would you like to personalize to that garment?

Personalize mwaa, liever echt zelf ontwerpen
Color schemes and design on my sneakers. Some brands are doing it but not all. Also shorts that don’t ride up when you run - would like the option to add the built-in nylon work out garment to any run shorts I find online.
Placement of logo’s / thickness of stripes etc.
Pants
I would leave the glitter and glamour you see nowadays.
Length and waist hight
perhaps a print or embroidery or that you can choose your preffered fabric
Fit
The fit
Most of the time the color
The fit; the length and the width, its always too long and too wide
Cut, shape, material.
The fit and the material
Fit/fabric), print/dessin, details
Shorten them
Prints, colors, details in the fit
The colour
Fit, colour, fabric, lengths of hemlines, basically anything.
Mainly fit

Length and fit of trousers, i feel like many of the clothes at fast fashion brands dont fit me properly
All sorts of
broeken
Jeans
Puff jackets
Tops and shirts
trousers
T-shirts, Sweaters, Tops
jeans and tshirts
Coats, Dresses
Tops and Outerwear
Chic winter coats ~

Mainly fit
innemen

Fit and Design Details
Stitch Patterns and prints
The measurements: because of my broad(er) upper body these garments often don’t fit me.
Buttons, stitching
Length
fit/length
Details
Fitting and style
jeans perfect fit
length, buttons
Small little details that distinguish a “basic” piece and make it a bit more special
Change the color
Buttons!
Would you pay extra for these adjustments?
33 reacties

- Yes: 87.9%
- No: 12.1%

How much are you willing to pay extra?
29 reacties

- 0 - 10%: 48.3%
- 11 - 25%: 24.1%
- 26 - 50%: 17.2%
- 50%+: 10.3%

Are you willing to wait longer than normal for your order if it is personalized?
33 reacties

- Yes: 90.9%
- No: 9.1%

How long are you willing to wait for your order?
30 reacties

- 0 - 7 days: 10 (33.3%)
- 7 - 14 days: 20 (66.7%)
- 14 days or longer: 4 (13.3%)
- Lighter net aan h…: 1 (3.3%)