The Future Figured:
the avatar in virtual fashion design

Introduction

Dressing and redressing a figure is a fundamental practice in the fashion designer's process. Until recently, hand renders and their corresponding technical drawings were considered sufficient methods. Today, new visualization options afforded by computer aided design software offer screen-based tools that can enhance the look and accuracy of a drawing. However, these still require a significant amount of drawing skill and garment construction knowledge – not to mention command of the software application. On the one hand, designers, despite common misconceptions are not necessarily good at drawing their ideas. On the other, 3D artists are not always apprised of the details of garment construction. This study identifies challenges including apprehension, frustration, the length of the learning curve, the disconnect from the materiality of creation by hand, and the different 'mindset' required. Indicators show that dependence on skilled specialists may increase, including collaborations with 3D artists. New specialist service industries may arise in the fashion landscape of the future – and indeed this transformation has already commenced.

The design process

The designer often initiates the creation of a new garment by sketching ideas free hand or on a flat figure template with pencil and paper. Further in the process, the designer drapes a sewn fabric sample of the prototype over a dressmaker's mannequin. The garment is scrutinized from every angle, considering fabric properties and its relation to the body's form. Fit adjustments may take place or entire construction lines might be altered – triggering renewed pattern cutting, assembly and refitting of another sample. After initial testing on a mannequin, the garment is tested for movement and function on a live house fit-model. The fit-model is a person who has the anthropomorphic characteristics, measurements, height and weight that align in body type to the brand's target customer. Body type specifications are meticulously accrued over time by the brand and form a fundamental part of the firm's intellectual property (IP), effectively adding to its competitive advantage. This process is iterated until the final look is achieved to the satisfaction of the creator and the production team.

Design ideas are communicated through visualization. It is important to distinguish the different types of visualizations required in the production of a garment. Firstly, the designer sketches several quick

and schematic thumbnail roughs – to visually think though an idea. A more resolved design is rendered as a flat technical drawing – showing all construction details. The purpose of the technical visual is to show the patternmaker the intended concept and construction. This tech drawing may be adjusted and rendered in greater detail after the sample is made for use in production communication – to show the manufacturer the intended final product. Additionally, a fashion illustration on a posed figure, can be drawn up. This artistic visualization allows for stylistic licence and even inaccuracies or missing details. Although requiring a high degree of proficiency, and unlike its importance in the past, the fashion illustrator's work is rarely used for production, and therefore not a highly sought after skill in the fashion industry today. Rather, this artistic visualization is used to convey a concept or mood - usually to merchandisers or buyers. Fashion illustrations are often rendered by specialist illustrators that are not necessarily designers. It is not usual or even necessary for the designer to be a good 'artist' if they can collaborate with specialist illustrators.

Emerging from the world of gaming and visual effects (VFX), the development of highly sophisticated rendering software has led to the rise of the 3D artist. Usually not one, but a number of software programs are used in combination by the 3D artist for Virtual Design (VD) outcomes. The VD image is a more accurate, photorealistic representation of garment design for use in the production as well as promotion of fashion, sometimes augmented with animation. This study argues that despite the sophistication of new software capabilities, the 'regular' fashion designer is neither necessarily equipped nor productive in this task. Rather the software provides an additional visualization option and therefore an additional role – combining the style of the 2D fashion illustrator with the conceptualization capabilities of the designer as well as the specifications supplied by the garment technician. Additionally, VD augments the work of the technical designer – communicating production information more accurately, thus increasing fashion production efficiencies.

Sampling

The fashion designer's vision is transformed into a physical three-dimensional garment prototype with the assistance of the pattern cutter and sample maker. Sampling is an inherently time-consuming practice. High costs have led to sampling sent offshore. Notwithstanding the cheaper wages, the process is still inefficient with many long-distance discussions and the dispatch of physical garments back and forth. This has led in some cases to reshoring the sampling process to save time as well as regain creative control. In the light of emerging digital innovations, the conventional sampling process is becoming a luxury many fashion producers cannot or will not afford. Brands are looking more closely at 3D prototyping and virtual design to replace or at least reduce the physical sampling process. Given the climate for better sustainable practice, coupled with economic pressures, the capabilities of virtual prototyping that mitigates risks and costs, is increasingly gaining attention.

