

Amsterdam University of Applied Sciences

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Publication date

2013

Document Version

Final published version

[Link to publication](#)

Citation for published version (APA):

Miles, R. (2013). *Fashion Design and Presentation using 3D Digital Prototyping: Experiences, Opinions and Knowledge*. Unknown Publisher.

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Fashion Design and Presentation using 3D Digital Prototyping: Experiences, Opinions and Knowledge

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Work performed in the framework of the project 'Fashion 3D 3.0'

AMFI - Amsterdam Fashion Institute - Hogeschool van Amsterdam

December 2013

1. Introduction

The Amsterdam Fashion Institute (AMFI) and the Research Group Digital Archiving & Compliance (School of Design and Communication), both of the Hogeschool van Amsterdam (HvA), are enacting a joint research and development project exploring and creating technologically innovative applications for the design and presentation of fashion garments in 3D. The long-term aim of the Fashion 3.0 Program that the Research Group has developed is to realize a 3D design environment in which it will be possible to virtually represent and render fashion designs in 3D "on the fly" with "dynamic draping". The short-term aim of this R&D project (financed by the Centre of Expertise Creative Industries) is to develop a virtually simulated textile database that renders 3D visual representations of these fabrics. The idea is for this database to be open source and be able to interface with 3D design applications such as those of Lectra. The textile database will include a number of different digital datasets per textile that contain information about the fabric's drape, weight, flexibility etc., to virtually render prototypes in a 3D simulated environment. As such, in building garments via a 3D software design application, designers will be able to see how a garment changes as new textiles are applied, and how textiles behave when constructed as different garments. This will take place on 3D avatars, which may be bespoke body scans, and will allow for coordinated and precise fitting and grading. This will require a great amount of research and the end result will be a work-in-progress. As many of the most used software programs for design do not currently have a dynamic and moveable avatar, an important innovation may be the development of a life-size holographic virtual catwalk to display the garments made in this virtual environment.

With the focus of this research and development project in mind, and the idea that the ultimate aim is to have students and industry practitioners make use of these tools, it is necessary to gain feedback from the professional community about the usefulness of developments.

As such, this report sets out to outline experiences, knowledge and opinions from the fashion and textile industry to explore the business case for these developments: to obtain information regarding their use of 3D design applications, their knowledge of 3D design applications, and their opinions of and interest in a digital textile database.

In order to explore the diversity of opinion, a range of industry practitioners were interviewed: those that are technologically advanced and knowledgeable in the realm of 3D and those that have little knowledge or digital applications in place in their company. As the focus of this research is the first part of the R&D project—the creation of the 3D simulated textile database—it is integral to include both design companies as well as textile industry proprietors in this process. While the development of this project takes place within the Netherlands it is also crucial to include the opinions of others who are using or who have used 3D design applications.

Total number of interview participants is 6: for fashion designers 5 and for textile manufacturers 1. In the designers group 2 participant companies have extensive knowledge of 3D applications and already use some kind of 3D design or presentation tool as part of their workflow (Nike, Adidas). Two companies have minimal-to-zero experience with 3D tools or make use of minimal computer technology in their design workflow as their current 2D workflows are productive for their respective businesses (Levi's Vintage and Just Brands). One company has had a negative experience with 3D and no longer uses it (Spoon/unitedstyles). Of the 1 textile company interviewed (Print Unlimited), they do not currently use 3D simulation technology in their workflow in terms of design, development or presentation.

2. Research participants consulted & their company workflows:

Fashion design companies:

1) Dominic Sluiter, 3D Lead at Nike Global Football, Nike Netherlands – Currently working with 3D simulation in workflow

As 3D Lead at Nike for Global Football, Sluiter's role is to be well-informed on the state of the art in 3D technology for design, advocate for its use as well as instruct and inform others. Sluiter trains factory workers and in-house users on the 3D technology in use at Nike, writes manuals for its use, tries to push the use of 3D while ensuring that 3D processes are smooth and add value to the workflows. In terms of using technology, Dominic creates 3D models and simulations to share and present designs to potential buyers and in-house as a communication tool. For each section of Nike (e.g. Global football, Global basketball etc.) there is a 3D lead who specialises, educates and advocates for 3D in their respective section.

Nike Global Football workflow:

- i) Designers make a rough sketch of a design in Adobe Illustrator and send it to the factory (Day 1).
- ii) Factory creates 3D digital prototype on 3D body form from the sketch that contains all-important information e.g. placement of graphics, fabric etc. and sends back to the office for review (Day 3).
- iii) Office reviews 3D digital prototype and sends the changes to the factory to adjust the garment (Day 18).
- iv) Physical prototype created at factory (Day 24).

In terms of software, Nike is currently using Browzwear and 2D OptiTex for design simulation.

2) Renate Eder, Team Leader Digital Creation / Center of Excellence – Brand Operations, Adidas Germany - Currently working with 3D simulation in workflow

Eder heads the Digital Creation team for Adidas, involved in 3D tech solutions for apparel as well as the implementation of these solutions. Working in the Center of Excellence, Renate develops systems and processes that directly assist, improve, and make possible, product creation.

Adidas workflow:

Adidas' current design workflow consists of designers working in a more "traditional" way, developing sketches on Illustrator to communicate their designs to the factory. The factory then creates a physical prototype for review. Design, fit etc. changes are likely suggested and a new physical prototype is made. 3D comes in after the final physical prototype has been made—with every final physical prototype the factory also produces a 3D virtual sample. For every garment produced, the factory has to make both a physical and virtual 3D sample, as such Adidas is doing mass 3D production with 15,000 articles being produced per season.

With 3D prototyping coming in after a design is finalised, the design and 3D development processes are currently independent. But as will be articulated later in this report, Adidas is currently in the final stages of working with Browzwear to develop a 3D software for the design phase of their workflow that will begin implementation in 2014 and finish implementation in 2015: "We started at the end in terms of 3D, and now we're going back to the front." In this way, designs will be made in 3D, with designers handing over a 3D package to the factory, instead of a 2D design.

In terms of presentation, this topic is one thought to be focused on too little at the moment, as there is currently no need for design concepts to be presented digitally as

the digital 3D model is only created after the design is finalised. 3D samples currently being produced are however used for marketing and sales. In the sales department a digital tool that can present 3D assets is used. Here most physical samples are replaced by virtual ones whereby the sales representative would likely have one sample of one style in one colour as a physical sample and the other colours of that style would be shown as 3D simulated models in the tool. This Adidas produced tool also has a selling function on it for B2B sales where retailers can order stock directly via the presentation tool.

3D models are currently not dynamic and can only be turned around 360°.

*3) Paul O'Neill, Senior Designer, Levi's Vintage Clothing
Netherlands – Not working with 3D and uses minimal digital design applications in workflow*

O'Neill is the Senior Designer at Levi's Vintage Clothing acting as the responsible designer developing collections based on reproducing vintage Levi garments into new collections with a small team.

