

Haptic acts of making:

A surface imaging design practice using digital and virtual tools.

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Introduction

This paper introduces a project that uses Motion Capture (mo-cap), 3D modelling and visualisation tools to design morphing dresses and surfaces, to speculate on a future where dress could become a digital canvas. The project seeks to extend the researcher's tacit knowledge of surface design and material knowledge through experimental modes of practice and the use of digital tools and technologies.

The discussion provides an overview of a process that emerged from reimagining textile and fashion surfaces with digital and three-dimensional (3D) methods. This process integrates transference from physical to digital design, incorporating the researcher's fashion perspective. In particular key insights are drawn from the comparisons of material knowledge across different states. In fashion design practice, the 'hand of the cloth' with its various material properties of weight, structure, fabrication, texture, drape and stretch, etc. dictates design possibilities. In this project the fashion researcher considers the 'hand of the digital' and what the aesthetic implications may be from engaging with the material properties of the digital itself.

Examining the design process in depth, the research utilises a hybrid methodology from the merging of physical and haptic approaches with digital materials. Outlining one specific design development process that is central to this remediated methodology, this paper addresses how a particular aesthetic emerged through recursive material engagement with physical, virtual and digital interfaces.

Approach

The project foregrounds the potential of knowledge gained through integrating new technologies and digital media with speculative acts of making and traditional textile techniques. Offering a practitioner's perspective contributes to a growing movement of fashion researchers addressing the definition of a particular fashion methodology and approach (Eckert and Stacey 2001; Bye 2010; Finn 2014).

Angela Finn (2014) describes 'practitioner research' as 'research that utilises creative practice as the main method of inquiry' (Angela Finn 2014: 13) and operates as a foundation for emergent fashion practices that engage with making, with an emphasis on creative practice that utilises tacit knowledge. This project explores the development of a practitioner's research made explicit through documentation of process and a discussion of methods. By speculating on fashion futures in particular, this research engages with a questioning of current fashion norms of production, and a disruption of the designer's tacit knowledge of traditional surface design techniques with new material knowledge gained through experimental use of 3D tools. The speculative framing of this project has a synergistic relationship to developing and engaging with possible futures through making, in a type of relationship described as developing discourse as 'surfaces in textual matter' (Krippendorff 2005).

It is intended that this speculative project offers insight into approach for emergent practitioner research in fashion, and contribute to the discourse on media practices and aesthetics from a different disciplinary perspective. The methods used in this project interrogate ways that cloth and surface can be re-imagined through the intersection of making in a digital or virtual 3D realm. Visualisation tools such as Motion Capture and 3D modelling are employed to investigate material structure and cloth dynamics in a virtual space, and combined with digital textile design techniques to produce innovative surfaces. This approach investigates how digital imaging techniques and digital culture might inform the design of future fashion and fabrication concepts.

Key Concepts - Remediation and Hacking

Combining fashion and textile perspectives with digital making emphasises remediation methods more commonly associated with digital media production. Glitches, mash-ups and cut 'n' paste methods are inherent to digital processes and images and define this approach as a remediation process, whereby new media is made from collaging, morphing and layering forms of the old. Bolter and Gromala argue that in a new media context remediation can be defined as a pivotal digital process 'making new media forms out of older ones' (Bolter and Gromala 2003: 83). Within this research, remediation as a digital process also reveals the potential of the digital for endlessly regenerated imagery and iterative idea development, with both design and process creating a palimpsest surface. Remediated digital imagery builds up a layered patina from data, process and code. This regenerative design process differs markedly from a typical fashion design process that iterates by sequential prototypes that are incrementally refined.