Virtual design

Virtual design takes the visualisation process from the pen and paper sketch to the screen. Computer aided design (CAD) has already been developed for flat, two-dimensional (2D) visualisation software through applications such as Illustrator and Photoshop. Hardware changes, such as stylus, tablet and touch screen, simulate the hand sketching of a garment – on screen. Increasingly, the large-scale fashion production sector is integrating new digital tools. For example, with over 650 brands using its programs, the opensource Browzwear platform offers a number of product development options such as Lotta, V-Stitcher and Stylezone and integrates another 35 tech solutions including Blender, StyleCad, Swatchbook, RenderStreet, Figure Forms and Meshcapade. Beyond these present capabilities, in the future, virtual reality (VR) versions are likely to offer the designer the possibility to be in the same 'space' as the design and enable draping by 'touching' and moving the virtual garment. The implementation of VR applications such as Google Tilt Brush, Poly, Oculus Rift, Gravity Sketch, and haptic feedback are already being applied in the engineering sector, industrial design and automotive industry. For example the Sansar platform supports virtual reality headsets (Oculus Rift, Vive and Value Index) and offers avatars with motion-driven body animations. In further developments, according to neuro scientists Sun and Parsons, neuroscience will bring design concepts from thought to screen and/or the virtual reality space .

Avatars

Fashion design requires the arrangement of pliable textiles over the polymorphic human figure. The gaming industries' development of character figures, avatars, has proven useful for the fashion design sector. Avatars are representations of figures with particular characteristics. Where 3D artists create characters for games, fashion designers need representations of their brand's standard fit model using their house specifications. Avatars can originate from two sources – either a generic modelled figure or a scanned actual figure. Companies such as mPort can scan real bodies using booths similar to airport security scanners. Handheld device applications are another option in development. Start-ups such as Puctto, Instituto de Biomecanica de Valencia (IBV) and Size Stream offer body scanning capabilities using smart phones. Notwithstanding the applications currently available in the ecommerce retail space, software for the design professional has developed to a level of sophistication whereby the designer can be in complete control of the model size and visualization of their idea.

Computer Aided Design Applications

Understanding the principles of flat pattern cutting is an important part of the fashion designer's training. Designers can use computer aided design (CAD) flat-pattern software offered by pattern development firms Lectra and Gerber, as well as by software providers, Adobe Illustrator, StyleCaD,

and Optitex to develop flat patterns directly on screens. This capability has led to several emerging business models and services such as Besopikify – which offers digital, customizable garment pattern libraries. If the pattern is to be visualized in a 3D simulation, proficiency in flat pattern cutting software is important because CAD patterns form part of the assets required by the 3D software to create the next step – that is, the garment's simulation on the avatar. Several layers of visualization – fabrication, fit, silhouette, fabric performance, colour, tension, ease, light reflection, fabric handle, trims, overall appeal and aesthetics can then be evaluated on the draped virtual figure. Clothing design programs that offer 3D visualisation capabilities include CLO3D, DAZ3D and Marvelous Designer. Browzwear can synchronise pattern cutting files created in Photoshop and Illustrator. Programs like iClone, Blender and Tuk3D by Tukatech, simulate sculpted shapes and fabric performance showing fluidity and particle properties, lighting effects and 360º views in a 3D turntable on screen. Other current software applications include Romans CAD for the footwear industry, Fusion 360 for 3D printing, Maya by Autodesk, Substance Designer by Adobe and ZBrush by Pixologic for advanced texturing and lighting effects. Reproducing garment appearance when the body moves is a further competency enabled by motion capture software, offering simulation rather than mere visualization. Unreal Engine shows physics and display animations from manual and motion capture processes. The 3D imagery serves several stakeholders within the industry providing accurate visuals of the prototype for designers, pattern makers, garment technologists and sample hands, factory production (which includes fabric selection, cutting, machine settings etc), buyers, merchandisers, wholesalers and retailers. Importantly this highly accurate, visually documented information also underpins IP as well as contractual agreements for fashion enterprises.

Virtual presentation and marketing

Virtual design software has also led to virtual presentation capabilities – such as virtual runways and virtual clothing ecommerce platforms. Digital games (for example, World of Warcraft, Fortnight, and The Sims) have been developing and selling skins (clothing, accessories and customizations for avatars) for some time. Amsterdam based virtual fashion design platform, The Fabricant created and sold its first virtual garment in 2019 for US$9000. This has led to an emerging market of virtual clothing ecommerce beyond gaming skins. The 'garments' are marketed to influencers who constantly need new content (that is, to be seen is a new garment in every post) – pointing to sustainability benefits because there are no wasted products.