Levi's Vintage Clothing workflow:

- i) Rough black and white hand-drawn sketch of collection is made. At this point it is known what fabrics will or should be used for each garment. The design team always has an idea of the fabrics to be used when designing. They use these sketches in meetings with the merchandising team to come to a decision of what the entire collection will be.
- ii) Sketches of the confirmed collection of garments are drawn out by hand in more detail than in the first round. Hand sketches are brought into Photoshop and Illustrator to layer with textures and patterns, prints. These are printed out and pasted on boards to illustrate the whole collection and are used to brief the sales team. For knitted and woven pattern fabrics, Illustrator is used to create fabric patterns.
- iv) Detailed drawings are sent to the factory with block measurements, fabric references etc. for the garment. The factory makes the pattern and creates a physical prototype. If the garment is a new development, e.g., a new check pattern, the process will often take longer to cut the piece and create the woven/knitted pattern. When new designs are sent to the factory a technical pack with all info is included with the sketch. O'Neill presumes that factory uses Lectra for pattern making.
- v) Factory sends sample back to office for approval. Takes about 4-8 weeks (on average 6 weeks) to get the first sample back. In the meantime the factory might have sent different options for fabric quality etc. By the time the first prototype is received back in about 6 weeks they have already decided on the fabric, final fit decisions etc. They do get prototypes back that they aren't happy with: usually 2 or 3 prototypes are made in

the process. With any new design development it seldom comes back perfect the first time. Whole process from sketch to finalised sample takes 2-3 months.

*4) Arjan van der Heijden, Manger of Operations, Just Brands
Netherlands – Not working with 3D and uses minimal digital design applications in
workflow*

Arjan van der Heijden is the Manager of Operations at Just Brands. As such, he is in charge of logistics, ICT and facilities. As the lead of ICT he oversees anything related to hardware or software investment, as it is part of his budget, which includes new design software. As Manager of Operations he is also the head of the management team, acting as the middleman between all departments: design, development and product care.

Just Brands is a company that holds 4 brands (PME Legend, Tripper, Cast Iron and Vanguard), and, as van der Heijden says, is more of a trend following brand than a trendsetting brand. It has a more traditional workflow and looks towards information from the shop floor of their retailers, trend and sales reports, and market research to learn what is popular, to decide what to put into production next or what garments to make more of, and for designers to focus their work.

Just Brands workflow and technology:

Just Brands works with a variety of 2D software for design, including Adobe's Photoshop and Illustrator and several Nedgraphics software applications (i.e. Easy weave that aids in creating pattern designs or Easy coloring that enables a designer to transfer a design from the weave program or scan a picture of a fabric and recolor it).

Just Brands has a more traditional workflow, but varies slightly depending on the garment. Shirt patterns are made in-house whereas the patterns of other products are produced in the factory and guided by the designer sending a 2D sketch to the factory. After being provided with a design, the first step for the factory is to provide a prototype in similar available fabrics to send back to the office to test for size and clarify what the fabric should be. When working with a familiar fabric, design (e.g. if it's a re-edition of a well-selling item) and supplier this prototype step is skipped and a sales sample is made right away. If the company is working with a new supplier a prototype is required.

The lifecycle from the design to the sales sample takes 9 months maximum.

Physical prototypes and/or sales samples are presented for internal communication and B2B marketing and sales. The design team and the sales manager are involved in

meeting and discussing the prototypes. The marketing and sales team are only brought in for the final design sample meeting.

5) Xander Slager, Co-founder and CEO, Spoom and recently terminated company unitedstyles.

Netherlands/China-based – Previously used 3D in workflow but found it problematic so now solely using 2D design applications

As owner of two fashion companies Slager has been in charge of developing business models in relationship to workflows and in the research and acquisition of technological systems to be used in the workflow of these companies. Having previously involved 3D design applications in unitedstyles and Spoom, Slager is well versed in the possibilities of these technologies for his companies.

Spoom workflow and technology:

Spoom is a traditional business model fashion brand for women's wear that focuses on coats. The company is currently working in 2D for both pattern and presentation, using Optitex software. It previously used 3D components of Optitex for 2 years before deciding to stop with 3D. In 2009 Spoom would send 3D virtual representations of collections to (potential) retailers, but they were not ready to look at a computer for samples and didn't like the way the representations looked.

unitedstyles workflow and technology:

unitedstyles started in 2011 with the idea that it could use technology to make changes to a traditional fashion business model, operating as a bespoke online shopping platform where customers could pick from a range of garments on the website and stylize them to their liking – e.g. change necklines, sleeve styles or length, and also details, colour and print, offering audience members a 3D preview of garments. This was enabled using Optitex software with the 3D prototyping component where customers could create in 2D and then “press a button” that would render the design as a 3D model allowing consumers to view a simulated version of their garment. Upon the customer submitting and purchasing the design it was outsourced to a production company in China where unitedstyles is based, and shipped out within 1-months time.

Unfortunately this alternative business model was losing too much money and the company began closing in 2012, finishing this termination in 2013. According to Slager, people were interested in creating their own designs but not necessarily in purchasing them.

Textile Manufacturers & Distributors:

*6) Jos Bastiaans, General Manager, Print Unlimited
Netherlands – Not using 3D in presentation but interested and engaged in textile
measurement.*

Print Unlimited is a pioneer in digital printing, working with this evolving technology since 1995. For 18 years they've been offering customers, including high-end haute couture and luxury brands other fashion labels and interior designers, the possibility to buy printed fabric with their own digital designs on it.

Print Unlimited workflow and technology:

Customers submit their design, quantity, and selects the appropriate fabric from Print Unlimited's selection of 100 textiles to choose from. The company will also print on customer-supplied fabrics if the order is for more than 50 metres.

In terms of presentation, the company's main point of contact with potential and returning customers is their website (www.printunlimited.nl). As such they are currently focusing on maintaining and further developing a good and customer-centric website. Other than drawing in new customers and keeping returning customers with an inviting and informative website environment, Print Unlimited is most interested in informing customers about fabrics: they want to show what the fabric looks like, but this is often difficult as a picture of a digital print on fabric just looks like a photograph; they want to show customers their print as it exists draped on the different fabrics they offer; and they want to be able to offer an image of different techniques that can be applied to the fabrics.

On the website there is a database type structure where the customer can make a combined selection of parameters to search for an appropriate textile. Parameters include: "Fabric", "Structure", "Used For" and "Weight". For each textile the website currently offers a description of the fabric and its structure; some technical information, including its name, weight, structure, composition, other measurements they have on the fabric that are particularly important to print (e.g. shrinkage, wash resilience etc.); what they have as a usable width; garments and other items the textile is often used for (e.g. dance clothing, dresses, wedding dresses, cuffs and collars, wall decoration, banner, cushions etc.); washing instructions; and whether there's any information about its sustainability.

Along with this information, every fabric is presented on the website with three hi-resolution images: 1) the fabric folded with a print on it; 2) an image of the fabric with no print, draped on a mannequin form; 3) a technical image that has a black and white background with a ruler showing the scale of the fabric details.

In order to get a fabric into the collection of Print Unlimited it must pass 27 out of 27 different measurement criteria. They use normal lab equipment such as a textile cloth meter to measure these. Bastiaans was not at liberty to say what these 27 criteria are,

but as their company deals with printing fabrics, many of these likely have to do with colour-fastness, shrinkage and other fabric properties that will effect the quality and durability of a print.

3. Results of interviews

As opposed to offering a summary of each interview participant, this report weaves and groups together information gleaned from like questions asked during the conversations. For a list of interview questions, see Appendix I.

3.1 Interviewees knowledge of 2D and 3D design software

In terms of knowledge about current fashion design software, such as Lectra, Gerber and others, companies already involved in using 3D and have 2D digital systems in place have more knowledge of existing software in general. Sluiter (Nike), Eder (Adidas) and Slager (Spoon/unitedstyles) were very familiar with Lectra, Gerber, OptiTex and Browzwear, amongst others, whereas van der Heijden (Just Brands) is less familiar with these but is familiar with Nedgraphics, a software suite they employ, and O'Neill (Levi's Vintage) whose workflow uses minimal digital tools is less familiar with this range of software. Bastiaans (Print Unlimited) is very knowledgeable of Lectra from previous work, but does not currently use it or another similar software in his business.