These methods of digital remediation influence the outcomes of making, and provide new perspective of hacking traditional views of surfaces as static. The resulting surfaces morph and shift, a result of the hybrid environment. Fashion constructs of 'dress' and notions of surface are hijacked by the approach through digital remediation and virtual hacks. Otto von Busch (2011) suggests we can understand the alchemy of fashion as a technology of code, which by hacking can be changed to intensify the technologies of the self. Through this, he suggests, fashion could be reverse engineered. This research project engages with the code of fashion through encoded virtual surfaces and digital surfaces, interrogating the potential of future fashion surfaces.

Motion Capture Environment

The starting point for this design process was data that was mapped from body movement at Auckland University of Technology's Motion Capture studio. The mo-cap environment consists of an enclosed performance space, with twenty-six infra red (IR) cameras positioned to record movement data from vantage points in a radius surrounding the performance space.

A fashion model with catwalk experience was bought in to the studio and motioned captured while walking, to record a specific range of human movement. The model wore a mo-cap suit, hat and shoe coverings, with reflective markers attached to key points on her body.

The IR cameras track only the markers, and accurately record the range of movement and map the relationships between each of the markers. This results in a recording of the markers that show the 3D form and range of motion (ROM) of the person being filmed, represented as 'points in space'. The cameras relay the motion captured directly into the mo-cap tracking software, Cortex. Designed by Motion Analysis, Cortex is software that handles all phases of motion capture within a single program - initial setup, calibration, tracking and post processing. After capturing the model's movement, the data is cleaned up in post-production to solve any problems with data 'gaps'. Figure 1 outlines the mo-cap pipeline in more detail.

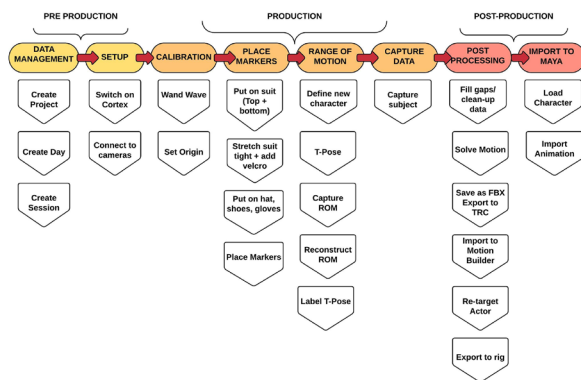


Figure 1 Motion Capture pipeline. (Smitheram 2016)

Avatar Generation

The data was then imported into MotionBuilder, a 3D character animation software where a character was rigged to form her skeletal structure. This process involves modelling or rigging a 3D animated 'body' onto the scaffolding of the recorded movement data. The motion capture data is mapped to a 3D avatar, so that the avatar performs the same actions as the fashion model. The rigged character was then imported into MAYA, a 3D animation and modelling software, and a cloth simulation tool, nCloth, was used to create the surface of the 'virtual dress'.

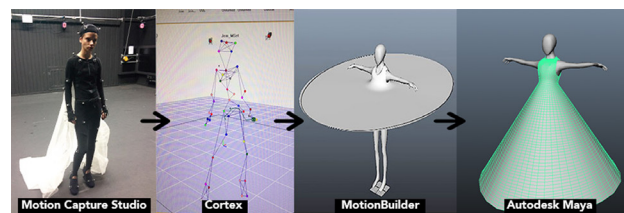


Figure 2 Diagram showing sequential stages of Motion Capture process, from fashion model to avatar, (Smitheram 2015)

The original movement data captured from the fashion model in the Motion Capture studio was then used as the base of the avatar, generating the movement and range of motion. The mo-cap data in effect drives and activates the avatar. Figure 2 describes the transfer from model in motion capture studio through to final form as avatar.

A simple animation entitled *The Liminal Dress*, 2014 (figure 3) was created featuring the avatar, wearing a dress with a morphing patterned surface.

