3D virtual prototyping implementation in big luxury fashion brands in order to reduce the number of samples produced

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3D VIRTUAL PROTOTYPING FOR LUXURY FASHION INDUSTRY

A research of possible 3D virtual prototyping implementation possibilities in big luxury fashion brands in order to lower the number of samples produced
Abstract

Product design and development process in the luxury fashion brand is considered to be very wasteful. Numerous samples are produced that go to waste leaving a massive impact on the environment and inefficiencies in how luxury fashion brands operate. Over the past years digital technologies, like 3D virtual prototyping have been developed as a possible solution towards the sample waste problem. Since designs can be simulated digitally requiring less produced samples in order to design a collection. This technology is being developed rapidly and is becoming a good replacement for traditional product development methods. There are multiple companies, such as Nike, Adidas and H&M that are working on 3D virtual prototyping implementation, however, luxury fashion brands are lacking behind. In order to solve the problem of wasted samples in the luxury fashion product design and development phases, this research focuses on the implementation of 3D virtual prototyping in big luxury fashion brands.

The research report starts with the analysis of traditional product development and processes in the luxury fashion brands through a literature review and interviews with product developers in the luxury field. A further focus is set on virtual product development and 3D virtual prototyping technology itself by analyzing literature reviewing, user case studies and conducting interviews with experts in the digital field. Additionally, potential implementation strategies for 3D virtual prototyping as discussed.

The research report states the possible impact and implementation approaches of 3D virtual prototyping for the big luxury fashion industry brands. To conclude, the conducted research confirms that 3D virtual prototyping is a feasible approach to decrease wasteful sample production by luxury fashion brands. Successful implementation of 3D virtual prototyping can also help to reduce a brand’s carbon footprint in the long term.

Word count: 6477
**List of abbreviations**

CAD - computer-aided design

SMS - salesman sample

RTW - ready to wear collection

CMT - cut make trim
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1.0 Introduction

1.1 Rationale

Product development is the strategic planning of styles using main areas of design, technical development, quality testing, production and distribution. It is one of the most important parts of the business as it translates ideas and designs to a finalized garment (Parker-Strak et al., 2017). In order to make a garment in the best fit and quality possible, designers and developers have to make and rework each garment multiple times before finding the best production-ready style (Tyler et al., 2006).

During my internship in product development, one garment was sampled up to 7 times, each consuming fabric, labor and trims. At the end of the season, developers have numerous samples in stock that are not usable and have to go to waste. Reverse Resources (2016) shows the same sampling is used for factory tested samples before shipping garments to the brand. Brands end up destroying garments that did not meet the required quality or did not sell during the season (Global Fashion Agenda, 2018, pp.55 and 57). This problem is especially visible within the luxury fashion segment. Companies assume discounting samples does not protect their intellectual property and brand value, therefore, brands destroy their stock by burning it or throwing it away (Pinnock, 2018). Consequently, lose millions of euro a year and leave a massive footprint (Dalton, 2018).

As fashion is a large contributor to pollution, consumers mostly focus on the production quantities (Fashion Revolution, 2018), rather than overproduction of samples. Shockingly, multiple Chinese factory managers identify product samples as the main waste problem without any possible solutions available (Lau, 2015). Entrepreneurs started imagining how 3D virtual prototyping can help to reduce the overproduction of samples. Instead of producing unused samples that require a lot of resources, companies are investigating 3D virtual prototyping to make the majority of samples digitally. After years of development, software companies such as CLO 3D, Lectra Modaris and Browzwear are advanced enough to revolutionize the industry (E and N, 2017).

1.2 Aim

The aim of this report is to investigate the implementation and impact of 3D virtual prototyping software on the reduction of the luxury fashion sample waste problem during the product development phase.

Product conducted from research report is going to be a step-by-step implementation guide for luxury fashion brands.

1.3 Questions:

To what extent is it possible to implement 3D virtual prototyping at large luxury fashion brands to lower the number of garment samples produced?

- How does a traditional design and development process work in a big luxury fashion brand?
- What is virtual product development and how does this process differ from the traditional product development process?
- How can 3D virtual prototyping technology be impactful and useful within the luxury fashion brand considering key characteristics, measurable impact and limitations?
What are possible implementation approaches for 3D virtual prototyping in the luxury fashion brands?

1.4 Methodology:

To be able to answer the main research question, primary and secondary research were obtained through sub-questions research. Then, results compared by creating an excel sheet with an overview of key characteristics and differed between product development processes.

In order to elicit the traditional product design and development process within the luxury fashion brands, triangulation methods are used. An analysis of existing literature from books and journals was used for a basic understanding of luxury fashion product development processes. To validate the literature findings, primary research was conducted. Data was acquired through observations during my Product development internship at Acne Studios and an interview with my manager. Observations were translated into a timeline table and key characteristics overview. Furthermore, semi-structured interviews were conducted with product developers working at Givenchy, Balenciaga, Calvin Klein, Burberry and APC. Interviews with product developers helped to contextualize the findings from secondary data and own conclusions into structured observations, timeline and conclusions that were portrayed into characteristics and timeline tables.

Further information into technology was done mainly by secondary research and validated by primary data. Secondary research was obtained by multiple research papers, journals, books and business case studies. All the collected data was translated into exceptions, illustrative findings and drawing main connections and correlations. In order to validate researched limitations and benefits, technology expert interviews were transcript into notes to draw conclusions. Findings from both primary and secondary data were analyzed by comparison of traditional product development processes.

To understand the virtual product development process, secondary research data was supported by primary data. The required information was obtained from books, journals, articles and websites. All gathered information was translated into theory confirming timeline and creating similarities and differences between the processes table. To further understand and validate the secondary research, professional talks with virtual development experts and researchers were conducted by taping the conversations and converting them into a transcript of notes.

Additionally, technology implementation research was fully covered by secondary research data. Data was collected in the form of business journals, podcasts and executive panel discussions that were conducted by journalists and consultants. Data was drawn into interpretations. All the gathered secondary researched served as important validation and satisfying base for implementation conclusions that were illustrated into 3 implementation approaches figures.

1.5 Structure:

The research report starts with an analysis of the importance of the topic, research questions based on the background study, as well as, methodology indications for research methods.

Secondly, the analysis of traditional product development at the luxury fashion brand can be found in chapter 2. Key activities, process timeline and limitations are defined to understand the traditional product development process. All the information obtained from the literature review is supported by interviews with product developers from the luxury field that are analyzed throughout the
traditional product development chapter. A clear summary of the processes and the changes needed in order to become more efficient and sustainable is also provided.

The third chapter, 3D virtual prototyping, analyses the technology by defining its capabilities, measurable impact and limitations, supported by literature and expert interviews. A clear understanding of technology and its potential impact on the luxury fashion industry is generated.

The fourth chapter, virtual product development, dives deeper into virtual product development supporting obtained research from 3D virtual prototyping technology and provides an overview of the virtual product development process. A comprehensive summary of key differences between traditional and virtual product development and the advantages of virtual product development are presented.