3.2 Challenges to using 3D software for fashion design and what companies are looking for in digital design applications

Levi's Vintage Senior Designer Paul O'Neill does not feel he has any real knowledge of 3D design and simulation technology for fashion design. He's seen some demonstrations at fairs for different systems, and they look interesting, but as he comes from an "old school" way of working he'd rather look at a garment and feel it, physically check the fit, and really play with the fabrics.

There are a number of reasons Levi's Vintage decides to stay with a more traditional way of working. Firstly, the system they use works for them. Secondly, because Levi's Vintage plays with reproducing vintage Levi garments there's something about keeping the feeling of their working process in line with the idea behind the brand: using hand drawn sketches because these offer more of a feeling, and are more representative of the brand in their appearance than drawings created in Illustrator.

Other than these two reasons, O'Neill thinks it's largely because most of the staff have been working in the industry for at least 10 years working in this more traditional way. Moving to a more digital design process whether 2D or 3D would be a big change. Because they're happy with their workflow O'Neill questions whether this distance from

the digital is also because they cannot or do not want to see the benefits of a more technological design process and workflow, but acknowledges that they will need to play catch-up if the industry requires it.

On top of this, the perceived time and cost to implement a new system and training/learning for all staff of these new tools and processes seems daunting and implausible especially with such a small team: three people for Levi's Vintage and four for Levi's Made and Crafted (both housed at the same office). There would not be enough time, O'Neill says, as it would disrupt the season. Perhaps if a younger person who was trained using 2D or 3D digital design applications joined the office and the rest of the team learned from them, this might be an impetus to change, but this change would not happen on their own.

This would also be an immense change for the way the design team works: "It's great that we all sit and work together, we have visual things to look at and put on the wall, and if we moved to a more digital design environment everyone would be sitting by themselves, facing away from each other, and staring at a computer screen. For us, we like the joint experience of looking and working together, we don't want to turn into everyone being separated." Furthermore, virtual fit does not sound appealing as O'Neill's background is in pattern making, and as such knows a lot about fit and construction so doesn't know if he could trust a machine to do as good a job. For example will the software program correct a pattern when you change the fabric from wool to leather in the 3D model?

While Levi's Vintage is not looking towards using more 2D or 3D technologies, there are however a few things they would be interested in such an application doing. Of interest would be a realistic simulation of exactly what happens when one applies a pattern to a woven or knitted textile. It is frequent that the weave or knit of a fabric affects how the print looks, and with no way to simulate such a relationship without making the patterned textile, it often requires multiple tests and iterations as what is wanted is not what happens when the textile qualities and structure affect the pattern's look.

Another importance for such a design system is the use of true colour representation. O'Neill thinks that if such a design system included true colour representation, in particular Pantone references as that is their preference, then he might be interested. It takes at least an hour to, for example, make a check pattern by taking a physical Pantone colour pallet as reference and putting it in Illustrator and then having to make visual colour-correction on the computer. If it was possible to just select Pantone colours from a list and they were truly represented that would be ideal.

Operations Manager, **Arjan van der Heijden**, of **Just Brands** feels he has minimal knowledge of 3D technology for fashion design. While he has seen some 3D applications from Nedgraphics, one of the main software suites they use, the company is currently not currently interested in implementing 3D. In terms of both internal communication

between departments and production facilities, and external communication with potential buyers, a physical sample is used to judge the design, as this is what everyone appears to want to use. Furthermore, van der Heijden says it is better to use a physical sample to decide on the commercial price.

Just Brands has chosen to not currently move towards 3D technology because their current workflow for design is productive and efficient for their company. Furthermore, perceived drawbacks of implementing such a system exist, including a large investment of money, time and the immense slowdown of a season's production. The components of 3D applications that he's seen, he says, also look a bit sci-fi with not that great visual quality.

For Just Brands to take on such technology, it has to offer an improvement to the company: "it's a big investment, so what turns out to be better/cheaper? What is the business value, what does it bring, does it save money, is it better and more efficient for the designers and thus the company?"

In terms of what such software could offer Just Brands, van der Heijden says that a shorter production cycle is one thing. In speaking with the company's retailers, it's clear to him that a shorter time for garments to get to market is desired. For example, he says, they could use 2D or 3D technology to change their presentation methods skipping physical prototypes and presenting garments to customers and retailers using 3D model visualisations.

Just Brands is currently selling to retailers using an Ipad and an app that displays 2D images where orders can be made. If there was a way to use 3D design with this application and a fabric sample to show retailers the way the garment would look, it would be easier to travel and see more remote customers because this would not require bringing a rack of physical prototypes. The use of 3D models could also enable selling the collection sooner because it would not require the creation of physical sales samples.

Furthermore, the time between receiving sales samples and the time the sales period starts is not enough to take pictures of all the new garments. If 3D models could help make presentation possible immediately or quicker this would be useful.

A concern, however, with using 3D models for sales is the possibility that a buyer might make an order based on a 3D model, but if the garments end up being different when produced, there could be an issue.

Internal communication could also be a place where 3D could be useful, such as communicating with suppliers about adjustments on articles and updates about product orders. If a "supplier portal" could show a 3D model and also track amendments and timelines along the production chain of the order could be useful. This would also bring

the designer and production factory closer together, and with this closeness gives a better chance of success from the beginning.

As such, ideas for what the technology could be useful for are related more to external communication with buyers and internal communication for production, than design.

Most important to this technology, van der Heijden says, is fabric representation and fit, but thinks fit would be difficult to show accurately on an avatar.

For **Xander Slager**, a previous user of OptiTex' 3D applications, the decision to stop using 3D for both **Spoom** and **unitedstyles** occurred for a number of reasons. For unitedstyles, the bespoke online company where customers could build their own designs online, the most underestimated issue contributing to the business closing, as Slager calls it, is the question of "the psychology of fashion". People were interested in creating their own designs, but not necessarily in purchasing them: the business model and design possibilities gave people too many choices to choose between for them to be able to decide what they wanted. This is problematic as the fashion industry is built on "seducing" people into buying things by creating a particular story or lifestyle around the garment, that tells the buyer they will look good and be confident if they buy this particular thing. Customers being able to design their own look however conflicts with the psychology of fashion as it's difficult to impress the story of confidence and beauty through purchasing a particular item, to seduce a customer to buy, when the customer is making their own design decisions.

3D comes into this equation as both companies were primarily using 3D prototypes for marketing and sales, to convince a customer to purchase a garment online through unitedstyles or as a B2B tool for Spoom to sell garments to retailers. For Slager, the 3D presentations were not realistic enough to use as a marketing/sales tool because they need to work with the myth-making psychology of fashion to create allure around the garment—fashion magazine editorials and advertisements are high-gloss and always amended with the idea of presenting something that is more than real and always has a story wrapped around it. 3D presentations of garments when used for marketing and sales need to be presented with this in mind both conceptually and visually.

The 3D models generated, Slager says, are not realistic or fashionable enough and look more like something you would get in a "nerdy" 3D game environment. These 3D prototypes need to be more fashionable, convincing and of higher quality to be in line with what's created in fashion magazine ads. For B2B sales to retailers, in 2009 Slager was using 3D models to show virtual representations of collections to potential retailers. At the time these retailers were not ready to look at a computer for samples and didn't like the representations. Two years ago their B2B retail customers in Europe were expecting to see physical samples, and Slager doesn't imagine this has changed much since.

For Slager, 3D presentations of garments work functionally in terms of actually presenting a 3D prototype, but do not work psychologically for customers because they do not look good enough to seduce them to purchase.