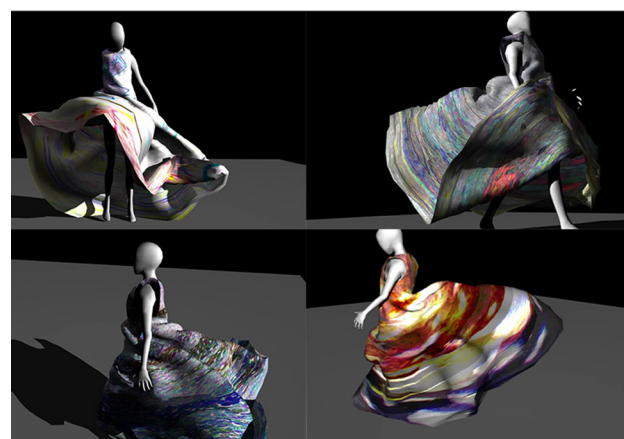


Figure 3 Stills from animation *The Liminal Dress* (2014)

The interaction of the 'actual' body (from the motion captured movement data) affected the movement of the virtual dress in an intriguing way. The model's physical motion propelled the dress and generated idiosyncratic and dynamic action as the simulated cloth responded to the 'actual' movement. The motion-captured body is invisible in the final animation, yet reveals its presence through this absence. Visually there is a sense of the 'ghost in the machine', or consciousness within the technology (Kurzweil 2005) with the fluidity of human movement apparent in the simulation.

This tension and interaction between the physical motion data and virtual surface was interesting and it was decided to explore this visual dimension further. The raw data could be reused in a different way to create a new work. In this new artwork, the design intention was to use just the physical motion and the simulated cloth, removing the mediation of the avatar. Instead of using the virtual dress as a surface to pattern, the virtual surface itself was used to generate the pattern.

Cloth Simulation

Working in MAYA, the virtual dress surface has a particular geometry, consisting of a mesh of multiple polygons connected together (as seen in Figure 4). The basic object used in mesh modelling is a vertex, a point in three-dimensional space. Two vertices connected by a straight line become an edge. These edges can be connected to make a polygon; a group of polygons that are connected by shared vertices is referred to as a mesh. In the new design process outlined here, the polygon mesh of the cloth simulation became the 'fabric', used both structurally and as the base visual design element.

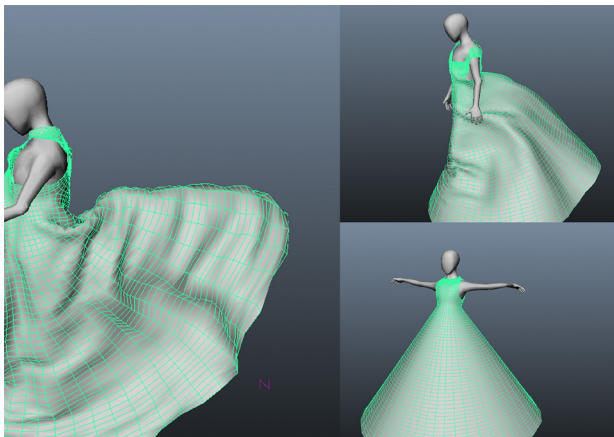


Figure 4 Screen shots of avatar with green polygon mesh in MAYA software. (Smitheram 2015)

The cloth simulation held similar possibilities to an actual fashion design process. Physical characteristics and material properties can be selected, which affect how the cloth behaves when it moves and interacts with other objects. The dynamics of the cloth were adjusted to allow it to flow and drape, giving an effect similar to a heavyweight silk crepe material. The cloth dynamics were able to be trialed rapidly, applying different values to see how the cloth responded to weight, gravity, volume, wind and density.

Certain limitations of the virtual cloth were noted: As the virtual dress is considered an object by the software, it needs to be parented to the shape of the virtual body. It lacks some of the behaviour of a physical dress, which generally hangs from the shoulders of a person, responding to the laws of gravity.

Difficulties were also faced by the complexity of the scale of the large polygon mesh required to simulate the dress, which resulted in collisions and occlusions- where the virtual cloth seemingly 'tangles'. This is common in cloth modelling as 'cloth has complex interactions; it collides with itself and rigid objects; it is driven by forces that are hard to model, including human motion and aerodynamics' (White et al. 2006: 3).