The fifth chapter, implementation, provides an understanding of the industry's current state and the possible approaches to 3D virtual prototyping in order to solve the sample waste issue. Using the research and understanding of how luxury fashion brands operate and considering limitations of the technology, 3 different implementation approaches are drawn to serve as a basis for the implementation report.

Finally, conclusion, limitation and future work summarizes results from the chapters, provides indications of limitations and future possibilities and answers the main question of the research: to what extent is it possible to implement 3D virtual prototyping in order to reduce the number of samples produced within big luxury fashion brands.
2.0 Traditional product development

It is important to understand and define the traditional product development process in luxury fashion brands. The following chapter defines product development key activities, problems, and digitization possibilities. The traditional product development process in luxury fashion brands is analyzed, indicating key departments and characteristics and an overview of the product development timeline, provides a clear research foundation and subtopics. Understanding the traditional development process will create a clear foundation for understanding virtual product development and 3D Virtual prototyping implementation.

2.1 Product development

The product development processes in a fashion brand provide the necessary steps to bring a product to the market. Key decisions on product creation are made as silhouette and fit preferences, color and fabrication choices, as well as quality and make of the products. During this period multiple people are involved (Appendix A). Product development is a key role since they are responsible for style sampling. As product development encompasses broad responsibilities and processes, product categories are created around teams to have a consistent and efficient workflow. Typically, tailoring and suiting fall into one category, knit, jersey and fleece into another, and denim with outwear have different teams. Depending on the range of a fashion brand and price point, the product development process can last from 12 to 30 weeks (Berg et al., 2017). As seen in Figure 2.1, fast fashion brands bring products faster to the market and product development is not necessarily the focus point. In contrast, luxury fashion brands usually spend longer on developing their collection to define artistic directors’ vision, quality and shape makes the product more special.

![The duration of an end-to-end fashion cycle widely varies by company.](image)

Figure 2.1: The duration of an end-to-end fashion cycle widely varies by company, source: Berg et al., 2018a

2.2 Current state in the luxury fashion brands

Luxury fashion product development differs from low or mid-range brands by focusing on the creativity of the artistic director and their experiment execution rather than various commercial styles (Berg et al., 2018a). In order to understand the processes better, interviews with product...
developers from luxury fashion brands A, B, C and D were conducted (Appendix A). These showed the artistic directors have the last say, meaning designs can be changed or cancelled as the artistic director decides. Luxury fashion brands’ unique selling points consist of quality, creativity, and durability. In order to achieve that, product developers, pattern makers and designers work closely to create the best product possible. As shown in figure 2, the process starts when the artistic director briefs designers who then start sketching, creating mood boards and fabric choices. Then product developers are briefed and first prototypes are launched. Prototypes can be made either in in-house ateliers or outsourced to suppliers - predominantly in France, Italy, Portugal or Eastern Europe depending on the style and factories specific skills. Prototype sampling lead times vary by category; Denim up to 10 days and trousers as little as 3 days. Once the prototype is received, a fitting model, designers, pattern makers, and product developers are collectively work on creating the best silhouette and fit possible. As the luxury fashion brand B product developer mentioned, one style can be made up to 5 times. Luxury fashion brand D product developer confirmed during the season, one style is fitted on average 3 times. If a designer does not make final decisions on fit, fabric or mood, the style gets canceled. Once these key decisions are made and the technical make of the garment is defined, Sales Man Sample (SMS) is manufactured.

### 2.3 Key product development characteristics

Product development key characteristics consist of pattern making, sampling, material sourcing, fittings, prototype making, product inspection, and manufacturing. As (Fung & Choi, 2017) demonstrated in Figure 2.2 below, these key characteristics define production ready garments.

![Diagram of luxury fashion brand product development](source: Fung & Choi, 2017, p. 30)
During the development period, sourcing starts with designers briefing the team on material inspiration and needs. The sourcing team communicates with various suppliers and manufacturers who provide options, lead times and prices, which are provided to designers to decide upon for the upcoming season. Efficient sourcing provides high-quality materials and freedom of choice for designers, however, it is also an expensive and time-consuming process that slows down product development (Y.-N. Fung & Choi, 2017).

Sampling period provides a clear glimpse and understanding of the collection and how styles have to be executed, yet the process is costly and wasteful. According to a luxury fashion brand D, product development budgets can be up to 1 million euros for one collection.

2.4 Sample management

In the product development process, sampling is one of the most important, resource and labor intense activities (Parker-Strak et al., 2017), making sample management a crucial topic. Interviews confirmed wasted samples and prototypes are of large concern for brands. “We do work sometimes and spend enormous hours on garments that are just going to be wasted” according to product developer from brand D. One product category can have up to 25 unused samples that either are given away, sold during company sample sales or thrown away. Luxury brand D product developer stated 60% of the samples and prototypes produced are thrown away due to lack of space to store the samples, amendments made during the fittings or inadequate quality of the samples. The destruction of these garments not only leaves a substantial impact on the environment but also carries a financial and efficiency burden. As mentioned in Quantis (2018), neglecting sample management issues will bring vast financial and environmental problems that will affect the way businesses and brands are operating.

2.5 Sustainability

Recently, sustainability became a major topic in the fashion industry (Global Fashion Agenda, 2017). Luxury brands like Chanel, Burberry, Stella McCartney have hired sustainability executive teams and publish annual social responsibility reports (Arrigo, 2015). However, interviews showed luxury brands are slow in adapting changes to become more sustainable. Product developers also indicated the change towards sustainable solutions is not the priority for designers and managers in the brands. Nonetheless, pattern makers are starting to shift to digital pattern making in order to become more efficient and reduce the resources needed, according to luxury brands A, B and D. When a paper pattern is handed to the sampling facility, factory employees digitize the patterns in order to be able to cross-check and update them. As a result of that, digitization and pattern updating takes up to 1 day and slows down the sampling process. To counter, brands started educating and implementing a digital pattern making in their internal process, according to brand D.

2.6 Summary

The existing product development process in luxury fashion brands generates substantial waste and has long product development cycles. From interviews and literature it became clear: product developers are aware of the existing waste problems, yet, it is not the main priority. Few companies started to digitize pattern making processes in the interest of efficiency, not necessarily sustainability. Thus, digitization of product development would give a big impact further research of the 3D virtual technology follows analyzing its impact and limitations for luxury fashion brands.
3.0 3D virtual prototyping

Within the scope of research, as traditional product development is defined, it became clear that the need for new technologies in order to solve sustainability issues are rising. Further, specifications of the 3D virtual technology, the measurable impact are defined and possible limitations are named. This research provides a clear understanding of 3D virtual prototyping technology, its advantages and potential significance for luxury fashion brands.