On top of these more presentation issues around marketing and sales, the technology, Slager says, was way too complex and difficult to use. In creating 3D representations for B2B sales, Spoom worked with Martin van Heusden a proficient business-user of Optitex, to help generate the models. Martin was very good at creating the models, Slager says, but retailers were concerned the models weren't good enough so Spoom stopped working in this way and returned to making physical samples. Making physical samples was easier and cheaper for them. It makes sense to Slager that for internal communication 3D representations are probably cheaper and easier to make, but for using these to communicate designs to retailers and customers it became much more expensive because it wasn't working commercially. He sees that 3D modelling could be beneficial to a company internally for things such as judging fabrics, designs and graphics because it requires lower 3D resolution quality.

For **Dominic Sluiter**, the **3D Lead of Nike Global Football**, 3D technology has been on the radar for a while. In 2006 they tried an initial implementation of 3D into their workflow, but this became confusing for those involved so it was held off. In general, Sluiter says, people are not used to 3D design software and the user interfaces of most 3D applications are ugly and old school looking. For designers, whose work is focused on aesthetics, such unappealing and complicated interfaces become deterrents to use. Designers, Sluiter says, are also deterred from using 3D applications because they need to invest more to get a design done, when they actually want to spend less.

Now that 3D has been implemented into their workflow, it has become a very useful tool. In particular, 3D representations of garments has significantly effected speed and reliability of communication between the office where the designing takes place and the factory where the 3D model is made. In terms of workflow, there is now a significantly shorter production time to get to the physical prototype with the aid of 3D models. Internal presentations have also changed since all images are produced in 3D: for design reviews, internal meetings, etc. Presentations and concepting are now "flashier" and better represented, also resulting in less time to express ideas.

The objective of 3D, Sluiter says, should be to a) be able to make things the right scale b) try to make the interface look more simple and easier to use. Designers also feel that the rendering of designs can be simple—they don't need camera animations etc, as the faster something renders the better. Furthermore, as designers are best suited to using 2D CAD programs to create designs—this is generally what they're most comfortable with—Sluiter likes the idea of a 3D software that interfaces with 2D design. Nike is currently working with Browzwear to develop a software where the 3D model made can be translated to 2D for design and then back to 3D for presentation, all existing within the same program/environment.

Furthermore, what is most important for 3D design software that interfaces with a fabric simulation database, says Sluiter, is the technical imaging of fabrics: a close high resolution image of the fabric and also as it appears modelled on the avatar in the 3D visualisation. Imaging should also include a specular map, bump map and an alpha map.

As mentioned, **Adidas** will shortly be implementing a 3D component as part of the design portion of the workflow (currently 3D models are only made at the factory after a design has been finalised). There were a number of things guiding the decision to develop and introduce 3D software into the design portion of the workflow. Mainly, as **Renate Eder** states, the current available software is too technical—Lectra, Browzwear and other software out there are very pattern-based and technical and are made more for garment technicians who are used to working with high-tech software and complicated interfaces. As such, the biggest approach in terms of developing software in-house was to get an as clean as possible user interface to attract designers' use. Functionality is definitely there in different companies' 3D design software, but the main issue is that how you present it to a designer cannot be the same way you present it to a garment technician. Attracting designers to use these applications is very important—the system should work in such a way that with the technology running in the background the designers don't care or don't have to think about it running.

Another main requirement for attracting designers to use a system is speed. Because designers at Adidas are doing “mass design” in their industry they won't want to wait for a system to take a few minutes to do something. So, for example, if they want to apply a new colour, material or property to their garment it needs to be instantly visible. Designers appear to be ok with a tool not being 100% accurate, says Eder, because they are currently used to working in Illustrator where there is no accuracy. What is wanted is as good and as quick as possible real-time rendering.

Developing and beginning implementation of 3D software as part of the design workflow was decided upon by Adidas for a number of reasons. Firstly, Eder says “you still need to improve and innovate yourself as a company, and if you don't question the way you work today, you might not be there tomorrow”. Furthermore, when designing in 3D you already have a realistic garment to show compared to a 2D rendering in Illustrator or a paper and pen sketch, which is incredibly helpful for internal communication. There can be numerous misunderstandings between a designer, factory developer and marketing team, but as soon as the designer knows what they want they can make a realistic rendering of it that's comprehensive to everyone involved. Physical prototypes can often be quite different than sketches, so introducing a 3D simulated garment as the sketch gives a more realistic rendering, cutting down on inaccurate prototypes, which of course cuts costs. Having a 3D model to start with is also key because it creates “one source of truth” to make changes to and annotate. In this way there is one central place where the latest product information and decisions are made, instead of having various pen and paper sketches, an Illustrator design, a physical

sample and 3D sample, where it might be confusing to backtrack to figure out which has the most recent information. This also helps keep creativity at the beginning of the process, when the designing occurs, and not when physical prototypes are produced.

3D models also assist in marketing and sales offering potential buyers a more accurate representation of garments as it's difficult to really see what a garment is like from a 2D image. Cutting down the production of physical samples also cuts down on shipping samples, lessening environmental impact by both waste and shipping reduction. For a company that makes millions of samples, reducing these two elements has great environmental impact, and of course also reduces costs.

In terms of the implementation of this new software affecting workflow, Eder does not think it's necessarily productive or even possible to change the process of the workflow radically, even though there are of course ideas of how to do this. The easiest and simplest way to get people on board with this new software at Adidas is to stick with their current linear workflow process because the staff are comfortable with this. Adidas will gradually implement the new 3D tools. For example, instead of using Illustrator a 3D design tool will be implemented in the same part of the workflow, having the designer hand over a 3D package to the factory that communicates all necessary information, instead of what used to be an Illustrator file. This is not necessarily a massive change to the workflow but significant and substantial in terms of better communication and quicker production via 3D garment simulations.

3.3 Interest in the digital textile database and opinions on current digital representations of fabrics

While some companies are minimally using digital applications for design and presentation and others are currently implementing innovative systems, how and in what ways do these companies see the usefulness of such a database for the 3D simulation of textiles and what are their perspectives of current digital textile representations?

While **Paul O'Neill** from **Levi's Vintage** is interested in hearing more about these technology developments because he's new to the realm, in terms of the company he does not have much interest in or see much use for the 3D textile database because there is no place in their workflow for it—they do not use software for design. In terms of his opinion of 2D and 3D fabric representations, he does not have because he does not use them. When fabric images are digitally used at Levi's Vintage it is often a photograph of a textile mapped onto a hand drawn sketch using Illustrator or Photoshop.

Arjan van der Heijden of **Just Brands** is also interested in hearing more about the developments of this technology and interested in staying up-to-date, but however is not currently interested in using such a digital textile database. Their workflow, he says,

is not so innovative, but this is fine for their brand as their current processes and technology works well for a company that focuses on creating already trending items.

Xander Slager of **Spoorn** and **unitedstyles** does not see a use for the database in their current work and also feels the development of such a system with a diverse enough range of textiles is impossible and extremely difficult to execute. This is the case he says because there are infinite textile properties and often variation within the same bolt produced. He's not certain on the usefulness of digital fabrics because fabrics used within the industry change all the time and vary greatly. However, he says, what could be interesting is the question and solution of "how to create a simulated fabric from real fabric in 30 seconds?" An application that would be able to do such a thing on the fly could be a great solution, for example, when entering a garment factory and taking a textile, digitizing it on the spot, and then being able to see yourself and show the factory associates a virtual garment of how the fabric and design work together.