Unwrapping Polygons

The observations of the interactions and behaviour of the cloth simulation propelled by the body prompted a design process working directly with the movement of the data itself. The polygon mesh of the cloth simulation became the template for the surface design. This process began with unwrapping the polygon mesh of the dress. The polygons from the avatar's surface were extracted by unwrapping the virtual dress, then separating all layers. Effectively just capturing the geometric mesh of the surface, without the solid 3D form.

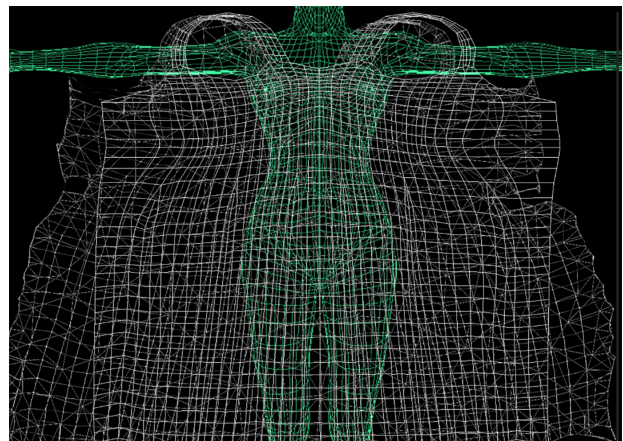


Figure 5 Unwrapping layers of polygon mesh from avatar. (Smitheram 2015)

This is commonly known as the UV mapping process, which at its simplest requires three steps: unwrapping the mesh, creating a visual texture, and applying the texture to the mesh, typically using graphics editing software like Adobe Photoshop.

In this particular design process however, the polygon mesh was used experimentally to create the visual texture. First the unwrapped polygon mesh dress files were imported into Photoshop as layers, as seen in Figure 6, and then deliberately warped and distorted to generate remediated two-dimensional (2D) images. Constructing surfaces out of surfaces. The design actions involved warping the perspective, copying, pasting, and repeating actions to create new patterns, feedback loops, distortions. By using the polygons themselves to generate pattern and surface, there was a sense of engaging with a questioning of what the material of virtual cloth really was.

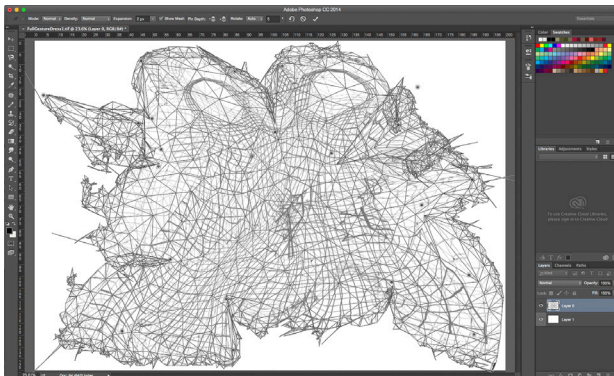


Figure 6 Polygon mesh files during remediation design process in Photoshop. (Smitheram 2015)

Mark making with Polygons and Pixels

During this phase of the process the design focus was to explore the materiality of the pixels, and the potential of the virtual surface itself to generate pattern. It was interesting to observe that when I started to pull at the pixels of the polygons, stretching vertices and degrading the data by distorting it, a surprisingly naturalistic imagery emerged. The resulting dresses had a gestural mark-making quality; by using the topographical mesh from 3D software to create 2D contour maps, the technological perfection of the digital image was disrupted. This was used as an iterative drawing process, capturing marks and movement through tracery. The pixels were approached in a fashion designerly way, treating them as if they were fabric material, by folding, draping, scrunching and crumpling the surface.