3.1 Technology

3D technology from early 1990 was introduced to different industries, such as architecture, industrial design or aerospace (Gal, Lyytinen, & Yoo, 2008, pp. 295–300). Over time, demand for 3D technology increased across different industries including the fashion industry. Today, the pressure of speed and fast production shapes how the industry operates and the consumers’ raising awareness of sustainability make fashion brands question their traditional methods (Fashion Revolution, 2019). Besides cost and waste reduction, speed to market and improved communication, are further benefits of 3D virtual prototyping.

Virtual sampling technology creates a three-dimensional photorealistic product that enables real-time editing of the pattern, 3D image rendering and preview of errors and possibilities of fit and silhouette (Li & Fung, 2018). Virtual prototyping can be categorized into two categories based on the working procedure used to create 3D designs. The first group allows designers to develop garment silhouettes and styles in a photorealistic manner (Appendix B). Another group of technology allows CAD patterns to be stitched around a virtual model to visualize virtual fit and simulate fabric drape and fit (Kamal, 2015, pp. 416–417). This group of technology includes software companies such as VStitcher from Browzwear, Modaris 3D FIT from Lectra and 3D Runway from Optitex (Sayem et al., 2010).

3.2 Measurable impact

The following chapter 3.2 and sub-chapters 3.2.1, 2 and 3 analyzes the measurable impact that results once 3D virtual prototyping is implemented. The impact is going to be analyzed by key subjects that are important for luxury fashion brands.

3.2.1 Prototyping

Luxury fashion brands produce numerous prototypes in order to be able to test the fit, fabric and overall collection dynamics. However, this process is very expensive. Prices for producing prototypes can vary from 100 to 1000 euro depending on the fabric, the complexity of the style and facility where it is produced (Johanson, 2002, pp. 5–7). When using 3D virtual prototyping errors can be detected faster and fit can be adjusted on designers wishes instead of sending the prototype back to the sampling facility (Cobb et al., 2017). Since brands can make decisions on whether the garment should be produced with fewer prototypes, the cost of canceling the style is also significantly lower (Iqbal, 2012, pp. 30–32). During an interview with 3D designer and pattern maker, Daniele Manassero from Miroglio fashion label, he confirmed 3D virtual prototyping technology reduces not only the costs but also a number of samples produced from 3 samples on average to 1.2 (Appendix B). Some key elements like variations of colors, print placements, and fabric variations can be tested digitally. According to Daniele Manassero, when virtual prototyping was implemented, Miroglio was able to sell the collection more cost efficiently when showing one physical sample and all the
possible variations of color, print placement and size sets digitally instead of producing all of the samples.

### 3.2.2 Speed

Speed is encouraged in the luxury fashion brands by competition from the so-called “fast fashion” companies like H&M, Inditex and Primark are able to produce the replicas of styles showed on the luxury fashion brands’ runways within weeks. While luxury fashion brands take months to present showcased samples in the retail stores. Revenues of these companies rose 8.2 percent in the last years, whereas luxury brands’ revenues grew only about 3.5 percent in that same period (Berg et al., 2018b, p. 2–3). 3D virtual prototyping could be a beneficial solution for the luxury fashion brands as long as they are willing to shorten the fashion calendar with the implementation of digital prototyping would make planning, design and development processes way faster.

Nevertheless, speed is required for internal communication and process as well (Heyn et al., 2018). Long unstructured processes while designing and developing affect the communication between the designer and the product developer creating unnecessary inefficiencies throughout the process. As seen in the interview with Luxury fashion brand D, long processes and high overlaps produce confusion between designer and developer resulting in numerous samples and last minute touch-ups or even finishing garments in the backstage of a fashion show. 3D virtual prototyping can distribute the workload more evenly and each product developer and designer can focus on their product category, which makes the workload more focused and efficient (Johanson, 2002, p. 9). That can result in improved speed to the market, more structured collections and better communication between designer and developer as results can be visible instantly in a photorealistic garment. A better-focused collection and work means better communication between a brand and a supplier making internal inefficiencies disappear.

### 3.2.3 Carbon Footprint

If brands test size sets, color variation and fit of the style digitally using 3D virtual prototyping, fewer prototypes have to be sewn and significantly less fabric is used during design and development phases. Consequently, sizes of the styles can be tested more thoroughly on digital fitting models that can be adjusted to the customer sizes resulting in fewer returns once sold in the retail shops (Fiore, 2008). Furthermore, digitally simulated collection reduces the energy used for manufacturing and shipping the collection and the number of materials, water and chemicals used for preparing, dyeing and treating the sample fabric. If patterns are made in CAD systems, it calculates the automatic inlay leaving less wasted fabrics when patterns are cut. Overall, digital solutions during design and development phases significantly reduce the brand’s carbon footprint up to 30% and help to achieve sustainability goals (Iqbal, 2012, pp. 32–33).

### 3.3 Limitations

Limitations and restrictions of virtual prototyping need to be considered for a successful implementation of the technology.

The luxury fashion industry is based on a tradition and craftsmanship that was developed over years of practice (Lo & Ha-Brookshire, 2018). Digital prototyping requires different skills to be implemented. Not only pattern makers have to be highly skilled but digital savvy as well. During the professional interview with 3D technology researcher and professor, Evridiki Papachristou pointed out luxury fashion companies are reluctant for a change and investment into 3D product development technology due to well-trained professionals who developed their skills over years of
practice and prioritize craftsmanship and tradition. Working with 3D CAD software means developing a new set of digital skills that could frighten conservative luxury designers (Amed et al., 2017). In order to implement the technology, some key factors have to be taken into account. Firstly, the mindset change of the current employees in the company has to be addressed. Secondly, costly staff training planned or consideration of hiring new skilled staff members can undertake digital development. However, that would possibly eliminate the jobs of the professionals who worked in a brand for years (Quantis, 2018). Luxury brands executives are reluctant to the upcoming changes in the product creation process due to the tradition as a standard that these companies hold, however, the demand for new technologies has to be considered in order to reach the set sustainability goals in the upcoming years (Setchi et al., 2016, pp. 3-10). According to Luxury brand A product developer, in contrast to fast and mid fashion companies, designers are considered as a backbone of the brand, meaning changes have to be approved by designers. The lack of proof of success and designers’ unwillingness causes major limitations that withhold companies from implementing 3D Virtual prototyping technologies in the creation process (Joosten, 2016). This emphasizes the importance of research and validation made by 3D technology experts as a support to assist companies to provide the possibilities that 3D virtual prototyping has to offer not only for product developers as well as designers and technical designers.

Nevertheless, senior apparel 3D Lead at PVH Orla Cotter implied fabric library and usage in 3D software are not to the highest standards yet. Some fabric qualities are easier to simulate than others. That raises the question of whether 3D virtual prototyping technology can dominate product development processes in the future. However, Orla Cotter added there are multiple startup and software companies trying to solve the issue by implementing new fabric scanning, measuring and processing technologies can help to reduce the misalignment between the physical and digital sample properties. Consequently, that could be a possible solution for the implementation of digital prototyping and reduction of the samples, yet, those technologies are still under development and testing processes and will take some time till it can be fully integrated. In addition, physical samples are still required for the fashion brands in order to test production facilities capabilities and quality. Taking this into account, it becomes difficult to imagine how possible would it be in the long term to fully digitize the product creation process and eliminate all the samples manufactured (Papahristou et al., 2011).