Slager does believe the most difficult part of the over-all system is the visual definition of fabrics: a 3D model from 2D is not difficult to create, but as soon as you add a fluid fabric on of this it becomes very complex to render.

Dominic Sluiter says there would be interest in using such an external database, but as **Nike** only uses fabrics produced in-house he does not see how the database would be useful to them. Furthermore, it would be impossible to contribute to such a database because the measurements and properties of their textiles are confidential.

3D representations of fabrics are very important to Nike. It is possible for them to make great garment simulations but when the textile quality is poor it won't be perceived as a good simulation even if, for example, the drape is accurate. In the early days of apparel simulations Nike grouped together certain knits and wovens, using generic texture images to represent each group, with their factories capturing the images. Through trial and error they have learned that consistency and accuracy is critical and texture images are no longer being enough. Specular and bump map images are a minimum requirement for them and need to be captured in a standardised and consistent way. Within their company they know how to capture good texture images but this requires a much manual work. For consistency and time investment it would be ideal if there was an automated process that would capture the required images in a standardized way that would work correctly with all software packages throughout the industry.

Eder of **Adidas** follows suit with Sluiter of Nike in that she does not see how the database would be useful to them as they mainly use Adidas-produced textiles, of which the properties are confidential as is par for the course in the highly competitive realm of sportswear. Adidas also already has some processes of fabric simulation in place with these textiles. Eder would however be interested in hearing about what mechanisms AMFI is developing for accurate and consistent textile measurements. The database, she says, is interesting to Adidas in terms of what might be learned from it, such as

drawbacks of certain software etc, but Adidas is currently looking more into a device for accurate and reliable textile measurements for 3D.

Regarding current possibilities for 3D representations of fabrics, Eder thinks that they can likely be improved and also with further research on how simulation can be adapted for more intelligent systems. For now, however, she thinks such simulations are acceptable for a number of application areas: "I know it's not 100% accurate, but why not use these simulations for an area that does not require 100% accuracy like a catalogue image or selling tool." For design, Eder also thinks the simulations are acceptable and that designers can cope with how it is now. However, if this question is applied to garments for athletes, for example, that have to be developed and tested to specific measurements, then fabric accuracy is more crucial.

Jos Bastiaans from Print Unlimited is interested in the technology because he is interested in innovation, but is not sure how much they would be able to spend on or use it. A paramount question from him is what is the value to the business? Will it create more sales or more brand awareness? Where will such a database save the company money? In terms of 3D presentation, Bastiaans would first need to know if his customers want the service and will it contribute to customer satisfaction and interest? Bastiaans sees the most value of such a system in its possibilities as a commercial tool to promote sales. For example, for the interior design industry that Print Unlimited also prints textiles for, a modelling system with integrated textile database could illustrate for customers how curtains would look and behave in a room if they were opened or closed or the window open, how the interior would look with different prints, and how the prints would behave with different fabrics.

In terms of 3D fabric representation, Jos does not feel that he has an in-depth knowledge in the field, but that showing the dynamic behaviour, textual structure and the "feel" of textiles will add to ways of presenting fabrics.

3.4 Review of list of properties and parameters for the digital database

To produce the simulated textile database for digital prototyping, a list of parameters and properties have been developed. Interviewees were asked about which properties and parameters in the list they thought were necessary or not for digital prototyping or for the production of garments at their respective companies. For the list of properties and parameters, see Appendix II. Those that were able to respond to the question are found below.

Dominic Sluiter, Nike:

Fabric input parameters: "Fibres" would be called "Base Material"; Construction of the fabric, Weight and Commercial fabric name are necessary parameters; Construction of the yarn/yarn numbers could be interesting but hardly used; Finishes is not necessary.

Important physical and mechanical properties are: These qualities don't seem to be necessary for 3D simulation. In an ideal world, Sluiter says a stretch test would be enough to decipher how you wouldn't use textiles. Flexibility could also be understood as "Bend" and testing the flexibility of length, width and diagonally is key.

The list seems too detailed for usability in production lifecycle. Need to think of the scale of such a system when a designer needs to produce many garments. Many of these parameters they would not use in a simulation, but could be useful as an internal sales tool to visualise the values.

Nike has an in-house digital textile database with about 150 fabrics (properties measured in-house). These property sets are important, but what is signed off on is the construction of the garment: fit is important but construction is more crucial, and material properties are not the most important.

Renate Eder, Adidas:

From the perspective of Adidas' current visualisation work, the following screenshot depicts the only physical parameters being captured by the company.

Fabric Properties [X]

Enable

Name:

Fabric Catalog

Catalog:

Category:

Fabric Name:

Composition:

Description:

Measured:

Physics

Mass: gr/m²

Friction:

Thickness: mm

Bend: **W** **L** dyn*cm

Hysteresis: **W** **L** Deg/cm

Stretch: **W** **L** N/m

Linearity: **W** **L** %

Shear: N/m

Linearity: %

Shrink: **W** **L** %

As can be seen these physical properties include: mass, friction, thickness, bend, hysteresis, stretch, linearity, shear and shrink. While this list is practical for the current work that Adidas is doing, Renate does agree that with the increased power of visualisation and the capabilities of 3D Adidas might need much more information like the extensive list that was provided to her for this question.

In parallel to these physical properties, Adidas also captures a variety of visual parameter information using photographs. These include the glossy, roughness and colour information that is needed for visualisation purposes: colour map, specular map, normal map, transparency map, diffuse colour, specular colour, emissive colour, roughness, Fresnel, transparency, U Tiling, V Tiling, Repeat mode, UV Rotation.

Jos Bastiaans, Print Unlimited:

All of the parameters seem important. The more technical production done to a garment the more measurements are needed to get an accurate idea of how it will behave when manipulated. Depending on the application of the textile, some

parameters are important and some are not. With textiles it's expected for the industry to know which textiles work best for their garments, but this is not always the case, such as forgetting about the necessity of a chlorine fast textile for a bathing suit, or transparency levels when wet.

3.5 How should the technology be offered and what would be required to use it?

When asked what the companies would require to start using such a textile database, a unanimous answer of a textile swatch book linked to fabrics in the system was a requirement. The ability to feel fabrics to assist in design decisions is necessary. As **Sluiter** from **Nike** says: "The combination of physical materials and digital materials is key. We always refer back to physical samples in our process, so a swatch book would be necessary. We need that tactile possibility in relation to digital datasets for fabrics in the design process."

As mentioned previously, for Sluiter the relationship between the physical sample and imaging technologies is also important: a close up image of the fabric modelled on the avatar as a 3D visualisation, but also a specular map, bump map and an alpha map would be a requirement of what the database offers.

For **Slager** at **Spoorn**, it is also necessary to have materials in the database that are available for physical production—textiles that are actually used and available.

For O'Neill of Levi's Vintage, a company currently using minimal digital technology in the design process, would require a technical team for support to help get such a system underway, or a person well versed in the technology who can work to build virtual models with avatars.

3.6 What conditions at the company would be necessary to consider implementing 3D technology or integrating the database with the company's existing 3D workflow?

For the interviewees different conditions would be required to start using such a system.

For **Levi's Vintage**, it is more about whether all factories start to work with 3D simulations, and as such they would then be required to upgrade and learn. Implementing new digital tools and changing workflows is not something they're thinking about or looking into currently and likely not soon.

At **Just Brands**, as soon as there is a belief of a necessity to be more innovative van der Heijden can imagine using 3D software would help.