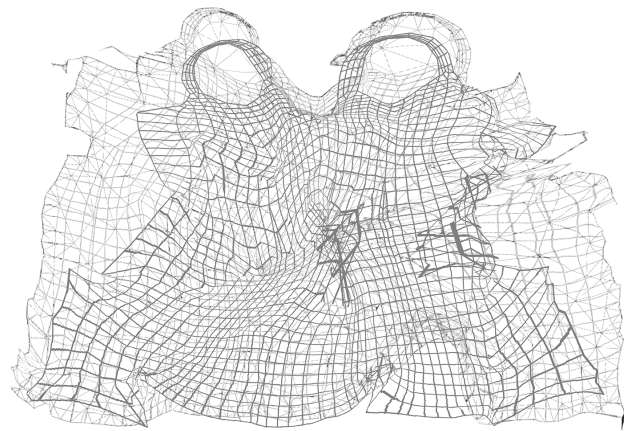


Figure 7 Screenshot of Photoshop file showing the transformation of the mesh. (Smitheram, 2015)

The reference to the body was still visible in the resulting new surfaces. The data came from mapping the body in motion capture and, through the stages of unpeeling the polygon mesh and creating new imagery, a sense of the movement of the virtual cloth and presence of the body still remained.

In other iterations such as Figure 8, visual remnants of the 3D data could be seen in the image, a perspective warped by digital processes, folded back on itself and seemingly multi-dimensional.

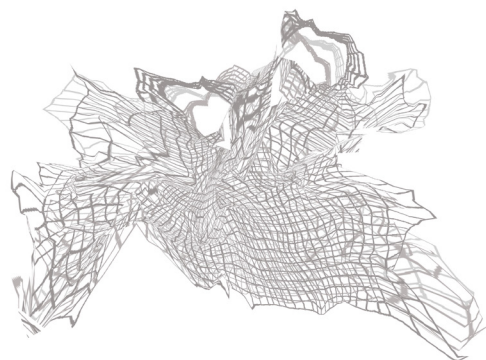


Figure 8 Screenshot of Photoshop file showing warping of 3D form. (Smitheram 2015)

3D-2D-3D

In the next stage, the new gestural, distorted and remediated images are exported from Photoshop back into the MAYA software, and become a new UV texture map. This part of the UV mapping process involves projecting the texture map back onto a 3D object, in this case the avatar and her simulated cloth dress. The letters “U” and “V” denote the axes of the 2D texture.

This altered the appearance again. The feedback loop closes as the transference completes from polygon mesh simulating the dress, to glitched remediated surface, which is finally placed back on the virtual body as a texture map. Working in MAYA, the ‘body’ of the avatar was turned off, and just the ‘virtual material’ itself could be seen, as illustrated in Figure 9. The idiosyncratic movement is still propelled by the original body mapping data collected from motion capture. In this iteration, just the cloth is activated, and the agency is co-produced. The gesture of cloth is latent, activated by another force, the auxiliary body.

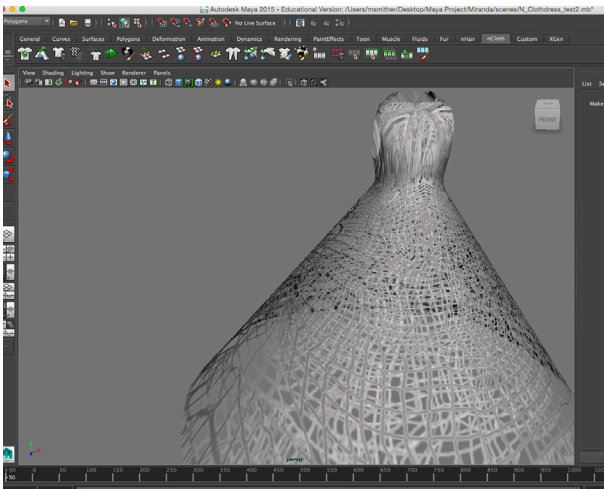


Figure 9 Screenshot of the new UV texture map in MAYA with the avatar body turned off. (Smitheram 2015)

The resulting 3D rendered animations could now be tumbled and looked at and through, whilst in motion. The transparency of the new surface altered the aesthetic. The gesture of the cloth became visible and amplified in this version (Figure 10 and Figure 11).