In the fashion promotion field, 'Metahumans' by Unreal Engine offers out-of-the-box avatars as well as customisable figures that the designer can import into clothing design programs. The development of avatars has reached a degree where it is possible to contract virtual models, for instance from The Diigitals - a world first virtual modelling agency. Virtual runways and virtual showrooms add to the

suite of applications available for fashion promotion, for example, Balmain's 2018 collection dotted with virtual models, or South African fashion designer Anifa Mvuemba's 2020 runway experiment (with no models – only moving garments) and Gucci's collaboration with Roblox. The gradual decline of the Fashion Week circuit – the increase in seasonal cycles and the outcry for more sustainable practices have conflated (and been accelerated by the pandemic) to arrive at this next step in the production, presentation and promotion of fashion: the virtual garment on the virtual model on a virtual runway or in a virtual showroom – sometimes even resulting in sales of virtual garments.

The design/visualisation relationship

Observations by fashion studies scholar Louise Crewe and fashion academic and editor Joanne Eicher suggest that the virtual design process distances the hand from the mind. Textile designer and researcher Anna Piper adds that designers still compare and identify analogue and digital design as two types of practice. Analyses by human geographers and psychologists Banfield and Burgess found the relationship between artist, tools, and artwork as well as the physical activity varies between artists who work in two and three dimensions. Where 2D artists appreciate and find value in their creative process, 3D artists derive enjoyment from the product of their artistic activity, and do not attribute artistic control to the artwork. This begins to explain the reticence fashion designers have towards using virtual design tools. Visual culture scholar Anneke Smelik notes that provision should be made for textuality when examining the digital transformation of the design process. This may be explained by what architect and academic Juhani Pallasmaa calls an 'embodied tactile journey', where knowledge, making and materials are combined with a haptic experience to enable the final outcome. While Pallasmaa sees computer drawings as lacking soul, designer/researcher Rachel Philpott suggests a hybrid form of production, combining handmade and digital processes. Balancing automation and precision with individuality and creativity would result in higher quality outcomes. In the past, professor of architecture and author, Malcolm McCulloch suggested that computer aided design and manufacture may not necessarily speed up the process – but could slow it down, when incorporating the increased design options. Nonetheless, designer, weaver and futurist Holly McQuillan suggests 2D patterns are more effectively conveyed to others when visualized in 3D. According to research director Jane Harris, digital innovations are no longer seen as aids to designers, but rather as forces that are altering design practise altogether. Piper takes a step away from a linear approach in which the analogue precedes the digital as a means of design conceptualization, by using an alternative 'transitional methodology' to challenge the limitations of the two modes of production while exploiting their advantages. But to work effectively in a hybrid mode, McQuillan advises resources that enable the switch between modes of work are required. Relatedly, the dislocation between hand and eyes will become even more extreme – perhaps untenable - in the virtual reality (VR) space. This is because when working in VR, the user wears a headset which effectively cuts off their vision from their hands/body. Arguably, VD offers new

ways of working, thinking and communicating, resulting in a shift of the fashion visualisation process. However, few enquiries have been undertaken into the experience of designers that can proficiently undertake all of the tasks required with VD software.

Method

Contextual research of software applications, webinars and instructional videos were initially undertaken to inform subsequent empirical data collection. Participant-centred, open ended interviews with designers, 3D artists, retailers and software developers were then undertaken to collect data, analyse findings and inductively arrive at implications. Twelve participants with varying degrees of proficiency in VD were interviewed locally and internationally in late 2020 to early 2021. Participants were asked about the anticipated length of their learning curve; if they felt it restricted or enhanced their work, to what extent they 'hybridised' work, and how they see the future for fashion design. Participants are anonymised but their roles are identified as per the table below:

ID	Participant Role
1.	Student fashion designer
2.	3D artist/fashion designer
3.	Animator and games designer
4.	Animation film director
5.	Student fashion designer
6.	Higher Education Fashion design educator
7.	Higher Education Fashion design educator
8.	Technical and Further Education Fashion educator
9.	Student fashion designer
10.	Animator and character designer
11.	3D Artist
12.	Animator and games designer

The interviews were open coded to identify the core themes arising from the investigation based on emerging response patterns. Themes arose across skills development in the visualisation process, learning curve, mindset, collaborations and digital transformation of the fashion design process.