For **Xander Slager** who previously used 3D a number of things would have to change with the technology for him to consider re-implementation. The software would have to be simplified and made easier to translate 2D patterns to 3D models, as these design tools require patternmaking skills with advanced and specific computer knowledge that is difficult to find in one person. The presentation output of 3D applications must also be improved—they're currently functional in terms of creating 3D models, but not commercially usable as the visualisations are not good enough to entice customer purchase. If both of these sides improve greatly, Slager would be interested in using it again. "Don't get me wrong", he said, "I'm still very interested in the technology, but from recent experience I'm sceptical of its use, most specifically from a customer relations and marketing point-of-view."

Adidas is in the process of implementing a 3D design system, and have decided to do so to remain innovative and create better internal and external communication. Conditions that were in place that allowed for such an implementation include money and also figuring out a way to implement 3D technology into the current design workflow so as not to disrupt the processes they currently have in place at this stage.

Textile printer **Jos Bastiaans** of **Print Unlimited** thinks people are reluctant about high-end investments because fashion is so quick to change. Print Unlimited would start using the database for two reasons: 1) it become the de facto standard in the fashion industry and thus their clients expect them to use it 2) because it is innovative and at the front of technology and Print Unlimited wants to be innovative. For both scenarios, there must be a business value attached.

3.7 Fabric measurement testing and who should be responsible

As the database is built it is likely that companies will have to test fabrics that are not (yet) available in the database. Who should test these: textile manufacturers, designers, an independent research body, university?

For **Nike**, the ideal would be to measure in-house via an all-in-one box that has a camera in it. This box would both measure and record all properties and also do proper imaging. Currently all textile testing is done internally at Nike but would likely like to outsource testing to a secure facility if they were to take on more fabrics. Nike would be interested in using this database, Sluiter says, but would not share the fabric datasets they've tested internally or externally because there is confidentiality for all Nike created fabrics, which makes up most of the textiles used by the company.

In-house measuring is already occurring at **Adidas**. As **Eder** mentioned previously, she would be interested in hearing more about the measurement device(s) researched and used as part of this project. Because Adidas is doing mass production with their own textiles it would make more sense for them to have an in-house accurate system to measure textiles.

Currently at Adidas textiles are measured with a simple device from Browzwear. This, Eder says, is not very sophisticated or reliable in terms of drape, etc.; two people taking the measurement of the same property will likely receive different results. When you input the measurements the simulation is quite reliable, but it's getting the right and reliable measurements of textiles that is difficult, she says. In terms of visualizing the different textiles with different properties, visual simulations of drape are not shown till an avatar is dressed, and Eder says, that these things are done at the factories currently so not done centrally at the moment.

For the 3D design software that Adidas is developing in-house and that will begin implementation next year, a measurement device is still being sought out. One measurement device that captures the surface, the optics, so that leather actually looks like leather has been developed. This is not a simulation but shows a textile's surface. There is a "one click solution"-type development that is doing this now in a sophisticated way for roughness and shininess, but the physical properties are missing, and as such Adidas is looking into the topic: "Do we either combine these two measurements with Browzwear's saying 'maybe your measurement device is not so fancy so perhaps we can develop something new here? Or, who has something new? We also look at universities to see if something new is coming out'".

For Adidas, because the properties of their in-house produced textiles are confidential, they would not be able to share these with textile database being developed as part of this project. But, Eder says, if the fabric mill was to offer the service of measuring and sharing textile data with AMFI, that is something they cannot control. For example, if the mill was to give the same fabric to Nike, Asics and Adidas, and they were to share the properties with the AMFI database in a similar way a textile supplier were to share a swatch book, then that would be their decision.

It would be interesting, Eder says, to see textile manufacturers send a physical sample of a textile as well as a digital dataset of its measured properties when they send out samples and orders.

Bastiaans of Print Unlimited thinks it will be difficult to develop such a comprehensive database and reliable testing measurements because there are millions of fabrics that are affected by applications and construction. Drape for example changes depending on the size of the material and construction so it's difficult to say what the measurement and behaviour will be if you don't first know how the fabric will be used. When you

really want to show the customer how the fabric looks, Bastiaans says, you need very specific information on how its use: e.g. a textile changes greatly if it is belted or not.

“Customers of the system will not have the drive to measure their own fabrics, and why should they?” Bastiaans says. “They already know how their fabric behaves.” According to him it sounds a bit like “Fabricpedia (taken from Wikipedia).” At the very least, he adds, what is needed is conditioned fabrics and controlled instruments with a controlled environment. There is no standard yet, so he thinks it will be necessary to have one body that can handle textile prerequisites and controlled measuring.

With a list of at least 100 textiles, Bastiaans said he would be interested in sharing the datasets of these textiles with the database.

3.8 How can the fashion industry and the education system assist each other?

Within the fashion industry there is a large relationship between educational institutes and fashion-related companies. As this research and development project begins from an educational context and seeks to engage industry players, what are the ways these two sides can assist each other?

One of the major ways the education system can assist companies, the interviewees said, is in providing interns. These interns contribute significantly to the company ecosystem and give the company awareness of changes in the educational field of fashion. These interns are also often quite computer literate, an importance as many companies use various software in their design workflows.

Paul O’Neill of **Levi’s Vintage** thinks another way education systems can contribute to companies is preparing students with more knowledge about fabrics: how they’re constructed, their different properties, how to wash garments and how this changes the fabric, and how to do different things to fabrics to give them a better finish.

Sluiter of **Nike** being one of their 3D Leads, thinks the education system can contribute by building students, and thus provide interns and future employees that know how to look at and understand 3D, and how to work with it: “They have visual awareness of 3D and understand how to look at it and its relation to 2D patterns and physical garments.”

Just Brands’ van der Heijden shares this thought, that a place where education can help the industry is training students in new kinds of technology so that they can bring these new perspectives and skills to companies. In this way they’d be able to illustrate for companies what’s coming down the pipeline of technological application.

For **Eder** of **Adidas**, it is important that educational programs offer innovativeness and 3D learning to students, and try to engage more student interest in this realm. It’s

helpful for Adidas that universities are trying to stay at the cutting-edge of technology, providing interns and young designers who can really design in 3D.

Another place the education system can contribute to companies is through trying to remain open: “What I really prefer is that universities really try to stay open. I’ve seen a number of universities stick with a particular software vendor because of commitments, but if the vendor doesn’t offer updates or particular applications then they are stuck or can’t do certain kinds of research or investigate certain issues because the software doesn’t offer it.” For Eder, universities would ideally offer a variety of tools to their students so they can learn from and choose the best for what they need to do. It’s important, she says “to stay open in terms of the future and being open to innovation and change, and also open in terms of universities trying to stay as open as possible to what the developments in the markets are.”

In terms of the ways companies can assist education, a number of items were repeated across the interviewees: they can give lectures and presentations at educational institutes and conferences, bring students in for workshops to demonstrate what the companies are doing; contribute time like assisting in research and offering feedback and direction, and of course, provide internships that really allow students to participate in the business to develop skills, knowledge and products.

In terms of collaborating in research, **Sluiter of Nike** said there is possible collaboration with projects, but of course needs to know what would be asked of them. For example, sharing information is something they could do. For Eder of Adidas, in terms of contributing to the current research she doesn’t know what Adidas could do. Adidas is currently trying to figure out what direction to go in, in terms of their fabric topics and know there are a variety of universities also looking into this. She would need a realistic timeframe and an idea of what the research collaboration would offer Adidas.

For **Bastiaans** of textile printer **Print Unlimited**, an agreement of the contribution of fabric samples to the project for testing has already been made. He is also open to sharing textile measurements.