### 3.4 Summary

3D virtual prototyping has multiple crucial aspects that make it a relevant solution for the luxury fashion industry. As the need to become more sustainable is inevitable for every apparel brand in the industry, luxury fashion brands have to consider adoption of the technology. 3D virtual prototyping distributes the workload more evenly and efficiently as well as decreases brand’s carbon footprint. However, for the 3D technology to be implemented, it is crucial to create a feasible implementation strategy that fits everyone involved in the product creation process. In order to understand the implied technology, further research into virtual product development and its specifications follows.
4.0 Virtual product development

In order to be able to compare and understand the main difference between the traditional product development and virtual, key characteristics, timeline and process of virtual product development need to be identified. This chapter provides a clear overview of differences and possibilities for a virtual process that will serve as a validation of possible 3D virtual prototyping.

4.1 Process

As demonstrated in Chapter 2.2, traditional product development starts with the product developer delivering tech pack information with garment specifications to the sampling facility. Subsequently, operators cut, make and fit the style and send it to the brand. Once received by product developers, the sample gets fitted on an actual model, corrections are made and the sample is sent back to the facility. This process lasts until the final fit is approved.

In contrast, as indicated in the figure 4.1 that was made from obtained research, the virtual product development process is more efficient and requires fewer resources.

Figure 4.1: Traditional versus digital product development process timeline
The pattern is made in CAD software by pattern makers and sent to the 3D operator responsible for the simulation of the garment in the 3D Virtual prototyping software. Once the garment is stitched digitally on a virtual avatar, fabric properties and technical details such as seam specifications, trims and finishings are applied. Once the style is fully rendered, fitting takes place with designers, product developers, 3D operator and pattern makers. Instant corrections and adjustments are made during the fitting. Once the fit is approved, 3D operator and pattern maker finalize production-ready patterns and physical sample can be made (Kamal, 2015, pp. 420–423). This process requires less time as garment adjustments can be made instantly. Virtual development process saves on average 2 to 3 samples per style (S. Fung & Pruzan-Jorgensen, 2018).

### 4.2 Key characteristics

The virtual product development process is faster compared to traditional product development as it reduces the time spent to develop production-ready samples by 50% (EFI & Optitex, 2018). Virtual sample review allows designers to see the finalized styles instantly, and immediately correct pattern and fit errors (Appendix B). Grading of the garment to desired sizes is done once the patterns are finalized and can be tested on a virtual fitting model to ensure the fit (Sayem et al., 2010). Producing samples digitally means no needed additional shipment of samples and using virtual product development means less paper is used as patterns are drawn virtually. Additionally, pattern inlay is calculated automatically reducing the number of fabric wasted (Papahristou & Bilalis, 2011). However, virtual product development integration requires training that slows the process short term. In the long term it provides clear advantages and possibilities (Papachristou & Bilalis, 2017).

### 4.3 Traditional versus virtual product development

To compare traditional versus virtual product development processes, table is made for overview: (1) efficiency to understand how long it takes to make a sample; (2) resources that include materials, like fabrics and trims; (3) samples to understand how many it takes to produce a final garment; (4) waste during sampling period; (5) proficiency, how long it takes to learn the skills and how it affects the lead time of the collection.

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<th>Traditional and virtual product development overview</th>
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Table 4.1 Traditional and virtual product development overview
As found during interviews, depending on the sample complexity, sampling facility, and product category, it takes from 3 to 10 days to produce one sample. On the other hand, depending on CAD operator skills and volume of work, the final sample results can be visible from 1 hour to 1 day making it easier to use during the fittings and make final decisions (Lee & Park, 2016, pp. 62–65). Virtually rendered garments need significantly fewer resources compared to physical sampling. However, sampling in the factory is vital for cost and material consumption estimation, meaning even if virtual development is implemented, a few samples have to be produced (“Sampling Process in Apparel Industry,” 2018). Lastly, traditional product development is faster short term due to developed skills over time, however, long term it is clear that virtual prototyping is more efficient and in order to reach that, proficiency in the software is vital.

4.4 Summary

Virtual product development not only reduces the time spent to develop the collection but also helps to reduce waste generated. Some key decisions can be made more efficiently and earlier in the process reducing the risk of wrong decisions cause longer lead-times. In order to implement the process, further research into implementation approaches and business objectives are made.
5.0 Implementation

Implementation approaches and objectives for luxury fashion brands is the last chapter of this research report. In order to find the most suitable approaches, findings from chapters 2, 3 and 4 are translated into an overview of a current state and business objectives lead to implementation strategies. While taking into account goals and objectives, the three most suitable approaches will be considered including limitations and benefits to find the best strategy. Considering all the technical aspects, implementation strategy will not be considered for Haute Couture line due to rules of the collection.

5.1 Current state

Over the past few years, luxury fashion brands started focusing on building more innovative organizations by hiring new digital and sustainability executives to reach their estimated goals (Woodworth, 2018). Most of these executives focus either on direct to consumer operations, namely, retail, marketing and customer service or logistics and supply chain traceability (Bughin et al., 2017). Therefore, significantly more people started covering the opportunities of the digitization in the product planning, creation and development fields. Digitization in the design creation process has the biggest return of investment potential (Berg et al., 2018b). Once a company invests money into the digitization of the product, brands can start achieving sustainability goals faster, become more traceable and be able to implement “see now-buy now model” and all the other possible innovations more accurately (CB Insights, 2019). All the coverage about the importance of product innovation made companies reconsider 3D Virtual prototyping and start implementing it from big brands, like Nike and Adidas, to H&M, PVH to name a few (EFI & Optitex, 2018). Since the software is in test runs, a lot more information is accessible about the implementation, multiple new use cases appear, financial reports after using the technology and research papers are published. Since more research appears and companies share the knowledge, there is a bigger possibility of luxury fashion brands to start identifying 3D Virtual prototyping as a possible solution to implement change (Appendix C).

Considering all the limitations researched, this chapter will provide a better understanding of how 3D Virtual change can be applied to a luxury fashion company, keeping all the possible limitations in mind.

5.2 Business Objectives

This report sets business objectives for a luxury fashion brand that has not implemented 3D virtual prototyping and related technologies into product design and development stages yet. Defined business objectives are formed for the three possible implementation strategies of 3D virtual prototyping technology for product creation processes in a luxury fashion brand (Appendix C).

Key implementation objective is to reduce garment sample production to one sample per style through the implementation of 3D virtual prototyping. Business objective results are divided into sustainability and business results. First of all, fewer resources, such as labor, trims, logistics, fabric and paper will be wasted. Therefore, CO2 emissions will be decreased, reducing brands’ carbon footprint by at least 15%. Further business results entail the increase in product design and development speed by at least 30% and lowering dedicated budgets by 50%.