This animated artwork raised many questions for the research. The translation from one materiality to another, from physical data collected in motion capture to virtual simulated cloth object, resulted in a conversion, a counter-materiality. What was lost or gained in this transference? What was transformed? This design process traced the behaviour of micro movement and mapped an almost infinite malleability. There no longer seemed to be a correspondence between the material and the representation of the material.

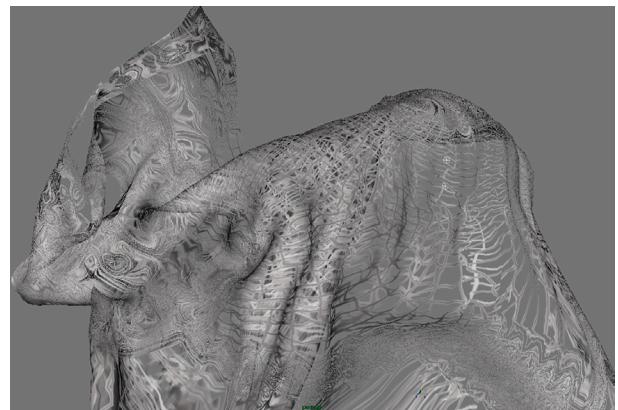


Figure 10 Still from animation showing the transparency of the new surface. (Smitheram 2015)

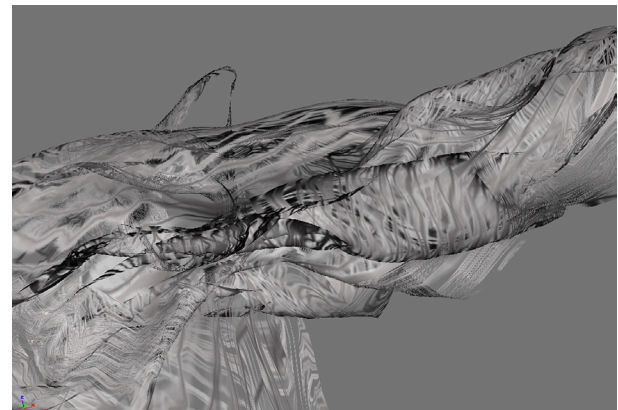


Figure 11 Still from animation showing the 3D appearance of the new surface in motion. (Smitheram 2015)

Discussion: Hand of the Fabric/Hand of the Digital

There are two definitions of the adjective haptic: meaning both a sensory relationship between optical and tactile, and also meaning the production through software of an 'illusion of real'. The haptic is a quality that is strongly indicated within the meaning of textiles, and Bryant and Pollock (2010) argue that 'this gives cloth powerful meanings of relationality' (Bryant and Pollock 2010: 145). An overarching principle of approach in fashion design is tacit knowledge that guides working with the inherent properties of a particular fabric. A stiff rigid fabric can form sculptural silhouettes, but does not drape well. A soft, fluid fabric flows around the body and lends itself to interpreting volume and drape. This tacit material knowledge underpins design decisions and determines outcomes.

Intangible and tactile measurements such as the 'hand of the fabric' in particular are used to judge the potential of a particular cloth. The hand of a fabric can be regarded as 'a tactile evaluation judged from physical stimuli of fabric mechanical properties' (Behery 2005: 4) and is often incorporated into consideration of a fabric, along with visual factors. Evolving over time, this speculative fashion research practice has engaged with digital and virtual tools, imagining a future material that incorporates both simulated (virtual) and physical (actual) properties. The hybrid design environment entwines properties from all three states of transference- physical, digital, and virtual. This has had aesthetic implications for the final project iterations.