4. Conclusions

The interviews conducted with fashion industry practitioners about AMFI-HVA’ s research and development project has revealed a number of crucial ideas and insights to be considered in the realisation of the project. Deterrents and requisites to using such a system, as well as positive affects of 3D technology and technology needs and wants have been identified.

List of deterrents to implementing and using a 3D system

Design software and usability:

- Time and monetary investment to implement a new digital system. Would disrupt business and require steep learning curve and workflow transformation.
- 3D design software is too complicated to use. These are also often too technical and very pattern-based, being geared more toward garment technicians than designers.
- Software interfaces are often unappealing and thus not enticing for designers to use.
- Programs that require too long a time to make or render changes lose designers interest.
- Not convinced that virtual fit would be as good as doing it by hand.
- Fabrics used within the industry change all the time so how can such a database cater to many different companies and also stay consistently up-to-date.

Presentation:

- Presentation of 3D prototypes do not look good enough to use as a sales or marketing tool.

Requisites and main business questions for use of 3D technology and database

- What is the value to the business? Will it create more sales and brand awareness (consumer and B2B)?
- Will it be efficient and useful for designer's productivity and pleasant for them to use?
- Where will such a database save the company money?
- Do customers (consumers and B2B) want a service that includes 3D presentation? Will this lead to customer satisfaction and interest?

How 3D has positively affected companies

- The use of 3D designs/prototypes improves reliability of communication between various parties involved in design decisions and production (between designers, producers and sales and marketing). 3D design also provides one central source where all design changes can be made.
- Increased speed of communication and production development between designers and factory as physical prototypes do not need to be made and communication is more accurate.
- Quicker time to market through cutting down sales samples.
- Cutting costs by reducing the number of physical prototypes made and number of prototypes that need to be shipped.
- Reducing environmental impact by reducing prototype production and shipping of physical prototypes.

Needs and wants for 3D design software, textile database and presentation

Fabric:

- Technical imaging should include a close high-resolution image of the fabric and also as it appears modelled on the avatar as a 3D visualisation, as well as a specular map, bump

map and an alpha map. These should be captured in a consistent and standardized fashion.

- Realistic and well-done virtual representations of fabrics.
- An application that would illustrate how the texture and weave or knit of a textile would affect the look of a pattern.
- For textile measurement consistency and standardization are key. In terms of consistency and time investment it would be ideal if there was an automated process that would capture the required fabric images in a standardized way that would work correctly with all software packages throughout the industry.

Design software and usability:

- Interface should look simple and easy to use.
- Be able to make things the right scale.
- Speed is crucial for designer use. What is wanted is as good and as quick as possible real-time rendering. 100% accuracy is often not needed by designers as they're used to working in systems with little accuracy, like Illustrator.
- True colour representation.

Presentation:

- Improved dynamic 3D models. Aesthetics need to vastly supersede the way video game avatars look and behave now.

Evidenced in the interviews it is clear that the project has a lot of potential, but there are challenges that need to be addressed as articulated in the list of perceived deterrents and requisites above.

It is clear that companies currently using 3D applications or thinking about the use of 3D applications see the most possibility and productivity in using virtual samples as communication tools: for both internal communication between departments and as external communication tools for B2B sales with retail clients. Adidas will soon be rolling out their 3D design software so will be interesting in the coming year to see how the design department has adapted to this.

The perceived main usefulness of 3D for communication instead of the design could be the current case as most garments are still created in 2D as sketches by designers, then patterns and prototypes are made off-site by garment technicians in factories/production facilities. As designs are made as sketches in 2D with pattern making outsourced, perhaps it's hard to envision how one could use software that combines design and pattern making?

Time, cost of hardware and other monetary investments are a perceived deterrent by companies currently not using 3D. Yet as can be seen by the companies interviewed who do work with 3D virtual prototyping, money and time has been saved through 3D digital garments as internal communication and external presentation tools, cutting

down on time to market and on the production of physical prototypes and shipping. There is of course starting funds, a learning curve and period of implementation required, but the companies currently using 3D virtual prototyping have found it both cost and environmentally efficient.

Moving from working in 2D to 3D is a large step that demands a new way of considering not only an entire workflow but an overall design process that requires a different kind of knowledge and different way of looking at one's design work. While there have been some challenges expressed in adapting such a digital textile database from both companies already using 3D and those not, it is evident that the project has great potential with each company interested in keeping up-to-date on the future digital ecology of fashion design. With eyes looking forwards, this project of AMFI-HVA is working towards building this future, to assist both students and industry practitioners in the advancement of their creativity and success as the industry moves towards a more digitally-practiced design ecosystem.

APPENDIX I: INTERVIEW QUESTIONS

Interview Questions: Questions for interviewees who have knowledge/make use of 3D 3D Design Applications and Digital Textile Database for 3D Prototyping in Fashion Design

- 1) What kind software or technology are you currently using for design? 2D, 3D?
 - What is your design workflow?
 - Do you use some kind 2D CAD programmes in designing e.g. Photoshop and Illustrator?
 - Do you use a pattern design application?

- 2) What kind of software or technology are you using for design presentations right now? 2D, 3D?

- 3) Are you familiar with the software of Lectra, Gerber or others?

4) What are you looking for in terms of a design software package? (3D important for them?)

- What are you missing in the technology you are using right now?
- What would you like a design software to do?

4b) If using 3D: How has using 3D technology affected your company?

- Has it changed the workflow and how?
- Is there a specialized person for 3D tech?
- Technical designer for 3D?
- Require different kinds of educated staff?
- Expenses and output?

5) Do you feel sufficiently informed about what the current possibilities are in terms of 3D technology/modelling for fashion design?

6) Please look over this list of 3D textile parameters/properties [*See List Attached*]

- Do you have a list of properties that you use already, or do you need a list supplied to you?
- Are there any missing parameters? Or there things that don't seem important?
- What key words do you feel are required in the list of textile parameters and properties for you to select the right kind of fabrics you're looking for?

7) How would you use such a 3D fabric simulation database?

- In what part of your design process or workflow could you see yourself using it?

8) What would be the benefits, or how would you benefit, from using a database that offers 3D simulations of fabrics?

9) In terms of using a 3D design system, what is most important to you and your designer peers?

- reliable avatar?
- fit?
- drape representation?
- good presentation of the design?
- assess fit – grading of garment on avatars in several sizes

10) What is your opinion of 3D representations of fabrics and in what way would you consider using such representations in your work process now?

11) What would you require to start using such a system? E.g. physical materials (like a swatch book) combined with digital materials.

- How would you like to have such a technology offered?

-Does it make sense to have a physical swatch book that is connected to the entries of digital fabrics in the digital database with clear zoom images and information about the fabric?

12) What conditions at your place of work are necessary for you to start working with 3D design software? (e.g. interest from all employees, new computers, time to learn etc.)

-And/or are you prepared or interested to start using such a system?

- How much money would you invest in such a system?

13) Would you be interested in using such a virtually simulated textile database?

- In what way would you like to use the software?

- In which processes of your work or points in the workflow?

14) What do you see as some of the drawbacks and benefits of

- implementing such a system?

- using such a system?

15a) It will be very likely that companies will have to test fabrics which are not (yet) available in the database. Would you prefer to measure the properties yourself or should fabric suppliers/manufacturers or an independent body, university?

If not yourself:

-Should there be a place where fashion houses send their fabrics to get properties measured?

If yourself:

-How much money would you like to spend for reliable test instruments?

-How much time would you like to spend on fabric testing?

15b) Would you share the datasets gathered from testing your fabrics with the database for other companies to have access to?