Regardless of the implementation strategy, company restructuring, changing development and design timeline are needed in order to ensure the successful implementation, supported by employee negotiations, management trust and supplier training. On a cost level, budget restructuring is needed to acquire software licenses that cost somewhere up to 10,000 euros.
depending on required features, luxury fashion brands have already acquired capable computers that can store the programs. Possibly one time investment is needed for high-resolution screens for virtual fittings that can cost up to 5,000 euros. In addition, employee trainings are needed to ensure efficient day to day operations that can cost from 70 to 3,000 euros. Since the budget would be decreased by 50% because virtual prototyping reduces the samples produced in half, the possible investments into the technology can be done.

Depending on the implementation strategy, the time frame of the restructuring of product design and development process can vary from two to five collections, alongside with regular day to day operations.

5.3 Implementation approaches

There are multiple implementation approaches to how innovation strategies can be implemented in a big luxury fashion brand. The success of approaches depends on the companies’ organization structure and financial prosperity. Further research is done into 3 different strategies to understand which one of them can be beneficial for luxury fashion brands in order to implement 3D virtual prototyping.

First approach: top-down by creating an external team (Appendix C)

The first approach requires executives of the brand to identify sample waste as a problem and 3D virtual technology as a solution. Once the problem identified, executives create a 3D team consists of in-house designers, developers and pattern makers, as well as, new external professionals. This team develops the basic skills and knowledge required for 3D prototyping by taking over the making of commercial styles that merchandiser proposes for the collection. Once the commercial styles get designed smoothly and all the feedback and knowledge is up to date, the collaboration of the 3D team and the rest of the in-house designers can start by creating ready to wear styles together. Finally, after aligning the working methods and skills, the 3D team is merged with the in-house brand and all the daily tasks are shared between both of the teams.

Second approach: top-down by hiring technology professionals for training (Appendix C)

Once the sample waste problem is identified by executives of the brand, managers hire 3D virtual prototyping technology experts to teach the selected team by involving more people each time. Once the skills are developed, the team can start working on commercial styles and creating a database of patterns and shapes while receiving feedback from the professionals. Later in the process, involving the whole team on integrating 3D virtual prototyping into daily processes independently.

Third approach: bottom-up by getting departments interested and asking for management support (Appendix C)

The third approach requires employees in product creation team to get interested in experimenting with the technology and sharing skills and possibilities with the rest of the team. Experimenting with own or brand garments to develop the skills, slowly introducing the possibilities and recommendation for the rest of the team. When capabilities are defined, introducing the software to the management team by asking support and financial possibilities to help the team innovate based on the findings.
5.4 Summary

Depending on the brand and its structure, all of the approaches are possible for 3D virtual prototyping implementation. However, as understood from the interviews with luxury fashion brands product developers, the third bottom-up approach would work as the best option. Luxury brand A and D product developers agreed as long as they see the potential and results that technology has to offer, convincing designers and executives becomes easier. Starting to learn the program and slowly implementing the technology based on their needs and capabilities would serve as the most successful implementation approach. As the technology and fabric properties improve, commercial styles and ready to wear collections can be fully digitized.
Conclusion

Currently, traditional product development produces a lot of waste and brands focus more on making the process efficient rather than sustainable. Furthermore, luxury brands process cycle takes double the time compared to other players in the industry, making it harder to compete with competitors and counterfeit styles.

The virtual product development process and 3D virtual prototyping increase efficiency, making product development cycle faster. By digitizing samples, instant changes can be done instead of sending adjusted samples back to sampling facility and waiting to receive a new sample. That leads towards more sustainable collections. However, 3D virtual prototyping technology is rather new to the industry, meaning it is not applicable to all processes yet. That is changing fast, as the demand for technology is increasing, the first implementation for commercial styles can be fulfilled already. As technology progresses, it can replace traditional processes further. The first implementation will already benefit brands as fewer samples will be produced, making design and development processes more sustainable. Whilst the applicability and technological fit of 3D virtual prototyping is given, its adoption also hinges on the implementation strategy brands put in place.

Designers in luxury fashion brands tend to be reluctant to change, and prefer to adhere to their traditional ways of working. A bottom-up implementation overcomes this hurdle by allowing designers and developers to be involved, set own requirements and have a steeper learning curve. This leads towards more efficient implementation as the designers would be more open to change and find compromises.

Ultimately, transitioning away from the traditional product development cycle to a digital one is largely feasible. Whilst technology has certain limitations, it can be operationalized for certain commercial styles. Once the fabric properties are approved and designers are more confident in 3D virtual prototyping, ready to wear styles can be gradually digitized as well. Along with a bottom-up implementation, it will also find large adoption amongst designers. This results in a drastic efficiency increase for the brands whilst reducing a brands carbon footprint. This technology not only improves operational processes and fulfils designers by providing technology adapted to their needs, but also bears the potential to revolutionize sustainability in luxury fashion.

Limitations:

During the research, a few limitations occurred. First, it is rather hard to find publications on product development in luxury fashion brands. Consequently, analysis on traditional product development was based on interviews obtained and personal observations from Acne Studios internship that were verified by internship manager. Furthermore, implementation costs were hard to calculate, as sampling costs were challenging to attain. Hence, rough estimations are provided only to understand the budget needed for possible implementation of the technology.

Future work:

A possible further investigation into the financial feasibility of 3D virtual prototyping needs to be done. This would indicate proof of the operational possibility and financial advantages if 3D virtual prototyping was implemented.
Reference List:


Joosten, P. C. (2016). *3D Virtual Prototyping to Product Creation Processes in Footwear.* [online] Retrieved from http://kennisbank.hva.nl/cgi/bib/bib-idx?rgn1=entire%20record;q1=Joosten;lang=nl;type=boolean;size=1;c=hvasenp;sort=year;cc=hvasenp;view=reslist;fmt=long;page=reslist;start=1 [Accessed 01 Mar. 2019].


8 Appendix

Appendix A

There are multiple people who are involved in the product creation process, like product design and development. First of all, designers who make sketches, fabric selections. The following pattern makers and technical designers who create patterns and technical specifications of the style, like technical drawings, pattern inlays, digital or physical patterns on paper (Fung & Choi, 2017, pp. 27–40). Depending on the brands’ structure and product group, fabric and trim sourcing teams are involved in order to make fabric and trim selections, as well as, merchandisers to consult the design decisions based on sales and add commercial styles that sold well last seasons in the collection line. During the collection, designers, product developers and pattern makers work the closest. They all attend the fitting session together. Pattern makers give input on technicalities of the garments, designers on visuals, shapes and feel of the collection and product developer usually represent the suppliers’ capabilities, keeping in mind the costs of the collection. During the fitting, the product developer takes pictures and comments that later they translate into a tech pack which is sent to the supplier. Based on comments, suppliers update the sample and send it back. This process continues all the way until the right shape is made. Fabric sourcing manager attends final fittings to help to finalize final fabric decisions. Merchandiser is mainly involved with designer and product developer as she/he is responsible for communicating which styles need to be made from commercial or so-called “continuity styles” in order to earn money.