The fashion practitioners' perspective gleaned from a haptic and tacit understanding of material knowledge gradually came to be applied also to the new digital/virtual material being worked with. Raising further questions: Can we read material properties from the 'hand of the digital'? What is visible and apparent in the material qualities and behaviours of the digital?

Comparison of properties

Within a fashion design approach, material properties play a pivotal role in determining design outcomes. This perspective on the experimental 'materials' used in this design process is summarised in the following diagram (Figure 12) identifying some key comparisons between the material properties of the simulated dress in virtual and digital space, and an actual dress in the physical realm.

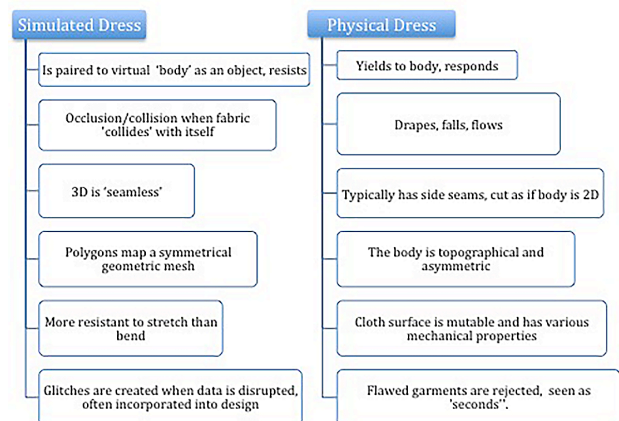


Figure 12 Diagram of Comparison of Key Material Properties. (Smitheram 2016)

Analysis

What lay somewhere in between these two modalities of digital and actual was a hybrid space, that was emphasised in this design process to remediate elements of the actual through the virtual and digital. This can be seen in the paradoxical quality of the image - unseen bodies activate the cloth (in mo-cap, model, technicians, etc.) - creating auxiliary gestures. This transliteration both loses and gains something in the transfer. Understanding and working in that particular state of a 'counter materiality' inspires this on-going research.

The constraints of technology to incorporate the less tangible qualities of materiality such as tactility as sensory information were noted during this investigation. An insight gained was the unexpected influence digital methods and the motion capture environment had on aesthetic outcomes. This has opened up another dimension of the project into the aesthetics of designing within hybrid spaces that remediate elements of the physical through the virtual and digital.

Could these differences between the actual and virtual be extrapolated and exploited rather than seeking to emulate each other, and contribute to a deeper understanding of what constitutes a 'technological materiality' (Küchler 2008). Observing whether digital materiality can be measured, how it can be altered, how it is activated, might also tell us more about the material properties of cloth itself.

Conclusion

This research project, and the particular design process outlined here foregrounds a fashion designer's approach to Motion Capture and 3D modelling that is experiential and performative as opposed to a technical or computational. Working in collaborative ways with mo-cap technicians and a digital designer was conducive to an experimental approach, by trialling interactions with material, cloth dynamics, and the relationship between the movements of cloth and the body in motion capture.

The research combines elements of tacit and haptic textile and fashion design knowledge with digital/virtual methods, resulting in emerging hybrid or mixed materiality. The influence of material knowledge, remediation of digital, and interpreting the material properties of the digital itself prompted a new methodology within the research, and provided an on-going direction of inquiry.

Through this design process, there was a shift from using digital and virtual programs as novel tools in a fashion/surface design process to foregrounding a fashion designer's perspective of material knowledge, which enabled an engagement with the material of the digital itself, exploring the cloth movement data as an aesthetic, by constructing surfaces from surface.

The developing methodology highlights differences between the actual and virtual and the constraints and potential of technology, by deliberately extrapolating and exploiting the 'hand of the digital' in the same manner as the 'hand of the fabric'.

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