16) Would you be interested in receiving further information or training from a programme of educators about the possibilities of 3D applications for fashion design?

17) What can the education system do to assist you? E.g. educate more students and in a particular way or about particular topics?

18) What are the ways you'd be willing to assist education: internship, research, sponsoring, money, fabric samples, time?

-Partner in research projects with financial or expertise contribution?

Interview Questions: *Questions for interviewees who have little knowledge of 3D and make little use of digital applications*

3D Design Applications and Digital Textile Database for 3D Prototyping in Fashion Design

- 1) What kind software or technology are you currently using for design? None, 2D, 3D?
 - What is your design workflow?
 - Do you use some kind 2D CAD programmes in designing E.g. Photoshop and Illustrator?
 - Do you use a pattern design application?

- 2) What kind of software or technology are you using for design presentations right now? 2D, 3D?
 - How do you communicate designs to potential buyers?

-Do you present work via computer/online?

3) Are you familiar with the software of Lectra, Gerber or others?

4) Do you feel sufficiently informed about what the current possibilities are in terms of 3D technology/modelling for fashion design?

-Why, why not?

5) Why have you chosen to not take on digital applications in the design process and workflow of your company?

-Are there things you feel are missing in terms of working digitally?

6a) What would you be looking for in terms of a design software package? (2D, 3D important for them?)

-What would you like a design software to do?

6b) In terms of using a digital design system, what would be most important to you and your designer peers? (3D)

-reliable avatar?

-fit?

-drape representation?

-good presentation of the design?

-assess fit – grading of garment on avatars in several sizes

7) Please look over this list of 3D textile parameters/properties [*See List Attached*]

-Do you have a list of textile properties that you use already?

-Are there any missing parameters? Or there things that don't seem important?

- What key words do you feel are required in the list of textile parameters and properties for you to select the right kind of fabrics you're looking for?

8) What uses could you see for a 3D fabric simulation database?

-In design workflow if you were to go digital?

9) What would be the benefits, or how would you benefit, from using a database that offers 3D simulations of fabrics?

10) What is your opinion of 2D,3D representations of fabrics?

11) What conditions at your place of work would be necessary for you to start working with 3D design software? (ie. interest from all employees, new computers, time to learn etc.)

-And/or are you prepared or interested to start using such a system?

- How much money would you invest in such a system?

12) What would you require to start using such a system? E.g. physical materials (like a swatch book) combined with digital materials.

-How would you like to have such a technology offered?

-Does it make sense to have a physical swatch book that is connected to the entries of digital fabrics in the digital database with clear zoom images and information about the fabric?

13) What do you see as some of the drawbacks and benefits of

-implementing such a 3D system?

-using such a 3D system?

14) Would you be interested in receiving further information or training from a programme of educators about the possibilities of 3D applications for fashion design?

15) What can the education system do to assist you? E.g.. educate more students and in a particular way or about particular topics?

16) What are the ways you'd be willing to assist education: internship, research, sponsoring, money, fabric samples, time?

-Partner in research projects with financial or expertise contribution?

Interview Questions: *Questions for textile manufacturers and distributors*

3D Design Applications and Digital Textile Database for 3D Prototyping in Fashion Design

1) What kind software or technology are you currently using? 2D, 3D?

-What is your workflow?

-Do you use some kind 2D CAD programmes in designing e.g. Photoshop and Illustrator?

2) What kind of software or technology are you using for textile presentations right now? 2D, 3D?

-How do you present textiles to potential buyers?

-Do you present textiles 2Dimensionally, present them in garment form, other?

3) Are you familiar with the software of Lectra, Gerber or others?

4) What are you looking for in terms of a software package? (3D presentation possibilities important for them?)

- What are you missing in the technology you are using right now?
- What would you like a software to do?

5) If using: How has using 3D technology affected your company?

- Has it changed the workflow and how?
- Is there a specialized person for 3D tech?
- Require different kinds of educated staff?
- Expenses and output?

6) Do you feel sufficiently informed about what the current possibilities are in terms of 3D technology/modelling for fashion design and textile presentation?

7a) Please look over this list of 3D textile parameters/properties:

- Do you have a list of properties that you already use?
- Are there any missing parameters? Or things that don't seem important?
- What key words do you feel are required in the list of textile parameters and properties for you to select the right kind of fabrics you would be looking for in the database?

7b) Discuss sustainable textiles and environmental benefits/waste reduction of 3D.

8) It will be very likely that companies will have to test fabrics which are not (yet) available in the database.

- As a textile manufacturer/fabric supplier do you already measure the properties yourself or would you like to?

If yourself:

- How much money would you like to spend for reliable test instruments?
- How much time would you like to spend on fabric testing?

If not yourself:

- Should fashion design companies do this? OR Should there be a place where fashion houses send their fabrics to get properties measured? Independent body, university etc?

9) Would you share the datasets gathered from testing your fabrics with an open database for other design and textile manufacturing companies to access?

10) How would you use such a 3D simulated textile database?

- Would it be useful to you?

-In what part of your work could you see it benefit?

-Internally?

-Presenting textiles to buyers?

11) What would be the benefits, or how would you benefit, from using a database that offers 3D simulations of fabrics?

12) What is your opinion of 3D representations of fabrics?

13) What do you feel would be required for designers to use such a system? E.g. physical materials (like a swatch book) combined with digital materials.

-Does it make sense to have a physical swatch book that is connected to the entries of digital fabrics in the digital database with clear zoom images and information about the fabric?

14) What conditions at your place of work are necessary for you to start working with 3D software/textile database? (e.g. interest from all employees, new computers, time to learn etc.)

-And/or are you prepared or interested to start using such a system?

- How much money would you invest in such a technology?

15) Would you be interested in using such a virtually simulated textile database?

- In what way would you like to use the software?

- In which processes of your work or points in the workflow?

16) Would you be interested in receiving further information or training from a programme of educators about the possibilities of 3D applications for fashion design?

17) What can the education system do to assist you? E.g. educate more students and in a particular way or about particular topics?

18) What are the ways you'd be willing to assist education: internship, research, sponsoring, money, fabric samples for testing and swatch books, time?

-Partner in research projects with financial or expertise contribution?

**APPENDIX II: LIST OF PROPERTIES AND PARAMETERS FOR DIGITAL TEXTILE
PROTOTYPING**

Textile Properties for Digital Prototyping

Goal

In order to bring important garment processes to a higher technological level, the clothing and textile industry calls for virtual simulations, which do not only satisfy the human eye with realistic representation of a garment, but also mimic precisely mechanical and physical characteristics of textiles

Preconditions

- Available
- Delivery time

- Supplier
- RSL
- Sustainability

Fabric input parameters:

- Fibres
- Construction of the fabric
- Construction of the yarn / yarn number
- Finishes
- Weight
- Commercial fabric name

Important physical and mechanical properties are

- Flexibility
- Compressibility
- Elasticity
- Resilience,
- Density
- Surface contour (roughness, smoothness)
- Surface friction

- Thermal attributes
- Durability (tensile strength, tearing strength and resistance to abrasion)
- Colour fastness
- Thermal insulation
- Water permeability
- Vapour permeability
- Air permeability
- Durability (tensile strength, tearing strength and resistance to abrasion)
- Form stability (elasticity): bagging, stretching, wrinkling, wrinkle recovery
- Pilling resistance
- Dimensional stability (shrinking and stretching)

- Shear
- Bending (Drape)
- Elongation: Strain-stress profile (Tensile strength and the recovery process)
- Dynamically moving

The applied physical tests analyse and reflect the sensation felt during the subjective fabric assessment.