Product category division mainly depends on the brand itself and how it is structured. One product category manager can have from 2 to 5 different categories. According to product developer from brand D, he is responsible for the following categories: denim, trousers, tailoring and leather.

Luxury product development process timeline made by me from literature data, my own experience from Acne Studios and interviews.
Interviews with luxury fashion brands A, B, C, D.

Luxury Brand A

Key takeaways:
In fast fashion and mid-range brands, product managers/developers are as equal as designers. In luxury fashion brands, designers have the last say. That is why it is easier to convince product developers but all focus is supposed to be directed to designers.

Design:
Designers like fittings, it is an integral part of their job. Using 3D means eliminating a job that they really enjoy. Implementing digital prototyping means changing the system how they worked for a
very long time and that change requires a lot of social change. Technological acceptance model. That's one of the things that could help.

3d virtual prototyping could work for commercial designs. However, it wouldn't work for the runway or conceptual pieces.

One of the main important points when designing are fit, color, fabrication and details. The key thing is to see if it all works together. Sometimes, for example, the fit might not work but everything else balances it all out. So decisions are made accordingly. That can be tested only by doing physical fittings. Also, fittings are the moments where designers and pattern makers work together. As well as, when it comes to conceptual garments, patterns might be odd and complicated, that would be hard to visualize and render.

There are two levels of pattern makers:

Creative pattern making - they make conceptual, difficult patterns
Production pattern makers - production ready ones.

Perhaps, the implementation of 3D could start from production pattern makers.

One of the interesting points: the car industry makes small scale clays out of actual material for car models. In that way, they test designs and quality to see if it works. Question: If the car industry, which is a billion euro industry, uses physical samples, maybe there is a good reason for that.

During fittings, you use actual fitting models. You get attached to them. One of the reasons for fitting, models is to see the “vibe”, “feeling” that collection gives you. Putting garments on an actual, real person makes it much more understandable. However, if you design a specific design for a specific fitting model, some fit flaws can come up. There is no perfect fitting model. One can have broad shoulders, other long arms and etc. and it usually doesn’t resonate to an actual customer. That’s why sometimes some decisions are made, purely because of the fitting model, and that wouldn’t look the same as it is in on the shop floor.

One of the examples is a fitting model that we used. He had broad shoulders, meaning that some designs were based on his look and the fit was not correct. The garment didn’t sell at the end.

**Skipping steps:**

Our brand used to do counter samples. These samples would be made in bulk fabrics and trims. The main idea of this fitting was to make sure that overall all look great, however, there was an agreement that fit shouldn’t be changed. 1 out of 10 times we would change the fit because it wouldn’t make sense or mistakes would be visible.

Before we used to do counter samples that would be a sample that would go before shipment sample, everything would be made in the bulk fabric, bulk trims, that would be to see how the final collection looks like, how it comes together. At some point, the head of the product decided to stop doing counter samples because of money and time spent on it. However, what they realized after eliminating counter samples that actually that was very important. You shouldn't skip this step for quality checks, they are very important.

**Reliance:**

In order to fully integrate it, the software has to be bulletproof. Fashion is a very conservative business, especially when it comes to luxury and design. The design is a craft. You have to be 99% sure that it works in order to use it.

Using 3d means, eliminating part of the jobs that people love. Focus on the social aspect to realize how to help to overcome that.

**Luxury Brand B**

**Timeline and process:**

The art director gives input and briefing to the designer. Designers make fabric and styled proposals for the first protos. Developers make those protos happen and the collection is gradually growing
with upcoming fittings: comments from AD to refine previous choices, add-ups, cancellations, new style attributions on approved fabric groups. Along the way, the merchandising team adds a selection of "commercial" styles that also need to be approved by the art direction. It usually lasts 3 month total for a single collection but this changes all the time due to an evolving organization. I think properly split the collection between different factories without knowing what will be approved or rejected by design. We need to make sure the factories understand how we work and align their interests with ours to make sure development gets rewarding for everyone.

Sample make:

Usually, styles for which the fit is really important are sampled a lot until the shape is perfect. And even more, samples might be ordered along the way if the decided measurements are not carefully followed by factories. Known styles are usually ordered once or twice to have different factories options but rarely more. For my product category (denim), we usually outsource all proto making to factories. But other product categories rely a lot on the atelier in-house. I think classical woven products mostly. Jersey and knit is all done in factories, as well as, denim and shoes and accessories since it takes special equipment.

It was following the same rule at most places I worked for. All that could be done in-house was done in-house. Acne was the exception since I don’t remember a lot of protos being done in house. It takes 10 days on average but some factories have large sampling capacities so they can accept as much as 30 or more samples to be made in the same 10 days timeframe.

Sample management:

On rare occasions, it is offered to the staff but the most of it is kept in a warehouse to be sold to company’s employees at large sample sales later in the year when the actual productions as reached stores. Some very visual styles, if canceled by the art direction get destructed to avoid any chance of being seen with the brands’ logo on it. Lately, it started happening quite often, unfortunately.

Samples wasted: In a real creation oriented brand it is a good 60% or more.

Sustainability:

It affects us gradually, meaning that new "sustainable" or "eco-friendly" objectives are adding up along the way. For now, we are challenged with the fabric sourcing (has to be organic, has to avoid waste of water using different washing techniques, has to use recycled fibers and so on) but when that is taken care of I am sure we will be challenged at other levels. Very important as we see the styling and creative decisions being made on ecological grounds more and more often. Such fabric gets selected because it’s organic for example although another one looks nicer. At development we mostly take into consideration what matters to our art direction since we can’t really move forward without their approval. If that’s organic then web source organic fibers, if that’s saving water then we look for waterless washes.

Problems:

My biggest issue is the fact that mills won’t bother weaving a good fabric with organic cotton unless some brand orders a huge order (usually from 3000 to 10000). But we can’t go that far since we need to make sure we will have a need for this fabric. Knowing that there is a high possibility of the fabric group being canceled even before showrooms... It would be great if brands could collaborate to place fabric orders together to have it all organic.

Yet it is complicated to action since all brand must show some kind of exclusivity with regard to fabrics used. But it is plain stupid as long as the customers do not mind where the fabric is from or
what fabric that is. I mean it is not like brand advertises the name of their fabric supplier or anything it looks just the same for most people. Of course, I work for a product category for which it is truer than others but that is an issue I am facing when trying to turn a good fabric into the good organic fabric.

Digitization:

We heard quite a lot of conversations about it and the importance of the programs. Most of our samples are made in a paper pattern but we are trying to switch to digital patterns as much as possible because it is easier to communicate them to the factory. I see digital change as a good possibility but it would take time to be implemented.