Results

The study found that challenges experienced by individual designers include apprehension, frustration, the length of the learning curve, the disconnect from the materiality of creation by hand, the lack of touch and feel and the different 'mindset' required. Of those practitioners with a willingness and curiosity to embrace new technology the study found that learning took place in short sprints, and that

they were motivated by attempting to achieve a new visual effect and learning one new technique at a time. The study did not find conclusive evidence that designers work in both the physical and the digital simultaneously as suggested by the 'hybrid' theorists cited above. Practitioners tend to remain within their designated 'workrooms'. This is because the degree of skill (and equipment) required in these areas is highly specialized and requires a certain mindset or degree of concentration. Nonetheless, the study also finds that new occupations, and/or services and/or cross-disciplinary collaborations are emerging. The new roles are located between designer and 3D modelling artist – that require partial knowledge in one area but expertise in another. Alternatively, the technology gives rise to a new role – that is the 3D fashion artist/designer. That said, only around 10% of design and or animation professionals are likely to be interested in taking on the challenge of becoming a 3D fashion designer according to Participant #4. The technology will likely create new business models, serving those that do not have the resources to invest but wish to take advantage of its capabilities. For example, 3DRobe offer a group of services from simple to complex and customisable visuals, as does Tmtechpacks. Upskilling in a specialization could serve designers' careers well as changes to production methods and business service models evolve in the fashion industry. Finally, cross-disciplinary communication and collaboration between fashion designers and animators is also evident.

The learning curve difficulty has been acknowledged by some software developers. For example, computer scientists Rong Yang and Burkhard Wuensche found a half page of information on the tools of the software were enough to get users started on their application. Although they found its functionality intuitive, some users had trouble selecting the required rotation axes and angles for animating 3D artefacts. 'People forget that they're looking at a 3D image on a 2D screen and therefore get confused' (Participant #10). Developers Chen Mao, Sheng Feng Qin, and David Wright also recognized the lack of computer skills and developed a similar program creating a graphical pipeline called 'Stick Figure Fleshing-out Skin Mapping' which breaks down the difficulty of figure drawing and improves modelling and animation performance significantly. But this points to another problem – somewhat unrelated to using drawing software – and that is the ability to draw per se. This reinforces the need to have prior skills and knowledge in the more traditional fashion design skills – before successfully embarking on design visualization using computer aided design.

Although VD promises to provide fashion firms with greater efficiencies economically and environmentally – the costs of 3D modelling are considerable. Participant #4 is very clear that at around USD2M per minute in the feature film industry, 3D artefacts are very costly to produce. Economic considerations for the fashion designer constitute the program subscriptions, the hardware – including high end gaming computers, large format drawing tablets/screens with stylus, internet speed, memory, cloud storage and significant energy use. Participant #2 says: 'Unreal Engine needs a lot of CPU (central processing unit) and I can't run more than one software at a time. It will take about 30 minutes to render

a garment'. Although Participant #10 adds that specialist marker pens and paper are also cost intensive, Participant #4 says: 'you can see the expenses going up dramatically; even if you use a drag and drop kind of level you are still using all this software and technology that's expensive - it's not like pen and paper!'

Discussion

Although the literature suggests that designers can work in a 'hybrid' mode, alternating between analogue and digital tools, the results here indicate that designers favour one method over another and will specialize in their preferred area. This is because a significant amount of investment is required not only in upskilling but designer aptitude, mindset, motivation and dedication. The findings indicate that the designer's usual workflow of drawing, pattern making, adjusting and redesigning is not necessarily aligned with the VD workflow. Indeed, fashion and sustainability scholar and artist Timo Rissanen suggests about 8 workflow variations from sketch to pattern to sample from existing garment to pattern to alteration to sample and so on. The steps can move from 2D-3D-2D (sketch-sample-pattern) or just 2D-3D (pattern to sample). Unlike physical methods such as pen and paper and indeed physical fabric draping, digital tools do not offer the same feel or interaction between artefact and designer. Digital tools should be seen as a complement to, rather than a substitute for, the analogue tools currently in use. This analysis also identified the key reasons for the reticent adoption of 3D virtual design software by fashion designers. The main points are lack of information on the software available, failure to choose the most appropriate tool for the task, the costs in training, time to learn, and the ability to create assets. Asset development platforms include textiles simulators and flat pattern cutting software. Therefore, knowledge of not just one, but a suite of tools is required. Finally, although most designers accept DIY learning through instructional videos, the resources are not organized in a manner that builds skills logically and incrementally. These results extend the current literature by removing the blanket opinion that adopting new technology is an imperative, and that learning VD skills is easy for 'digital natives' (as represented by the student designers). It dispels the notion that 'you push a button, and the character starts performing' (Participant #4, #10) and presents some of the challenges encountered by designers. Nonetheless, Participant #6 was persistent despite setbacks and motivated because the result 'looks cool'. This reflects computer scientist Stuart Dreyfus' theory on the invested practitioner, becoming emotionally devoted in the task and their own development.