Luxury Brand C

Process:

Even though we are considered as a luxury fashion brand, our structure and hierarchy are more like a mid-range brand. Our artistic director is an owner of a brand as well, he does have a lot of say during the process but developers opinion and say is very important as well. If the style is already launched but he wants to change major details or fits, a developer can say no to him. In the previous brand where I worked, you couldn’t say no to a designer at all. The process works quite efficiently, it takes around 20 weeks. Collections are made of 60-70% carryovers that would not need a prototype. For the remaining 30%-40%, one single proto would usually be made in house to ensure the style is approved before having the factories do it. The timeframe was 6 collections a year. The main issue in product development is making sure to have the actual sample delivered in time for the editing since we usually ordered samples only once. A missed delivery usually meant the cancellation of style altogether. That is very expensive and useless. It is only a handful of the first protos that need be dealt with since the majority of prototypes actually become SMS.

Sample problem:

One of the very big problems we have is to understand and find solutions for canceled styles. Sometimes we would have over 30 canceled styles. They would all be produced in different colorways and would have 3 SMS each. We can’t sell them, so we would either do in-house sample sale or throw them away, depending on the logos and branding.

Sustainability:

We are prioritizing sustainable organic fabrics as much as possible, however, it is still not a major priority. Hopefully over the time, we will be able to become as sustainable as possible but for now, we are taking only small steps further.

Digital:

Our pattern makers started to adopt virtual pattern making as much as possible. 80% of the patterns are made or at least digitized. Virtual prototyping is not used at all but it could be a good addition for our carryover styles.

Luxury brand D

Process:
Development timeline highly depends on the product group and artistic directors mind. If AD decides to change shape or make a completely new garment, you have to do it. It happened quite a few times that some garments were made at the backstage of the show. One season we had to create 35 different shapes of trousers and only 5 of them made it through and were produced. The rest of them were thrown away. Prototypes and samples that are made are used as prototypes, they are cut through during the fittings and used to shape new designs. Our brand has 1 in-house atelier, 1 haute couture and one for menswear. Because the ateliers in-house are very small, most of the samples are produced in factories. For womenswear, we mainly use France and Italy. If we send a prototype, it can come back already in 3-4 days depending on complexity. Our AD is very demanding and requires to see changes as fast as possible because she works only from Tuesdays till Thursday, so if the sample is fitted with her on Thursday, she already expects to have a new one on Tuesday ready to fit. Once we launch a style, we do pre-fitting with the development team and designers and depending on the quality of the sample and adjustments made, only then we can show it to the designer. If the garment takes too much time to be adjusted, there is a possibility that it will be simply canceled. Because our budget for the development phase is very big (more than 1,000,000 euros per collection) there is a lot of space to experiment. When it comes to suppliers, we send them usually paper patterns, then they take around 1 day to digitize the pattern using Lectra Modaris and adjust it based on our comments, then 1 day stitching and then sending it back to us. My brand is very demanding and requires a very fast pace, that is why we pay our suppliers quite a lot.

**Samples:**

We work on our prototypes quite a lot. If we see that some changes need to be done, we sew on it, cut it and etc. Depending on the style, some of the samples are kept in our archive for reference, some of them are sold in the sample sale for employees and some of the samples are being sliced and thrown away.

**Problems:**

I could identify 4 main problems:

1. Sustainability and respect for the suppliers: at least try to get ethically produced fabrics, now that is not transparent. Also, social aspect towards our suppliers, We do pay a lot of money for their service, however, we sometimes ask them to work very long hours or even during holidays (they were supposed to work during this Christmas because the director wanted to see the collection on the 29th). That attitude should change and flexibility needs to apply as much as possible.

2. A number of samples produced: we sometimes make samples that we can’t do anything with them because they look “last week”. People should start taking this into account because we do work sometimes and spend enormous hours on garments that are just going to be wasted.

3. Last minute changes: we do have moments that we work all night or produce the collection last minute and it doesn’t work long term. This needs to change in order to have a healthy work-life balance.

4. Our samples are produced on a fitting model who is very skinny and usually, it doesn’t resemble the size of the runway model, so last minute changes need to be applied.

**Sustainability:**

Sometimes due to the change of mind from AD, we have thousands of good quality fabric left in the warehouse that ends up thrown away just because the color didn’t fit the overall idea or designer just decided to cancel the style altogether. That is why the level of sustainability in our brand is very low. Maybe 5% of the collection, in general, is produced sustainably but the rest is definitely not.
Our denim is from recycled fibers and we research a lot about new washing and finishing techniques in order to apply more sustainable practices. But overall, the number of sustainable garments are so low that we cannot advertise it or actually use it in our advantage. You can feel this as a very big frustration in the brand because people want to change and don’t want to waste that much fabric, samples or their time.

**Digital:**

We are starting to working with Lectra Modaris for patterns for quite some time, however, knowing the 3D software myself, I believe this could be a useful change for the system. It can definitely help to cut down the number of prototypes produced and especially during first fittings. Also, once the fit is analyzed, instead of producing an actual sample for color or fabric variation, I would love to be able to do it digitally. It is a hard change and especially for designers but I see it as a very great possibility.

<table>
<thead>
<tr>
<th>Luxury fashion brand</th>
<th>Samples produced</th>
<th>Samples wasted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luxury fashion brand A</td>
<td>Did not specify</td>
<td>Did not specify</td>
</tr>
<tr>
<td>Luxury fashion brand B</td>
<td>From 3 to 5 per style</td>
<td>60% of prototypes are thrown away; 40% prototypes stay in the archive For SMS and samples incorrect fabric: sample sales or thrown away, depends on a collection</td>
</tr>
<tr>
<td>Luxury fashion brand C</td>
<td>3 each style</td>
<td>Internal sample sales or thrown away</td>
</tr>
<tr>
<td>Luxury fashion brand D</td>
<td>Up to 5</td>
<td>Either archived, then sold at the sample sale or thrown away</td>
</tr>
</tbody>
</table>

Table 2.1 Interview findings
Appendix B

Development of drape and shape into photorealistic manner. That means that designs are draped from a canvas in the software already. In contrast to other method, where design starts from patterns, here design is visualized from drape. This method is becoming highly popular for designers, as it can replace physical draping.

<table>
<thead>
<tr>
<th>Features</th>
<th>Virtual-fashion</th>
<th>3D Fix</th>
<th>VStitcher™</th>
<th>Ethnic Couture 3D</th>
<th>eFactory Simulator™</th>
<th>Vicya</th>
<th>3D Runway</th>
<th>TPC</th>
<th>TPC 3D Interactive</th>
<th>DesignConcept</th>
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</thead>
<tbody>
<tr>
<td>Wrapping 2D patterns on 3D body</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Developing 3D design on 3D body</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Flattening 2D patterns from 3D</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Realistic fabric draping</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Adjustable mannequin</td>
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<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Dynamic pose/ virtual fashion show</td>
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<td>Online fit session</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Figure 4.2 3D virtual prototyping overview Source: Sayem et al., 2010

VStitcher by Bowzwear:
Source: (Otmazgin, n.d.)

Modaris 3D FIT by Lectra

Source: (Laurens, 2018)
Interview with Daniele Manassero. Designer and patternmaker at Miroglio fashion label in Italy

How did you start using 3D virtual prototyping?

I learned about the program from my friend, he was learning the program at his job. I liked gaming when I was young, so I thought it looks like a nice opportunity to design and “play” at the same time. By the time, I did not speak any English, so CLO community was also a good place to learn English. I tried the program for the first time 3 years ago and since then use it daily.

When did you start applying this program in your work?

It took us a lot of time to start using it. Previous CEO of the company did not see the potential, so we did not do anything with it. But since new management came, it became better. They got interested to see how it works, why is it good. It is still at the beginning of implementation but it is step forwards. Information is very easy to get on these programs and how to use them, so it is not that hard to learn them.

What are the main benefits of the software that you are using?

For patterns we use Lectra Modaris and for 3D we use Clo 3D. Clo is very easy to use, you can learn the program very fast. To make it perfect, it takes time but it is a lot of fun. Also, when we just started implementing the program for first styles and from all the research that I did, it is possible to lower the number of samples produced from 3 to 1.2. To lower to 1 is hard but if you are really good, it is possible. We also started to do styles that we produce every season in 3D. You can check the variations, placements easier. My friends from Clo community said that it is very useful because
one sample can cost to 1000 euros in big fashion brands. When started to also do collection buying digitally. We show one garment physically and all the variations digitally. People like it a lot.

What are the limitations that you are facing?

First, people are very reluctant to change. Designers want to touch every single garment, so it takes a lot of time to convince them. But designers like modular tool because there you do not need to work with patterns, it is easier for them. Also, fabric library is not the best. Leather and all the stiff fabrics are easy to use but fabrics that have stretch are a bit hard to simulate and they are not as realistic.

What do you think would influence big luxury brands to start using the software?

1. Money. Their samples cost a lot of money and all the tests that they do save millions. I spoke with one designer for one of the Italian luxury brand, he said that he wants to use it because it would help to save a lot of money. Also, managers would be very interested in that.
2. Time. Faster to make a collections, easier to see the final result.
3. Sustainability. Very important, design and development is very wasteful.
Appendix C

Haute Couture: according to business of fashion dictionary “Haute Couture is a much-misused phrase that actually has very specific rules for qualification. Translated literally, couture is French for dressmaking, while haute means high. These are garments created as one off pieces for a specific client.” As rules are very strict for this collection, everything has to be made custom fitted by hand.

“See now – buy now” refers to a new business model for the luxury fashion industry in order to be able to fight counterfeit problem. This model means that after showcasing the collection at a line release or fashion show, clients are able to buy the collection instantly after the show (Rinaldi & Bandinelli, 2017, pp. 35–40). This model was thought to be as a revolutionary for the luxury fashion industry, however, in order to be able to meet the deadlines, it became way too difficult to continue.

Technology acceptance model is a feasible model to implement and analyze how technology can be accepted for the luxury industry. Please find bellow drawn illustration by me analyzing all the gathered data about the industry, 3D virtual prototyping and virtual product development:

As more and more information there is regarding 3D processes, attitude toward using is changing as user cases and results are visible for the public. As the attitude changes, clarity of implementation to use is becoming for clear as more and more people get interested into the programs and that leads to an actual system use.

Figure 5.1 Technology acceptance model
## Business objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Reducing garment sample production to a maximum of 1 per style while implementing 3D virtual prototyping</th>
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| Key Results | **Sustainability:**  
- Maximum of 1 sample produced per style, wasting fewer resources, namely fabric, trims, paper, labor  
- The carbon footprint of the brand reduces at least by 15% by producing less CO2 emission in daily activities  

**Business:**  
- Product creation including design and development processes speed increases at least by 30%  
- Product creation budget decreases by 50% |
| Requirements | • Company restructuring  
• Software licenses  
• Time investment  
• Budget division  
• Employee training  
• Supplier training  
• Employee negotiations  
• A management buy-in (sponsorship) |
| Time-bound | From 2 collections to 5 - depending on the implementation strategy |

Table 5.1 Business objective table

**Figure 5.2** Top-down approach by creating an external team

### 3D TEAM CREATION

- Process starts by 3D dedicated team developing and learning 3D virtual prototyping skills, knowledge. Testing shapes, creating pattern database.
- New team created from in-house employees and new hired professionals that are experienced in 3D virtual prototyping.
- Developing skills and knowledge.

### COMMERCIAL STYLES

- Once skills are developed, 3D team starts taking over merchandiser styles that are called commercial styles.
- Building commercial styles database introducing new digital styles to retail and wholesale.
- All variations created digitally.

### RTW COLLABORATION

- New collaboration with the rest of in-house designers on creating collection together by teaching everyone 3D skills, sharing feedback and knowledge.
- Sharing knowledge with in-house product creation team.
- Collaborating on styles together Existing in everyone into a process.

### TEAM MERGE

- Once both teams work together well, the merge is made. 3D team and in-house team becomes one by dividing tasks and positions.
- Sharing and dividing tasks based on the feedback from previous collections.
- Everyone is working together well.
Approach benefits:
During this approach, slow implementation is developed involving every single employee in the process. As well as, testing of perceived usefulness works slowly preventing mistakes.

Approach limitations:
It is a costly approach, as new employees have to be hired and selected in-house designers, developers and pattern makers excluded from day-to-day operations. This approach is rather time consuming, takes time to develop the skills and implement fully.

Example from the industry: Acne Studios implemented product lifecycle management (PLM) technology by training a selected group of people and slowly involving everyone in the process until the software can be fully integrated into a company successfully.

Approach benefits:
During this approach, rather fast results are possible if employee training works efficiently. Every single employee gets quality training.

Approach limitations:
The approach is rather costly, as trainings are expensive. As well as, employee resistance is bigger as they are thought by external experts who do not necessarily understand how luxury product development works. Rather big structural change as certain designers have to become 3D focused.
Example from the industry: 3M “Scotch Masking Tape” invention by Richard Drew. While visiting a number of local auto shops Richard understood the limitations that their current product had. Richard spent 2 years developing a recipe into introducing a more efficient possibility for painting cars that ended up being a scotch tape. After convincing the manager of the possibilities that the tape could provide the company, it was mass produced and revolutionized how paint jobs of all sorts were made (Honrubia, 2018).

Approach benefits:
Company employee engagement increases. Employees themselves are able to determine needed requirements and specifications. As well as, this approach looks the most feasible regarding possibilities named by Luxury brand A and D product developers. Technology acceptance model is incorporated the most. Team restructuring is based on skills.

Approach limitations:
Negotiations with managers can possibly slow down the implementation. Designers and developers need to get interested, however, that can be possibly addressed by product idea. Budget negotiations.