A few limitations of the study must be kept in mind. The technology is relatively new (for fashion applications) and there are few empirical studies in this area due to its limited adoption. Furthermore, as the designer is concerned with ideas rather than garment construction – although the software can combine all of these processes - the person using the software may not have strengths in all areas such as pattern cutting or technical specification. This means that if the desired effect is not being achieved

in the garment (visual simulation) the designer may not necessarily know how to adjust the (digital) pattern to make it work (Participant #6). The designer would still have to consult the pattern cutter to resolve an issue – at this point the pattern cutter would theoretically also have to be proficient in the software – and one could feasibly see a collaboration online where both specialists work together on the same garment. Effectively this brings us back to the original configuration of designer, pattern cutter and sample hand working together – whereby the sample hand may have somewhat fewer iterations to sew, and the 3D artist creates interim virtual prototypes to facilitate quick decision making and save time and costs as well as improve simulation of the prototype.

Conclusion

This study ascertained the current use of digital fashion avatars and the virtual design process as well as the implications for the fashion designer, that is, which skills the fashion designer will need to develop for the future. Despite the availability of highly sophisticated VD programs, it is unlikely that the 'regular' fashion designer will be required to achieve a high level of competency in 3D modelling skills as a necessary part of their job. However, the designer should have an understanding of the assets and details required by the 3D artist to be able to collaborate efficiently. Rather, it is likely that the 3D fashion designer will arise as a specialist position within large-scale firms or that this job will be outsourced. Indeed, the transformation to specialist VD enabled skills has already commenced with services available for computer generated pattern making, plotting, cutting and grading services - affordable and cost effective even for small scale firms. In most cases, an intermediary position for this task called the Technical Artist who knows both code and art and can facilitate communication between the two groups is emerging. The implication for educators and learners is that they will need knowledge of the assets requirements, best practice work flow and logic behind 3D visualisation programs – as well as the interrelationship of the program types and their capabilities. 'In the long run all these digital tools are merely implements…the magic lies with the artist and not the software' (Participant #3). It is foreseeable that the technology will give rise to a new occupation: the virtual fashion designer.

References

Crewe, Louise, and Joanne B. Eicher. 2017. *The Geographies of Fashion : Consumption, Space, and Value*. London, UNITED KINGDOM: Bloomsbury Publishing Plc.

Dreyfus, Stuart E. 2004. "The five-stage model of adult skill acquisition." *Bulletin of science, technology & society* 24 (3):177-181.

Harris, Jane. 2012. "Digital practice in material hands: How craft and computing practices are advancing digital aesthetic and conceptual methods." *Craft Research* 3 (1):91-112.

Mao, Chen, Sheng Feng Qin, and David Wright. 2007. "Sketch-based virtual human modelling and animation." International Symposium on Smart Graphics.

McCullough, Malcolm. 1998. *Abstracting craft: The practiced digital hand*: MIT press.

McQuillan, Holly. 2020. "Digital 3D design as a tool for augmenting zero-waste fashion design practice." *International Journal of Fashion Design, Technology and Education* 13 (1):89-100.
Pallasmaa, Juhani. 2009. *The thinking hand: Existential and embodied wisdom in architecture*: Wiley Chichester.
Philpott, Rachel. 2012. "Crafting innovation: The intersection of craft and technology in the production of contemporary textiles." *craft Research* 3 (1):53-74.
Piper, Anna. 2019. "Material relationships: the textile and the garment, the maker and the machine. Developing a composite pattern weaving system." Nottingham Trent University.
Rissanen, Timo. 2007. "Types of fashion design and patternmaking practice." *Nordes* (2).
Smelik, Anneke. 2018. "New materialism: A theoretical framework for fashion in the age of technological innovation." *International Journal of Fashion Studies* 5 (1):33-54.
Sun, Lushan, and Jean Parsons. 2017. "Design Cognition in 3D Modeling Wearable Product: Exploring Challenges and Transitions for Apparel Designers." International Textile and Apparel Association Annual Conference Proceedings.
Yang, Rong, and Burkhard C Wünsche. 2010. "Life-sketch: a framework for sketch-based modelling and animation of 3D objects." Proceedings of the Eleventh Australasian Conference on User Interface-Volume 106.